Research Plan

Title of Graduation Project

Rethinking by design: envisioning a future where dikes become dams.
Exploring future adaptation of waterworks in alignment with Deltares' strategy for living with water.

Keywords

Living with water, waterworks, flood defense, dikes, dams, adaptation.

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General Problem Statement

The Netherlands has been shaped by the dynamics of the sea, rivers, and precipitation, influenced by the forces of the wind. The current landscape is not a mere coincidence but rather the result of extensive human intervention. Over the centuries, water management systems such as quays, dikes, and canals have molded the land and constrained water in defined forms (Bobbink, 2016). Waterworks have been safeguarding our country from floods for over two thousand years and have played a pivotal role in shaping our urban landscape (Pleister et al., 2015).

While the Netherlands has a history of shaping its landscape through the construction of water-related infrastructure, the nation is now confronted with complex and contradictory water challenges. This persistent struggle with water presents an ongoing battle against the forces of nature. The fundamental query that arises is whether this is a battle worth engaging in or whether we are on the verge of becoming submerged.

Through the Delta Program, the Netherlands is actively preparing for the impacts of climate change on various fronts, including water safety, freshwater supply, water excess, drought, and heat stress. In 2019, the Sea Level Rise Knowledge Program was initiated to comprehensively assess the effects of rising sea levels. Findings from this program reveal that sea levels are increasing at a faster rate than initially anticipated (Deltares et al., 2022). To safeguard the Netherlands against accelerated sea level rise, four distinct adaptation strategies have been formulated. Outlined in the report Strategies for Adaptation to High and Accelerated Sea Level Rise by Deltares are the following adaptation strategies: protection, living with water, retreating to higher ground, and seaward expansion (Haasnoot et al., 2019).

Continuing to construct a closed system of waterworks is unsustainable for the future. The accelerated sea-level rise will inevitably lead to a system crash, returning rivers to their natural flow. To manage this transition, the focus must shift toward a more adaptable half-open flood defense system (Delta Urbanism Interdisciplinary Research Group et al., 2023, pp. 109-133). The strategy ‘living with water’ envisions a future where living with water is embraced. Land use will be adjusted in alignment with the characteristics and prerequisites arising from water systems. Nature takes center stage, with the restoration of the natural system being the foundation for this transition (De Beer et al., 2023). Other principles outlined in the report include protecting urban areas at a local level and maintaining existing structures without expansion or reinforcement, which may increase the risk of flooding. Additionally, areas outside dikes must adapt to more frequent floods and higher water levels.

The Netherlands boasts a rich history of pioneering water management, built on a foundation of experience, success, and pride. However, our current solutions are more reactive, addressing past disasters, rather than proactively preparing us for the future. This presents a unique opportunity to showcase our capabilities on a global stage. To effectively contend with the ever-changing forces of nature, our existing flood defense system must undergo substantial transformation. As maintenance of these structures grinds to a halt, certain areas within the Netherlands will eventually become submerged, while the extensive dike systems will evolve into dams. Yet, as adaptation strategies are penned at national and regional levels, the precise impact of embracing life with water on the human scale remains unknown.

“God created the world, but the Dutch created Holland”

Overall Design Objective

"We are the first generation to feel the effect of climate change and the last generation who can do something about it." – Barack Obama

Climate change connects to changing demographics, urbanization, economy, and ecology. The risks posed by floods are intertwined with basic needs for clean water, food, energy, and prosperity. These risks and needs show clear and strong interdependencies on regional and metropolitan scales. It is in this complexity of interdependencies that opportunities are found. With everything interlinked, a comprehensive approach always yields multiple benefits (Ovink & Boeijenga, 2018). The first objective is to embrace the complexity of the project and to include the effects on various scale levels.

The substantial intricacy of a future-proof design approach necessitates a setting for experimentation, reflection, and innovation. It requires the temporal and spatial freedom to step beyond entrenched interests and frameworks, as sanctioned by the daunting challenges that lie ahead. These challenges are inherently incompatible with the prevailing methods, conditions, established procedures, and institutions firmly grounded in the past. There is a pressing demand for the latitude to experiment, embrace risks, acknowledge mistakes, and facilitate learning (Ovink & Boeijenga, 2018).

There is a choice to make regarding the future adaptation of the Netherlands concerning sea level rise. The citizens of the Netherlands must be aware of the choices they have considering the future. By illustrating the consequences of sea level rise on the human and architectural scale, I aim to raise awareness among the people of the Netherlands regarding the impacts of sea level rise and the choices they have regarding adaptation strategies.

