Royal HaskoningDHV
Enhancing Society Together

client | US Army Corps of Engineers (USACE)

"Royal HaskoningDHV has brought in depth engineering, hydraulic and modelling expertise to this project. Their international experience has added a new dimension to our thinking. They have become known for their innovative approach. Some ideas that at first seemed strange have turned out to make sense after all."

Bob Turner, Regional Director of the South Louisiana Flood Protection Authority

New Orleans: closing the floodgates

Greater New Orleans is home to 1.2 million people. Located between the Gulf Coast, the Mississippi and a large inland lake, almost half of its territory lies below sea level. Every year hurricanes build up in the Gulf of Mexico and sweep inland, often causing devastation and flooding. The Mississippi river is also prone to flooding. The city's flood defences are on a vast scale, comprising 350 miles of levees and barriers, but their weaknesses were exposed when Hurricane Katrina struck in August 2005.

Katrina was a slow moving storm with massive amounts of rainfall and an unexpectedly severe storm surge in the Gulf of Mexico. Multiple breaches of the levees and floodwall defences resulted in the flooding of some 80 per cent of the city. The floodwaters penetrated up to six miles inland, caused over 1,000 deaths and destroyed or severely damaged over 200,000 homes and businesses. More than 800,000 people fled the area.

In 2006, Royal HaskoningDHV was commissioned to advise the United States Army Corps of Engineers (USACE) on the redesign and rebuilding of the entire Hurricane Storm and Damage Risk Reduction System. Since then they have provided expertise in hydraulic modelling and design, flood forecasting, GIS-based mapping and risk management.

Tasks have included establishing baseline data, analysing flood defence performance, and developing and applying innovative modelling and data management tools. An American company, Haskoning Inc., was set up with a New Orleans office staffed by experts from the Netherlands and the UK.

The client's overall objective was to provide a "100 year level of protection", or more accurately to protect the flood prone areas against all except the worst 'one per cent' of hurricane events. This apparently simple definition raises some interesting questions, not least what this means in practice and what happens when one of the worst 'one per cent' hurricanes actually occurs.

Mathijs van Ledden explains: "The Federal Emergency Management Agency (FEMA) guidance said that the levee height should be one foot above the height of the 'one per cent' wave, the extra foot being added to allow for uncertainty in the design variables. However this approach did not take account of different levels of uncertainty and degrees of risk. For example, if two locations had the same expected wave height for a given storm, but the forecast for one location was more uncertain for the other, it would make sense to provide additional cover for the risks at the second location.

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"We constructed a probabilistic design methodology to allow for this in the design of the system, taking knowledge that was already in existence and applying it to have a practical impact. This approach was new to the USA and is now included in an engineering technical letter from USACE on how to cope with uncertainty in design. This creates a new state-of-the-art that others can follow in future."

It is essential to make the system more resilient so that when the 100 year storm occurs the damage will be minimised. Royal HaskoningDHV's Ries Kluskens describes the ongoing efforts to strengthen the levee walls by additional support known as 'armouring':

"One of the problems exposed by Katrina was that the back slopes of the levees were eroded away, especially where they were made of weaker materials like soil.

Another source of weakness was at transition points between different structures and types of material, for example at rail or road crossings. We looked in detail at these areas of weakness and designed structures to support and strengthen them. As a result these structures will be resilient against storm events that are far more severe than the authorized 100 year standard."

The designs have also been planned so that most overflows of water occur in areas that can cope with them. The client's original projections required the height of the defences in the vulnerable "storm surge" area to the East of the city to be raised to a specified level, but Royal HaskoningDHV identified that some water could safely be allowed to overtop the flood wall because it would be dissipated in the wide Inner Harbor without causing damage to residents or structures. This idea stood up to detailed analysis and was implemented, saving time, and releasing hundreds of millions of dollars for use elsewhere in the project.

The marshlands of the Louisiana coast act as a natural barrier against the sea but have been eroded over time, mainly due to human activity. Royal HaskoningDHV advised on how to rebuild and strengthen the marshlands, both as a flood defence and from a wider environmental perspective. Advanced hydraulic modelling confirmed the possibility of diverting part of the Mississippi river to move more sediment into the area and effectively create a new delta, again making the overall defences more resilient.

Royal HaskoningDHV also helped to improve the operational processes surrounding the use of the flood defence structures. Royal HaskoningDHV's Resident Director, Maartje Wise, elaborates: "Five days before a storm a lot of decisions have to be made. People may need to be evacuated and emergency services deployed in the right locations. More than 300 floodgates need to be left open, or closed at the appropriate time. Closing them is not necessarily simple or without consequences, because they may close off access to streets or transport links and prevent the movement of emergency vehicles.

"Royal HaskoningDHV has helped to develop a Levee Information Management System that brings together all the information the decision makers need onto a high level dashboard, with the ability to drill down to detailed technical information for each section of levee. The system has worked well in tests and people have been trained to use it."

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Another innovative operational tool is the hurricane surge atlas. Royal HaskoningDHV's Tim Burgess explains:" USACE had already modelled the potential outcomes of some 300 different types of hurricane, based on variables such as the speed, direction, air pressure and size of the hurricane, using a military Cray supercomputer to handle the high volumes of data.

"We made the data accessible electronically, on-line, and even with a paper copy for use in an emergency such as a power cut. Government scientists can now identify which of the storms in the atlas the current hurricane most resembles, and immediately obtain a detailed assessment of the impact across the Southern states from Mississippi to Texas. The big advantage of the Atlas is that it allows for a very quick initial estimate of maximum surge levels, which enables immediate action to be taken in the areas most likely to be affected."

The Hurricane Surge Atlas was first used during hurricanes Gustav and Ike and proved very valuable, in some cases providing better estimates of the maximum water levels than the live model results from the weather forecasting systems.

The work done by Royal HaskoningDHV has enabled a better designed, more resilient and more operable system to be handed over, helping to reduce the risks faced by current and future residents of New Orleans.

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