CASE STUDY 6:

Flood Risk Reduction in the Netherlands: The "Room for the River" project

The problem

Four major European rivers run into the North Sea through the Dutch delta making almost 60% of the country vulnerable to large-scale flooding[1]. Major flood defence work was undertaken throughout the previous centuries, including the construction of thousands of kilometres of dikes. However, as the Netherlands' population and assets have continued to grow, the land they inhabit beyond the protective dikes has subsided.

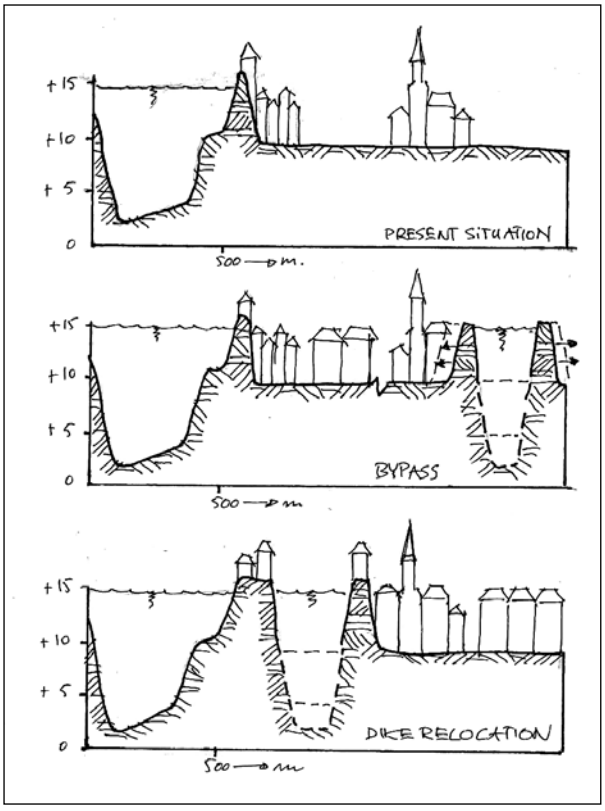

Figure 1: Options for increasing river flow at Nijmegen. The top drawing represents the current situation. The middle drawing shows a bypass channel with 8m-high dikes, excavated down or not, creating a "mini polder". The bottom drawing shows a 200m backward dike relocation creating a side channel in the river around an island of former dike, this channel may be excavated or not. *Source: van Alphen, 2003*[2].

"January 1995: Europe has been savaged by rainstorms for days. The water level in the Dutch rivers begins to rise rapidly. The risk of dike breaches becomes greater and greater and could result in flooding for miles across the flat Netherlands. A total of 250,000 people are evacuated."[3]

Near floods such as the one in January 1995 highlighted the pressing need to re-think how the rivers could be contained now and in the future. In the Dutch city of Nijmegen, plans for a large riverside urban development, combined with expected river level rises, required a 'now or never' decision on flood prevention[4].

The science

The Dutch Government used engineering science to undertake the 'Resilience Study', modelling the likely effect of flood risk reduction measures along the course of the Rhine and its branches[5].

Experts considered extreme river discharges into the Rhine and how this might increase due to climate change. They factored in sedimentation rates on river beds and scientific understanding of how water flows through channels and around obstacles[6]. They could then create computer models to predict how different interventions might help protect against flooding, now and in the future. These included floodplain lowering, temporary storage of water, removal of obstacles like ferry ramps, channel deepening, backward dike relocations and creation of bypass channels at narrow points in the river[7].

The application to policy and practice

The city of Nijmegen straddles the Waal River – the largest branch of the Rhine – at a point where the river makes a large bend and rapidly narrows, creating a bottleneck. The expected increase in extreme river discharge, due to climate change, could result in river levels rising by 80cm at Nijmegen in the coming decades. In addition, a proposal was recently made to build 12,000 new houses behind the protective dike on the north side of the river. If allowed, this development would reduce options for improving flood defences now and in the future.

1 Dutch Ministry of Infrastructure and the Environment. Delta Programme 2013. Working on the Delta.The Hague: Ando, 2012.
2 van Alphen J, Alberts J, Kors A. Dig or Dike? Resilience of the Dutch River Rhine System in view of increased discharges: strategy, measures and first examples. ISDB 2003, Niigata, Japan, 7th-10th December 2003.
3 Nijssen P, Schouten M. Dutch national Room for the River project: Integrated approach for river safety and urban development.1st IS.Rivers conference, 26-28 June 2012, Lyon, France.
4 van Alphen J, Alberts J, Kors A. Dig or Dike? Resilience of the Dutch River Rhine System in view of increased discharges: strategy, measures and first examples. ISDB 2003, Niigata, Japan, 7th-10th December 2003.
5 *Ibid.*
6 *Ibid.*
7 *Ibid.*

The knowledge and principles employed in the 'Resilience Study' were therefore used to evaluate the specific options available that would protect Nijmegen from the predicted river level rises and the likely flood risk. The options included deepening the river bed in the bend itself, lowering downstream floodplains, digging a new bypass channel to carry water in times of flooding, and inland relocation of the current dike to widen the river channel (Figure 1)[8, 9].

Local government officials and engineering experts assessed these options in consultation with communities, taking account of the social and economic needs of local communities and each option's potential for improving the environmental quality of the area[10].

The decision was taken to relocate a stretch of the dike at the river bend, moving it 350 metres inland. Detaching the old stretch of dike from the new dike layout and flooding the area in between the two will create a new side channel in the river, providing extra river flow capacity. The one kilometre stretch of former dike will become an island in the river, to be developed with new housing and nature reserves and connected by a new bridge (Figure 2). The channel will be developed for water recreation, with urban waterfront development at points along the new dike.

Did it make a difference?

At Nijmegen, the threat of river flooding has been turned into an opportunity to create a whole new waterfront and an urban island in the River Waal. This was a difficult decision to make as relocation of the dike will result in the demolition of fifty houses and a number of businesses[11]; however this was seen as the best, safest and most future-proof option to protect Nijmegen from floods now and in the future.

The plans have received international recognition for combining flood safety construction with close community involvement (International Waterfront Award, 2011) and for communication strategy (Red Dot Public Space Award, 2011)[12].

Figure 2: The 'Room for the River' plan at Nijmegen. The green line indicates the current line of the protective dike. The red line shows the position of the proposed relocated portion of dike. In the bottom image, the new river channel is shown in blue and the new island in yellow/green. The white arrows represent the bridge connections planned for the island.
Source: Nijssen and Schouten, 2012[13].

8 *Ibid.*
9 van Alphen JSLJ. How to eliminate a hydraulic bottleneck: Nijmegen the first example in the Netherlands. Proceedings of the Second International Symposium on Flood Defence 2002. New York: Science Press, 2002, pp.651-658.
10 van Alphen J, Alberts J, Kors A. Dig or Dike? Resilience of the Dutch River Rhine System in view of increased discharges: strategy, measures and first examples. ISDB 2003, Niigata, Japan, 7th-10th December 2003.
11 Nijssen P, Schouten M. Dutch national Room for the River project: Integrated approach for river safety and urban development.1st IS.Rivers conference, 26-28 June 2012, Lyon, France.
12 *Ibid.*
13 *Ibid.*