Traditionally, floods have posed a threat to the Netherlands, and how to deal with them is a crucial topic in societal and political debates. However, the question arises as to whether the livability in the low-lying areas of the Netherlands can still be maintained (Kok et al., 2016). According to the adaptation strategy of living with water, the current flood defense system will no longer be maintained, and its future function is unclear (Haasnoot et al., 2019). The aim is to develop a future scenario in which the current water defense system is utilized and assigned new functions.

Overall design question

How can we adapt the flood protection system in the Netherlands to ensure its effectiveness and sustainability in the face of future climate change and sea-level rise, while addressing the complex interplay of demographics, urbanization, economy, and ecology to secure the livability of low-lying areas?

Reflection on the relevance

Since the beginning of the Common Era, the global sea level has hardly changed until it began to rise in the 19th century. In the last 50 years, there has been an acceleration: about 2.3 mm/year in the period 1971-2018 and 3.7 mm/year in the period 2006-2018 (Dorland et al., 2023). However, uncertainty about the future sea-level rise arises from the effects of the melting of the West Antarctic Ice Sheet. The melting of this ice sheet acts as an accelerator for rising sea levels (Haasnoot et al., 2020).

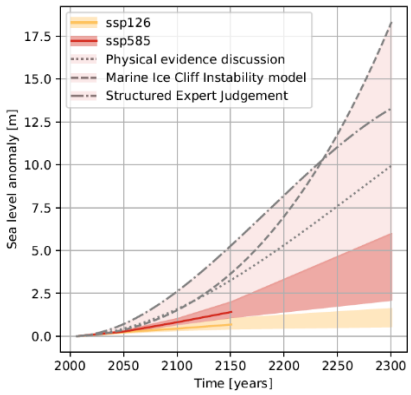

Figure 1: expected sea level rise until 2023 (Dorland et al., 2023).

The urgency of climate change demands immediate action. Each day of indecision exacerbates the situation, leading to more despair and increasing disaster risks, while the costs of mitigation and adaptation continue to rise rapidly. The imperative is clear: we must act now. Embracing the future and its inherent complexity is our daring challenge, allowing us to comprehend and harness it for tangible, meaningful change (Ovink & Boeijenga, 2018).

The living with water adaptation strategy outlines its impact on national and regional scales, which maintains an abstract level of detail, lacking consideration for the human and architectural scale. Designing at an architectural level provides the citizens of the Netherlands with an example for future adaptation at the human scale.

Thematic Research structure & Objective

The primary goal of this research is to evaluate the waterworks in the southwestern delta of the Netherlands, to identify the most suitable waterwork segment for the design task. The research consists of four distinct phases, each progressively filtering the waterwork segments until the most pertinent segment remains.

In the initial phase, a comprehensive assessment of the entire southwestern delta is conducted. This assessment relies on the findings presented in the "Safe Netherlands in Perspective" report (Rijkswaterstaat Projectbureau VNK, 2014) to evaluate the impact and probability of potential flooding. Waterwork segments with a probability of failure higher than 1/40,000 are excluded from further consideration in the study.

The subsequent phase focuses on categorizing the waterwork segments based on their height. This assessment considers an estimated sea level rise of +2.5 meters by 2100 (Dorland et al., 2023). Waterwork segments located below the anticipated sea level of +2.5 meters, added to the existing gauge, are excluded from the study. The remaining waterwork segments are categorized by typology, following the guidelines outlined in the study conducted by LOLA landscape architects (2015) on the dikes of the Netherlands. The Dutch dike system comprises primary water defenses, non-primary water defenses, and non-water-retaining dikes. These dikes are further classified into dike groups, dike systems, and dike types. The following list provides an overview of the dike groups, dike systems, and dike types found in the southwestern delta:

- Dike Groups: Sea dikes, polder dikes, meadow dikes, canal dikes, waterline dikes, dams, storm surge barriers, and emergency dikes.
- Dike Systems: Waker - inlet dike, harbor channel - sluice basin dike, polder - polder dike, meadow dike - compartment dike, main resistance line - access - inundation basin.
- Dike Types: Inlet dike, waker, harbor channel dike, sluice basin dike, accretion dike, ring dike, polder dike, land foundation dike, meadow dike of the new land, compartment dike, meadow dike of the old land, canal dike, main resistance line, access, flush dike, open dam, permeable dam, closed dam, sandbag dike, gabion dike, flood board, floating barrier, inflatable dike.

