

Dutchies in Texas

Engineers from Delft have designed a kind of Delta plan for Texas. The aim is to protect the inhabitants in and around Houston against floods caused by hurricanes.

A collection of flexible storm-surge barriers, double dikes and multifunctional coastal defences are covered in the book *Delft Delta Design*. This 'Delta plan' shows what can be done and aims to provide subject matter for discussion. 'We are taking the ingredients we need with us' says Prof. Bas Jonkman, Professor of Hydraulic Engineering in the faculty of Civil Engineering and Geosciences (CEG). 'It is up to them to make something nice with them.'

Vulnerable

The awful calamity of 1900 has not been forgotten. A storm surge flooded the port of Galveston, leaving it between 2 to 4 metres underwater. Around 8,000 people perished and the harbour was never the same again. On average, a hurricane hits the area once every nine years, the most recent being Ike in September 2008.

About six million people live around the Galveston Bay estuary that is about the size of the IJsselmeer. There are mudflats and sandbanks in the bay that provide a rich source of nutrients for shrimps, crabs, oysters and fish. It is an important stopping-off point for migratory birds on their route between North and South America. The nearby

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Houston harbour is home to a lot of petrochemical industry, comparable to Europoort near Rotterdam. Around the city of Texas, development tends to take the form of urban sprawl. Many incomers have little knowledge of the area's low-lying location and lack of effective dikes. Finally, on the Bolivar Peninsula, many houses are built on piles to protect against high water.

However, they have no protection against a hurricane, as Ike recently revealed.

'People have become more aware of how vulnerable the area is', says Antonia Sebastian, MSc., from Houston's Rice University who spent ten months in Delft on a Fulbright scholarship. 'It started with Katrina

that devastated New Orleans in 2005. When hurricane Rita was heading for Houston a month later, 100 people were killed in the evacuation. This led Rice University to establish the Sspeed Center (Severe Storm Prediction, Education & Evacuation from Disasters, ed.). After Ike (2008), the centre received additional funding for its activities.'

By that time, Professor William Merrell from the Texas A&M University at Galveston was already working on a plan for an Ike Dike or coastal spine. His aim was to improve the protection of the coast and islands around Galveston Bay and prevent a storm surge from the Gulf of Mexico. His plans were the equivalent of a Delta Works for Texas.

Texans

This is why, starting in 2011, two separate groups of Texans visited TU Delft. Staff from the Sspeed Center visited Professor Han Meyer in Architecture and the Built Environment. Meyer is one of the chairs of the Delft Infrastructures & Mobility Initiative (Dimi). He was also involved as an urban designer in transforming New Orleans after Katrina.

At CEG, Professor in Hydraulic Engineering Bas Jonkman welcomed colleagues from the Texas A & M University who were eager to find out more about the Delta Works and navigational surge barriers. Based in Galveston, the A&M researchers were more interested in a primary line of defence against the Gulf of Mexico than in local protection for Houston and its industry.

'Two years ago, A&M and Rice were in two different camps', recalls Sebastian. 'A&M wanted a coastal spine, but the Sspeed people were more interested in how they could combine the dikes and dams in and around Houston into a single defence system.'

It did not take long before efforts on the Texas project at TU Delft were linked together. The design studio Delta Interventions (led by Han Meyer) began working with final-year students in hydraulic engineering and researchers at TPM.

The book has fifty authors, including five doctoral candidates, 23 final-year students and senior researchers from both Delft and Texas. Although awareness of the vulnerability to flooding may have increased, work has yet to start, since no funding is available. Most of the research



Aerial view of the residential community of Gilchrist after hurricane Ike. (Photo: Jocelyn Augustino/FEMA)

conducted so far has also been unpaid, and is thanks to all the final-year students, occasionally supported by a trip, a business internship, etc. Sebastian believes that the cultural differences between Texans and the Dutch play a role. 'The Dutch avoid risks and have great trust in the government. In Texas, the opposite applies: people hate the government and prefer to look after themselves.' But the realisation that major hydraulic engineering work is based on solidarity is only slowly sinking in.

There is also the golden rule of hydraulic engineering: the money only

comes after a flood. That was also the case with Katrina (18 billion dollars invested) and after Sandy had flooded New York and New Jersey (12 billion dollars spent on measures). Ike was the exception, but it still caused 25 billion dollars' worth of damage. The demise of Goldman Sachs ten days after the hurricane seized all of the media's attention and Ike was quickly forgotten.

*Download the book *Delft Delta Design* from the Delft repository: bit.ly/ddd-rapport or request a paper copy from b.l.m.kothuis@tudelft.nl*

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1 Closing the Bolivar Roads will not end the danger to Houston completely. The Galveston Bay estuary is so large that a hurricane can also cause dangerously high waters. This is why a navigational surge barrier is also planned in the Houston Ship Channel. This will be a 350-metre long steel wall that will be rolled out from the dock on the left on a rail to reach the other side. The design by ir. Martijn Schlepers (Civil Engineering) protrudes as far as 11 metres above the water as a result of upward pressure in the canal. The movable dam wall will primarily protect the harbour area and the petrochemical industry around it.

2 The oyster reefs are part of the natural structures that play a role in hydraulic engineering, supplementing dikes and coastal defences. The reconstruction of the reefs is an example of building with nature, as nature is used to reduce the risk of flooding. But the graduation project by civil engineer Robert de Boer reveals that the oyster reefs have a limited effect only. To use oyster beds to break the waves, they need to be placed close to the banks and high above the water, rather than at the centre of the Bay as here. However, depositing sand to build an archipelago of artificial islands would help.

3 The plan for the Bolivar Peninsula involves a 43-km long dike across the centre. The early draft designs are based on a dike-in-the-dunes concept integrated as far as possible into the environment. With a height of 5.8 metres above the average sea level, the dike can protect against a storm surge the likes of which happen every hundred years and will not overflow. The dike will offer no immediate protection to residents on the Gulf side, although it will keep



the route on the Bay side of the peninsula free for evacuation. A side issue is the fact that residents often refuse to evacuate because they cannot imagine the effects of a hurricane. This means that there will need to be education for coastal residents as well as dike construction.

4 An unusual storm-surge barrier is planned for the narrow strait Bolivar Roads between Galveston Island and Bolivar Peninsula. The movable gate on it will be a floating steel or lightweight concrete caisson measuring 220 x 36 x 22 m (LxHxW). The concrete version of this colossus will weigh more than 70,000 tonnes and hang from the new pier. When open, the caisson will withdraw into the pier and the Houston Ship Channel will be accessible to ships up to 220 metres in width. If a hurricane is approaching, the caisson will turn 90 degrees and close off access to the Bay. Once in place, the caisson will be partially submerged: the concrete container will continue to float and protrude 5.5 metres above sea-level to withstand even the highest waves.

5 At the San Luis Pass, a storm-surge barrier has been fitted with a lift gate to enable smaller ships to enter. Larger ships travelling to and from Houston harbour pass through the barrier at Bolivar Roads (yellow). According to the graduation project by Maarten Ruijs (Civil Engineering, 2011), the partial closure of the San Luis Pass has only a limited effect on the current and water levels in Galveston Bay.