

**Levees in a changing environment
Synchronizing and anticipating local challenges**

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Figure 1 (right). The Dutch 'layer model' (De Hoog et al. 1998) consists of 1. occupation layer, 2. network layer, 3. subsoil layer. The model is predominantly used by Dutch spatial planners. Flood defenses are part of the occupation layer.

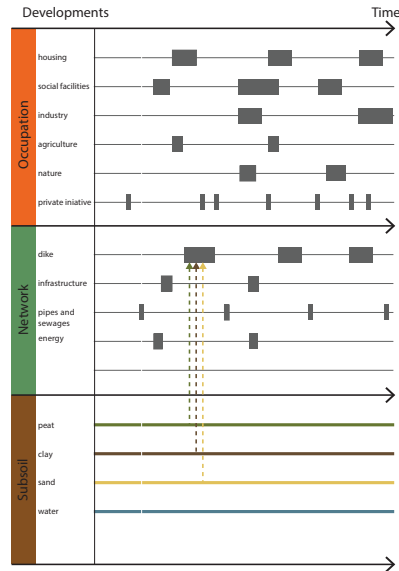


Figure 2 (far right). Integral approach for synchronization Delta Dike.

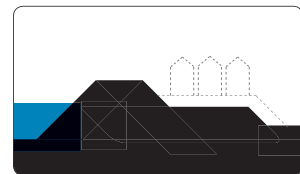
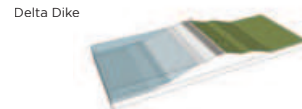
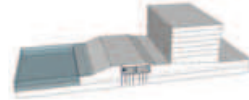


Figure 3. Schematic representation showing anticipated developments.

Integral approach for synchronization Delta Dike



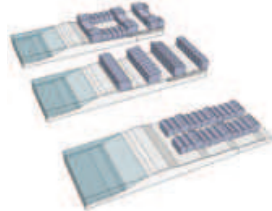
Use of underground space



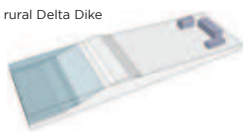
Adaptive integral Delta Dike



Integral urban Delta Dike



Integral rural Delta Dike



Ellen Tromp

LEVEES IN A CHANGING ENVIRONMENT

SYNCHRONIZING AND ANTICIPATING LOCAL CHALLENGES

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(Tentative) dissertation title: 'Enhancing knowledge transfer and uptake in the design processes of flood defences' (forthcoming, 2018)

PhD supervisors: Prof.dr. Bartel van de Walle, TU Delft Dr.ir. Pieter Bots, TU Delft

In recent years, spatial planning and flood risk management (FRM) have been further coupled, thus creating opportunities to incorporate water management measures in urban construction/reconstruction and landscaping. In addition, it is essential to find more than just technical solutions to potential flooding problems, and look for strategies that also address governance, funding and more integrated design processes. Research in recent years has identified two dominant strategies - *synchronization* and *anticipation* - based on the question whether there is a flood risk issue and/or a spatial development plan and on the degree to which a flexible approach is available that will allow separate developments to be synchronized. These strategies can be used in both urban and rural areas.

Research (Tromp et al., 2014) has shown that opportunities are created in the physical area around a dike if time and space perspectives are both considered. The subsurface changes physically at a rate slower than the rate of network change, which is in turn slower than

changes in physical structures on the surface layer (Figure 1). Dutch dikes are designed for a period between 50-100 years. The lifetime of the built environment (housing) is generally 30-50 years, but changes are always possible due to the desires and demands of local residents. Furthermore, some buildings have longer lifetimes because they represent the cultural heritage

However, dikes are often reinforced earlier than their expected lifetime. This raises the question whether changes to dikes and the other developments coincide in time. As improvements to flood defenses and spatial development cannot always be carried out at the same time, we need to identify opportunities for flexibility in future spatial development. Important spatial developments may thus take place independently of each other (Figure 3):

- Dike reinforcements can anticipate future spatial developments.
- Spatial developments can anticipate future flood defense developments such as dike upgrades.

Two strategies were identified (Figure 4, and Tables 1 & 2, page 108). In Strategy 1, developments are synchronized. When this is not possible, the challenge is to create enough space to anticipate possible future developments (Strategy 2).

Strategy 1: Synchronization

Basically, synchronization means linking the timetables of two or more stakeholders and collaboratively defining the budget, operational approaches, cost-sharing, and maintenance plan. Synchronization will allow stakeholders to coordinate and combine activities and developments.

In some cases, synchronization may need to be 'forced', with developments being accelerated

or delayed to allow them to run concurrently. In practice, investments at an early stage make joint developments more likely. Among other things, synchronization depends on flexibility in time and budget. Table A describes the benefits and obstacles of this strategy, presenting aspects that are specifically applicable in the Netherlands.

Strategy 2: Anticipation

When synchronization is not an option, two other possibilities exist. The first is a sectoral approach in which the two developments are separate. The second option is an anticipatory approach, which can in some cases lead to cost benefits, as well as generating surplus value for society as a whole. Depending on the time frame, either flood risk management or spatial development will be the starting point for the anticipatory approach.

Different benefits and obstacles of this strategy can be identified for each time frame (short, medium and long term). Table B presents these, and considers institutional, financial and organizational aspects. Different spatial designs can be developed for each strategy. Figure 4 shows how this can work.

This research project delivered the following key findings:

1. Collaboration between organizations is essential in both the synchronized strategy and the anticipatory strategy. This means that agendas, policy frameworks, and legislation applying to one organization must adapt to those of other organizations. The aim is to work towards an integrated approach. In the case of water authorities, this means that they must adopt a pro-active approach to identifying and understanding the interests of other parties.

