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Case Study: Vlissingen
Conceptualizing flexibility

Anvarifar, F.

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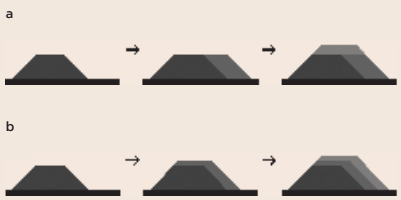
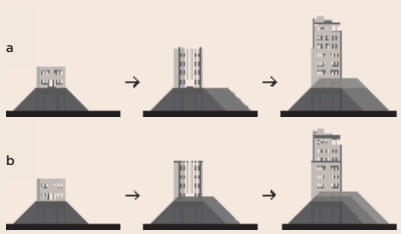
Figure 1 (below left). Two possibilities for enabling the option to delay the dike reinforcement interventions.

Figure 2 (right). Two possibilities for increasing flexibility in the design of a combined structure of a sea dike and residential buildings.

Figure 3. (below below). Vlissingen multifunctional boulevard. (Image by municipality of Vlissingen)





Fatema (Flora) Anvarifar

CASE STUDY: VLISSINGEN

CONCEPTUALIZING FLEXIBILITY

Vlissingen, situated along the Western Scheldt, in the province of Zeeland, has buildings and a promenade built onto the sea dike. For this case, the framework explained on page 87, was used to discuss flexibility of the sea dike to deal with uncertain sea level rise. Accordingly, two options for increasing the flexibility of the dike are proposed (Figure 1). In both options, some extra land is reserved for the staged reinforcement of the dike. Both options increase flexibility by enabling the postponement of dike reinforcement until more is known about the extent of sea level changes.

Next, the framework is used to discuss flexibility for the buildings. The aim is to handle uncertainty about the demand for housing. It is proposed that constructing the buildings on stronger foundations (Figure 2), will make it possible to develop more housing in the future if the demand increases.

Finally, the framework was applied to discuss flexibility for a multifunctional flood defense when the sea dike and the buildings are combined. When the two structures are combined to become a multifunctional flood defense, the embedded flexibility in each structure can reduce the flexibility of the other structures. For example, the need for a stronger building foundation will require a different dike design, one which can carry the extra load caused by the weight of the raised buildings in the future. The need for a stronger dike requires more initial investment in dike construction. Hence, increasing the flexibility of the secondary function can actually reduce the flexibility to delay the dike reinforcement interventions.

In contrast, it can be seen that when the framework is used to address uncertainty of the whole multifunctional flood defense integrally, the design of one structure can actually increase the design flexibility for the other structure. For example, in the situation described above, if the buildings are built to be flood proof, they can contribute to flood protection. In this way (Figure 3), a lower dike can be built. Therefore, the extra safety provided by the secondary function can increase the flexibility of the dike since the dike reinforcement can be postponed even longer.

From this case study, we conclude that increasing the flexibility of multifunctional flood defenses cannot be effectively achieved if the flexibility required for each function of a multifunctional flood defense is determined in isolation from the other structure.

In this case study we have found that the framework provides a useful way to structure the discussion of flexibility for multifunctional flood defenses. This is particularly important for the designers and managers of the flood defense since the framework provides a common ground, which allows specialists from different disciplines to communicate about uncertainty and flexibility. The framework's clearly defined and consistent terms provide a common ground for discussing uncertainty and flexibility among the stakeholders involved in the design and management of multifunctional flood defenses. Additionally, the framework makes it possible to identify the areas of flexibility that need more attention and discussion. Using the framework, the challenge of increasing flexibility while combining functions becomes tractable.

The text on pages 86-89 of this volume is an adapted version of a journal article that extensively explains the frame work and the Vlisssingen case study: Anvarifar, F., Zevenbergen, C., Thissen, W., & Islam, T. (2016). Understanding flexibility for multifunctional flood defences: a conceptual framework. Journal of Water and Climate Change, 7(3), 467-484.

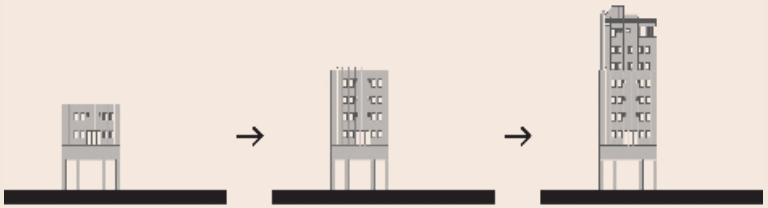


Figure 4. One possibility for enabling the option to expand the number of floors of the buildings.