Finally, in the last phase, an evaluation of the demographics, urbanization, economy, and ecology, as mentioned by Henk Ovink in Too Big: Rebuild by Design (2018), of the surrounding areas is conducted. This structured system of categorization and analysis is designed to yield an outcome that serves as the foundation for the prototype during the subsequent design phase.

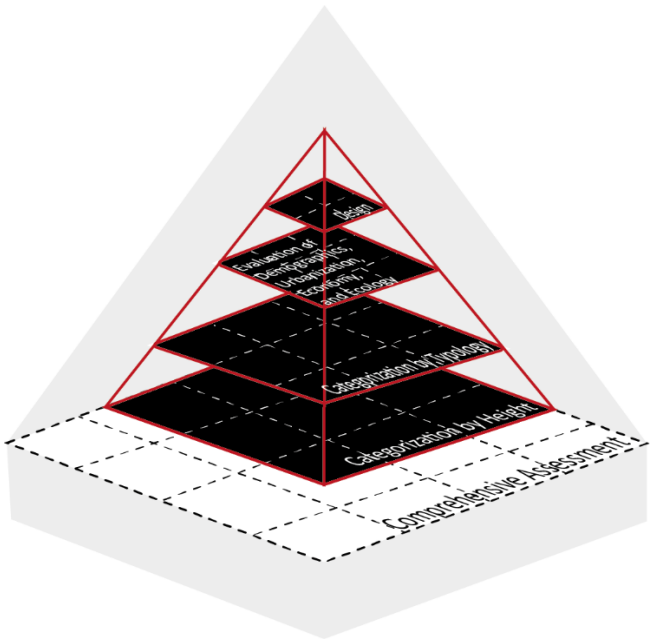

Figure 2: representation of the research structure (Zuidmeer, 2023)

Thematic Research Question

Research question:
Which waterwork segment in the southwestern delta of the Netherlands is the most suitable for a future design assignment aimed at the reuse and adaptation of flood protection in the face of sea-level rise, considering its adaptability to the future scenario of living with water by Deltares?

Sub-question:

- Comprehensive Assessment:
  - What is the overall vulnerability of the southwestern delta of the Netherlands to flooding and sea-level rise?
- Categorization by Height:
  - Which waterwork segments within the southwestern delta will be situated below the projected sea level of +2.5 meters (including the existing gauge) by 2100?
- Categorization by Typology:
  - What are the different types of waterwork segments found within the southwestern delta of the Netherlands, and how can they be categorized based on dike group, dike system, and dike type?
- Evaluation of Demographics, Urbanization, Economy, and Ecology:
  - How do demographic factors, urbanization, economic activities, and ecological conditions impact the suitability of the selected waterwork segments for the proposed design assignment within the southwestern delta of the Netherlands?

Reflection on the relevance

The significance of this thematic research closely aligns with the importance of the design project. In addition to addressing the pertinence of climate change and the added value of considering the human scale, this research delivers a current assessment of the flood protection system in the southwestern delta. Through typological research, fresh insights are acquired regarding the functionality of the existing waterwork system. Consequently, this research serves to reiterate the urgency of flood protection while also highlighting its current inadequacies to the residents of the Netherlands.

Thematic Research Methodology

This thematic research aims to address the problem of rethinking and adapting waterworks in the southwestern delta of the Netherlands, in alignment with Deltares' "Living with Water" strategy. To fulfill the thematic research objectives, a structured methodology will be employed, encompassing the following phases and research methods:

Phase 1: Comprehensive Assessment

- Research Method: Literature Study
- Description: A thorough review of existing literature and relevant reports, including the "Safe Netherlands in Perspective" report (Rijkswaterstaat Projectbureau VNK, 2014), to assess the impact and probability of flooding in the southwestern delta. This phase involves a qualitative analysis to identify segments with a probability of failure exceeding 1/40,000, excluding them from further consideration.

Phase 2: Categorization by Height

- Research Method: Data Analysis and Projection
- Description: Utilizing data on sea-level rise estimates (Dorland et al., 2023), a quantitative analysis is conducted to determine waterwork segments situated below the projected sea level of +2.5 meters (including the existing gauge) by 2100. Segments falling into this category are excluded from the study.