Figure 4. (below). The different strategies explained.

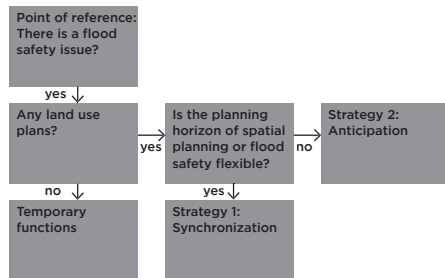


Table 1. (below below). Synchronization strategy.

Strategy 1: Synchronization	
Opportunities	Creating surplus value for environment Increasing public support Solution with local and financial benefits
Obstacles	Dependent on third parties Possibly conflicting individual and public interests
Institutional aspects	New law as legal instrument for integral approach Formal project decision at managerial level needed to ensure integral exploration Political involvement based on agreements (co-deciding, co-producing)
Financial aspects	No flexibility in current debate Positive stimulus for cooperation required
Organizational aspects	Administrative flexibility, recognition and support needed for integral approach Integral project manager needed, different competences Involvement of triple helix required, public-private partnerships

Table 2 (right). Anticipation strategy.

Strategy 2: Anticipation			
Time scale for flood risk management	Short term (0-12 years)	Medium term (12-24 years)	Long term (>24 years)
Opportunities	More synergy, delaying dike reinforcement by taking temporary measures Ability to facilitate future spatial development	Temporary functions in anticipation of future developments Adaptive building, anticipating flood risk management needs	Adaptive building is feasible Ability to facilitate future spatial development
Obstacles	Outlay must precede returns and reside with different stakeholders. Stakeholders are not aware of each other's agendas	Temporary use of land is difficult to anchor in legislation Desire for adaptive building cannot be rooted in plans	Difficult of anticipating developments at this time scale because of possible changes in legislation and regulation Execution of measures should be within a given time frame
Institutional aspects	New legislation as legal instrument for integral approach		
Financial aspects	No stimulus to encourage the anticipation of future development. Funds controlled by the water authority, or by a public investment company within a framework of public control, could be an option. This creates an entity that facilitates the management of incoming financial resources so that beneficiaries (including non-risk-driven participants) can obtain a return on their investment. In the anticipatory strategy, there is a potentially long time lag between outlay and return. This time lag should be kept to a minimum.		
Organizational aspects	Different views of the integral approach On-going cooperation between public stakeholders. Political and government agendas need to include, on an on-going basis, development issues involving a combination of spatial planning and flood risk management. This generates interdependency between public stakeholders. Furthermore, a complementary advisory/consultancy role for all stakeholders establishes bonds between the partners involved. Communication is important due to the dynamics and complexity of the task		

2. Water authorities need to develop a spatial 'dike vision', a strategic, long-term plan based on a lifecycle analysis. This makes the water authority's agenda clear for a longer period of time and makes it easier to seek shared opportunities with other stakeholders, with potential win-win situations as a result, introducing flexibility and enhancing the role of the water authority as a network partner. A dike vision can be an important element in integrated planning processes and it makes the water authority an active partner in the spatial environment at the strategic level. Such strategic long term planning can already be found in the area vision documents of the Dutch National Delta Program, which was developed with the national, provincial and municipal government authorities.

3. Funding: Regional authorities can invest in spatial development and flood risk management, provided that benefits emerge over time. This buffer does not develop by itself. Benefits can be produced by in a variety of ways: for instance, profits from wind turbines can be used later to pay for the more complex statutory assessments. Locating spatial developments on a berm can reduce the cost of dike upgrades in the future. In addition, water authorities can act as developers, since many dike projects involve purchase and sale of land and buildings. Public investment companies with public shareholders may also be able to provide the necessary impetus; by controlling risks and uncertainties, they enable private investors to participate in integrated development of riverbanks and coastal zones on the basis of flood risk management.

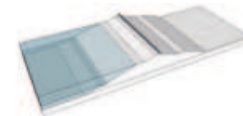
4. Active building policy for space on and next to flood defenses. More space for development can be created when there is an understanding of how 'simple' building techniques can create more flexibility for future reinforcements. Since the area around a dike is a special environment, it makes sense to require specific construction methods. Municipal authorities must support this policy, since they are the ones authorizing construction.

In sum, the creation of flexible strategic planning requires both water authorities and municipalities to show willingness and start working together. By respecting each other's interests, responsibilities and political agendas, and by working together to identify optimal solutions, surplus value can be created for local residents.

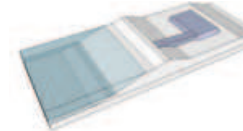
Figure 5. Examples for anticipatory strategy

Short term (0-12 years)

Delaying the dike reinforcement by taking temporary measures. Possible solutions include temporary constructions as sand bags and flood barriers.

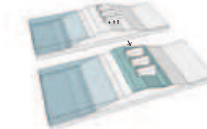


Creating more synergy. Often these are incidental measurements where anticipation is possible.

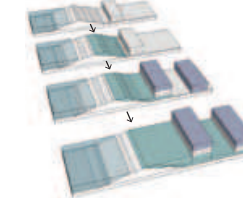


Medium term (12-24 years)

New and old buildings on and beside the strengthened dike can be built on jack up lines to meet future challenges. Should climate change or other standards require it, they can be jacked up to allow strengthening of the dike.

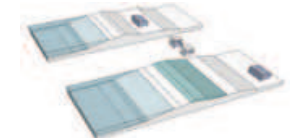


Ground floors are reserved for future dike reinforcements.



Long term (>24 years)

A building can be moved to another location in the event of a dike reinforcement.



For areas where anticipation is required for the long term, opportunities arise to allow new functions, e.g., wind turbines.

