Multifunctional flood defenses
Technical design problem or policy challenge?

Vrijling, J.K.

Publication date
2017

Document Version
Final published version

Published in
Integral Design of Multifunctional Flood Defenses

Citation (APA)
Vrijling, J. K. (2017). Multifunctional flood defenses: Technical design problem or policy challenge? In B. Kothuis, & M. Kok (Eds.), *Integral Design of Multifunctional Flood Defenses: Multidisciplinary Approaches and Examples* (pp. 56-57). Delft University Publishers.

Han Vrijling

MULTIFUNCTIONAL FLOOD DEFENSES: TECHNICAL DESIGN PROBLEM OR POLICY CHALLENGE?

REFLECTION

Prof.drs.ir. J.K. Vrijling is emeritus professor of hydraulic engineering at TU Delft University of Technology, faculty of Civil Engineering & Geosciences and director of Horvat & Partners. He was one of the founders of the STW-Multifunctional Flood Defenses research program, and a promotor in the project 'Safety and reliability assessment of MFFD's'.

Over the ages delta areas have greatly benefitted their inhabitants. They generally provide fertile soils, rich fishing grounds and easy water transport, which facilitates trade. These natural resources stimulated population growth and made deltas densely populated areas. The threat of flooding by storm surges at sea or high discharges from the rivers has never driven the inhabitants to higher and safer grounds. They accepted the recurrent disasters as inevitable, or they started to defend themselves and their properties by building on existing hills or by building artificial mounds or even dikes. We can see this in the occurrence of the Dutch words for mounds and dikes in the names of old cities and streets, like 'hil', '-warden', or '-terp', and '-dijk' or '-dam'.

The combination of delta life and relatively costly flood protection proved very successful. Not only have delta cities survived to the present day, many are also the richest parts of their respective country. This wealth means they are well positioned to cope with the challenges of the future that are common to all: population growth, exploitation of resources, pollution, soil subsidence, and sea level rise perhaps intensified by climate change.

In the eyes of engineers, such challenges can be overcome by technical solutions, which may be so successful, that they further stimulate and enrich city life. Examples are sewers and drinking water supply, which greatly improved public health; but also underground metro systems - first built in London in the 19th century - which facilitated city transport unbelievably. These underground technologies were the first to show the way to the 'multiple use' of space, which is necessary to keep cities pleasant to live in and economically successful.

History has also shown that flood protection is economically beneficial, not withstanding its cost. The slow recovery of New Orleans after Hurricane Katrina provides empirical evidence to support this theoretical analysis (Dupuits, 2017).

Ever higher and safer flood defenses have to be built in ever denser cityscapes or in ever scarcer nature reserves. This dilemma has to be solved by the 'multiple use' of space. This means that flood defense functions have to be integrated with functions like living, parking, recreation, transport, or amenities.

From a strictly hydraulic engineering standpoint, integrating multiple functions in a flood defense is less difficult than designing a storm surge barrier in an open estuary, because of the smaller scale, the less exposed situation and the better-known subsoil. However, if the intention is to apply multifunctional flood defenses more widely, it might be wise to clarify and standardize the design approach. A comprehensive effort to categorize the elements that are required in a proper flood defense has been made by Voorendt (2017). His overview helps to check if the function 'flood defense' is safely implemented in the multifunctional structure, and provides a basis for the probabilistic evaluation of the probability of flooding as required by law. A similar multifunctional approach can be applied to dikes situated behind environmentally valuable salt marshes (Van Loon-Steensma, 2014), although in this case the attention is shifted from the dike itself to the wave-reducing properties of the marsh.

As shown above, introducing multifunctionality seems rather simple when judged through the lens of a single scientific discipline like risk optimization, hydraulic engineering, traffic engineering, or nature conservancy. However, in real cases the difficulties mount because in real life each function is connected to a special interest group, and the structure has to fulfill all the different functions in order to gain the support of all the interest groups. Moreover, each interest group is governed by its own set of laws and regulations, each of which follows a distinct path through institutions like city government, water board, planning authority and, last but not least, the ministry which provides funding. The planning, design, construction and commissioning of the multifunctional structure can follow only one path to completion, with the planning requiring the most time.

To discover, analyze and attempt to solve this real life problem, the specific structure of this research program was chosen (Figure 1). Horizontally, the mono-disciplinary studies are sketched, but vertically the real case studies show that all requirements have to be met for the project to come to life. It is typically the task of the civil engineer to combine all aspects simultaneously to create a solution in a single design. And although this design is usually technically quite feasible, in practice various interests seem to create problems, leading to the

Figure 1 (below). Structure of the MFFD Research Program.

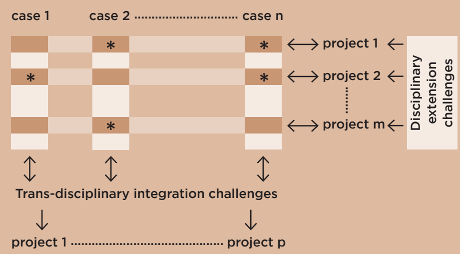
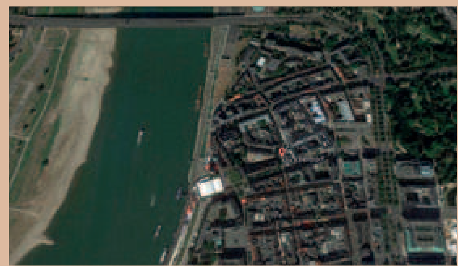


Figure 2 (below). Parking garage in dune Katwijk (Courtesy RWS beeldbank, Maarten van Rijn).

Figures 3 & 4. (below below). Urban flood defense construction along Rhine river, Dusseldorf, Germany; including car traffic tunnel and multi-functional promenade (Image courtesy Google Earth).



choice of less efficient solutions. The case study in Katwijk (see Figure 2, and Voorendt page 24-25 and Anvarifar page 90-93) shows one aspect of the problem. From a technical point of view, the two functions 'flood defense' and 'parking' can be combined most efficiently and without compromising safety by combining them into one single diaphragm wall, which may never be pierced for other functions. However, policy requirements prohibited this simple and cheap solution. This forced the designer to propose two separate walls, one for each function. In the course of the study, the real reasons that this seemingly simple problem was not solved could not be identified.

Another example of a less efficient solution is the design of the Dakpark (Roof Park), an attractive shopping mall that looks like a dike (see Program Case pp. 166-183). Technically speaking, this kind of structure could also function as a sea defense, but in fact the actual dike was built in front, and then both structures were covered by a park. Apparently, the gain of saving space by combining functions could not be made.

Less efficient solutions seem to be chosen due to the specific planning paths through the various institutions, which are often governed by different regulations. Combining all the functions efficiently would often extend the completion date of a project too far in the future. The requirements of the shortest or the politically preferred time path can thus lead to the abandonment of the optimal multifunctional project. This problem needs attention, and all the concerned parties need to communicate openly in order to provide society with the solutions it needs to attain the highest level of welfare.