Phase 3: Categorization by Typology

- Research Method: Typological Analysis
- Description: A qualitative typological analysis, drawing from the study conducted by LOLA landscape architects (2015) on the dikes of the Netherlands, categorizes the remaining waterwork segments based on dike group, dike system, and dike type. This method allows for a structured classification of the segments to be considered in the design assignment.

Phase 4: Evaluation of Demographics, Urbanization, Economy, and Ecology

- Research Method: Case-Study Analysis and Field Research
- Description: This phase involves a qualitative case-study analysis and field research to evaluate how demographic factors, urbanization, economic activities, and ecological conditions impact the suitability of the selected waterwork segments. The method will entail conducting on-site field studies and assessments to gather pertinent data for a thorough evaluation.

By structuring the research into these distinct phases, a combination of qualitative and quantitative methods is employed to address the research problem and meet the thematic research objectives. This approach ensures a thorough evaluation of waterwork segments in the southwestern delta, considering their adaptability to the "Living with Water" strategy while maintaining a comprehensive approach.

Expected results of thematic research and design implementation

The expected outcomes and deliverables of the thematic research are as follows:

- Comprehensive Assessment Report: A detailed report presenting the findings of the comprehensive assessment of the southwestern delta's vulnerability to flooding and sea-level rise.
- Categorization Report: A report categorizing waterwork segments within the southwestern delta based on their height in relation to the projected sea level rise.
- Typology Classification Report: A report outlining the types of waterwork segments in the southwestern delta, categorized by dike group, dike system, and dike type.
- Demographics, Urbanization, Economy, and Ecology Evaluation Report: A comprehensive report assessing the impact of demographic factors, urbanization, economic activities, and ecological conditions on the suitability of selected waterwork segments.

Key Performance Indicators (KPIs) to measure success and substantiate the research's impact:

- Reduction in Vulnerability: A decrease in the vulnerability index of the southwestern delta, as identified in the comprehensive assessment.
- Identification of Suitable Waterwork Segments: Successful identification of waterwork segments that are above the projected sea level rise, ensuring their adaptability to future scenarios.
- Clear Typology Classification: A well-defined categorization of waterwork segments based on dike group, dike system, and dike type.
- Improved Livability Assessment: An improved livability assessment of the areas surrounding the selected waterwork segments, reflecting the influence of demographics, urbanization, economy, and ecology.
- Prototype Design Acceptance: The acceptance and approval of the prototype design proposal by relevant stakeholders and experts in the field.

The knowledge and insights from the thematic research will be used within the overall design approach to:

- Influence Design Decisions: The research findings will inform the selection of the most suitable waterwork segment for the design assignment, ensuring it aligns with the objectives of living with water.
- Ensure Adaptability: The research will guide the adaptation of flood protection systems to effectively address sea-level rise and future climate change.
- Enhance Sustainability: The insights on demographics, urbanization, economy, and ecology will be integrated into the design approach to enhance the sustainability and livability of low-lying areas.
- Measure Impact: The KPIs established will be used to measure the impact of the design approach on reducing vulnerability and improving overall water management.

The research's knowledge will be a fundamental resource to guide the design process and ensure that the proposed solutions are well-informed, effective, and sustainable in the face of climate change and sea-level rise.

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General Problem Statement

History

Present

Threat: sea level rise
Response: adaptation strategies

Future

Adaptation strategie:
Living with water

How?

Thematic Research

Phase 1: Comprehensive Assessment
Literature Study

Phase 2: Categorization by Height
Data Analysis and Projection

Phase 3: Categorization by Typology
Typological Analysis

Phase 4: Evaluation of Demographics, Urbanization, Economy, and Ecology
Case-Study Analysis and Field Research

Where?

Design Objective

Embrace complexity

Experiment, reflect & innovate

Raise awareness

Utilize flood defense system

Design Question

How can we adapt the flood protection system in the Netherlands to ensure its effectiveness and sustainability in the face of future climate change and sea-level rise, while addressing the complex interplay of demographics, urbanization, economy, and ecology to secure the livability of low-lying areas?

Research Question

Which waterwork segment in the southwestern delta of the Netherlands is the most suitable for a future design assignment aimed at the reuse and adaptation of flood protection in the face of sea-level rise, considering its adaptability to the future scenario of living with water by Deltares?

Relevance

Climate change
Architectural scale
Assesment of flood protection system