Flood Risk Mitigation for the Jamaica Bay Area

Project Jamaica Bay: Summary

As part of the MSc curriculum of Hydraulic Engineering (Faculty of Civil Engineering) at Delft University of Technology, five students visited New York City and researched flood risk mitigation for the Jamaica Bay Area. The study took place from September to December 2013. This document is the summary of the report. For more information please contact info@projectjamaicabay.com.

Introduction
Project Jamaica Bay is a response to superstorm Sandy, occurring in October, 2012. The storm was a disaster for New York City, causing around 50 billion US dollars of damage. Research shows that 75% of the expected annual damage in New York occurs around the Jamaica Bay area. Another problem that has been going on for several decades is the disappearance of marsh islands. Due to human interference and effects of climate change, the bay area has been altered in such a way that the sustainability of the marshes is in dispute. This research combines the two problems and gives a comprehensive overview of measures that can be taken to improve both flood risk mitigation and the sustainability of marsh islands. The report focuses on an open Jamaica Bay. This means that scenarios in which a hydraulic barrier is implemented in the inlet are not researched. The study gives an answer to the question which perimeter measures could be implemented to improve flood protection for the Jamaica Bay area. Furthermore, it elaborates on the best way to improve marsh islands within Jamaica Bay and to what extent these islands have an effect on incoming storm surges.

Area Analysis
The Jamaica Bay area is characterized by a dense residential area, an estuarine ecosystem and several key infrastructure assets. The bay is surrounded by Brooklyn and South Queens, New York’s two boroughs with the highest population. The boroughs are vulnerable to flooding, and current sea level rise projections exacerbate this danger. The area lacks a comprehensive system of coastal protection measures. In addition, uncontrolled structural erosion is to be found. The waters and wetlands of the bay serve as breeding grounds and are a critical migratory stopover for a surprising diversity of birds. The bay is also of great importance to a great variety of butterflies, visiting seals, sea turtles and other species. Furthermore, the area needs to be shared with one of North America’s most important air transportation hubs, namely, John F. Kennedy International Airport. In 2012 JFK handled almost 50 million passengers. The area is also host to several infrastructure assets, which greater parts of the city rely on, e.g., land and water routes and water pollution control plants.

Boundary Conditions
The system of measures is designed for a storm with a return period of 100 years. This is according to the policy currently implemented in the USA. The governing water conditions during such a storm for the Jamaica Bay area have been subtracted from FEMA Preliminary Work Maps. For the Atlantic side of Rockaway Peninsula the governing storm surge level is 5.18 m and the governing wave height is 3.35 m. Within Jamaica Bay these values are respectively 4.27 m and 2.8 m. The design lifetime for the measures is 50 years, which means that the measures to be implemented still have to prevent flooding due to a 1/100 year storm in 2065. Sea Level Rise has been approximated to be 0.65 m in 2065 with the use of the most recent IPCC report.

Perimeter Measures
When looking at the safety of the Jamaica Bay area as a whole, it should be noted that the same boundary conditions should be used for all of the measures. Also, the measures should be connected in a way that guarantees the safety of the hinterland. The area analysis shows that there is a variable amount of space to implement a coastal protection measure throughout the Atlantic side of the peninsula. Therefore, because of its size, a dune alone would not suffice. Both the energy impact of the storm and the hydraulic level is taken into account. However, it is possible to combine safety, aesthetics and ecology to protect this area. Also, when the bay side of the Rockaway Peninsula is taken into account, the area analysis shows several different situations. It is found that there is a limited amount of space available for measures. Therefore, raising Beach Channel Drive is one of the pro-
posed measures in this particular area. The proposed solutions integrate multiple functions or take up a small amount of space, e.g. flood walls. When looking at further perimeter measures, the report also accounts for solutions for JFK Airport. The boundary conditions show that within a one mile radius no bird habitat can be constructed. Furthermore, because pilots need a clear vision of the runway, no measures can be applied that permanently reach above ground level. Therefore, temporary measures like self-closing flood barriers are proposed. The Jamaica Bay area encompasses a lot of infrastructure which disrupts the continuation of the shorelines. Hence, there are a couple of exceptions when looking at perimeter flood protection measures. The report briefly gives possible solutions for all of the exceptions within the area. The different creeks are elaborated on as well as Floyd Bennett Field and Broad Channel. For each of these exceptions, different options of protection are given and sketches are made on how they would look like. It can be concluded that it is possible to secure the whole perimeter of the Jamaica Bay area to protect the inland form flooding during 1/100 year storm surges.

**Living Shorelines**

A part of the research is analyzing the effectiveness of vegetation on wave height reduction. Reduction in wave height enables a reduced levee height. Also a hardened revetment would not be required resulting in a more ecological solution. From this research can be concluded that vegetation suffices in reducing wave height. The stems of the applied vegetation (i.e. Spartina Alterniflora) are modeled as vertical rigid cylinders, based on an article of Menendez and Lodosa (2004). Due to the drag between the cylinders and the current velocity induced by the waves, the wave height is reduced. An important parameter is the vegetation density. The research states that a steeper living shorelines slope leads to a lower mean water depth. The lower water depth results in a larger wave dissipation. For the Canarsie Pier area the reduction of vegetation based on the current slope is 40% and the reduction for a steep slope is 75%. However, it should be noted that constructing a steep slope requires a lot of landfill and, therefore, is an expensive activity. Therefore, another approach is advised for the Howard Beach area. For this area the current shoreline slope will suffice in reducing wave energy. At Howard Beach the large available space results in a wave reduction of 75% over 350 m.

**Storm Surge Control for Jamaica Bay**

Aside from perimeter measures, the influence of dimensions of the bay are researched. Shallowing is preferred regarding flood risk mitigation. The results show that shallowing the inlet and/or the channels in the inner-bay can contribute significantly regarding the expected storm surge level in the bay. Shallowing the inlet results in the highest storm surge reduction. On the other hand, restoration of wetlands hardly shows any influence on the surge. However, wetlands can have a positive effect on wave height reduction.

**Sustainability of Jamaica Bay**

Looking at the sustainability and ecology of wetlands in Jamaica Bay, several remarks and design directions can be formulated. In the last century the area has shown dynamic features. To address the exhaustiveness of the area, the study area is analyzed with an equilibrium theory for the outer delta, basin and inlet. The approach complies with measures and changes in the bay, which have occurred in the past. Therefore, it is advised to apply a system approach for restoration of the bay, instead of the current strategy of local measures. In practice this means that wetlands can be created in a more efficient way, by carefully thinking about their placement. Also the study shows that many channels are deeper than needed, eventually, shallowing these channels can have a positive effect regarding sustainability. In conclusion, restoration of marsh islands improves ecology and could improve sustainability.

**Delft3D**

Delft3D is used to evaluate the results of the storm surge mitigation and the sustainability of the system. A high resolution, small scale model with a high resolution (70m) curvilinear grid is forced at the boundaries by Sandy conditions to simulate a ‘1/100 year storm’. Results from the model calculations are discussed.

**Results**

The three most important conclusions of this study are given below:

- It is advised to implement a system approach
- Restoration of marsh islands improves ecology and could improve sustainability but hardly affects flood risk mitigation
- Shallowing the channels is preferred regarding both flood risk mitigation and sustainability

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