Influence of Entry Test and Trajectory Approach on Dike Reinforcement Projects in the Netherlands

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Colophon

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Preface

This is the report on my bachelor thesis in collaboration with Waterboard Rivierenland between the 5th of April and the 21st of June. During these 10 weeks I have been able to take a glance at the working field of Civil Engineering and learn how to do individual research. Due to the Covid-19 pandemic the research has mostly been executed from home.

I would like to express special thanks to both supervisors Jord Warmink (UT) and Mathijs Bos (WSRL) for making this research possible and guiding me throughout the process. I want to thank Waterboard Rivierenland for giving me the opportunity to work as an employee in the working field of Civil Engineering and providing me with information for the research.

Lastly, I would like to thank the involved waterboards (Rijn en IJssel, Hoogheemraadschap Hollands Noorderkwartier, Hoogheemraadschap De Stichtse Rijnlanden, Wetterskip Fryslan, Brabantse Delta) and the HWBP for their involvement in this research. Without their valuable experiences in the field this research would not be possible and they have helped significantly giving content to the report.

Sander de Groot
Enschede, July 2021

Abstract

The aim of this research is to gain a clear image of two recently introduced methods, the entry test and trajectory approach, in dike reinforcement preparation that can be used by waterboards to apply for the program list of the HWBP. Besides, the consequences of these two methods on a project of Waterboard Rivierenland are examined. 6 experts from various waterboards have been interviewed that have experience with at least one of the two methods, or both. From their experiences a benchmark analysis was conducted with the goal to compare the methods to each other. Considered quantitative benchmarks are lead time, time investment, amount of employees and (extra) financial cost. Most experts indicated a relatively small lead time (compared to the total assessment chain) and also indicated a parallel execution of tasks, leading to a small time investment. The amount of employees is comparable to a normal project team and the two methods do barely have any extra financial costs. Qualitative benchmarks are ease of use, administrative goals & ambitions and preparation. These benchmarks are scored on a scale based on expert experiences. The results are dependent on a lot of factors and include subjective judgement and should therefore be taken with caution. From these results possible consequences regarding planning for a project from Waterboard Rivierenland, Sprok-Sterreschans-Heteren (SSH), have been determined. Three options of method implementation on the SSH timeline are given as well as advice for the continuation of the SSH project regarding the use of the entry test, trajectory approach or both. It became clear that the entry test is a structured method that helps identify uncertainties, area partners and linkage opportunities early on in the dike assessment chain, and helps give projects an accelerated start towards a (pre-)exploration phase. Useful advice and tips for the continuation of projects are given by the assessment team of the entry test, resulting in more stable project scopes. The trajectory approach is a useful non-obligatory tool that helps defining a reinforcement strategy considering the area characteristics, uncertainties and planning of area partners. The implementation of the trajectory approach differs much per waterboard and is very dependent on specific characteristics of the dike reinforcement project and priorities of the waterboard. It is up to the waterboard how to integrate the trajectory approach together with the entry test, which could result in a considerably lead time.

Contents

Colophon 2
Preface 3
Abstract 4
Contents 5
Table of Figures 6
Table of Tables 7
1. Introduction 8
1.1. Background 8
1.2. Study area 9
1.3. Problem context 10
1.4. Goal and research questions 10
1.5. Report outline 10
2. Methodology 11
2.1. Literature research 11
2.2. Interviews 11
2.3. Benchmark analysis and added value 13
2.4. Consequences and added value 14
3. Characterization of ET, TA and previous methods 15
3.1. Previous Methods 15
3.2. Entry Test 16
3.2.1. Preparation 16
3.2.2. Execution 16
3.2.3. Advice & decision 16
3.2.4. Requirements 17
3.3. Trajectory Approach 17
3.3.1. Procedure 17
3.4. Casus projects 19
3.4.1. Project Jaarsveld-Vreeswijk 19
3.4.2. Project Petten-Den Helder 21
3.4.3. Combined project Spijk-Westervoort 23
3.4.4. Other projects 26
3.4.5. Advantages & Disadvantages 27
4. Benchmark Analysis 29

4.1. Quantitative benchmarks 29
4.2. Qualitative benchmarks 30
5. Consequences and added value 33
5.1. Project Sprok-Sterreschans-Heteren (SSH) 33
5.2. Consequences SSH 34
5.2.1. Entry test only 34
5.2.2. Trajectory approach only 35
5.2.3. Combination of ET and TA 35
5.2.4. Planning SSH 36
5.3. Advice 37
6. Discussion 39
7. Conclusion 40
Bibliography 42
Appendix A: Process plate of WRIJ 1

Table of Figures

Figure 1: Working field of WSRL from the Nederrijn and Lek (north) and the river Maas (Meuse) in the south. On the top right the 'Kop van de Betuwe' is highlighted and the SSH project area in orange and blue [8]. The image is received from WSRL within ArcGis software [12] 9
Figure 2: Rough course of steps in a dike development project. The emphasis of this diagram is at the start of the project, before the (pre-)exploration phase. 11
Figure 3: Scoring scale, where 1 indicates: benchmark is not to barely satisfied by the method, and 4 indicates: benchmark is completely satisfied by the method 14
Figure 4: Listed norm trajectories of WSRL for the period 2017-2022 [12] 15
Figure 5: Flow process of the trajectory approach, according to the guideline [7]. 18
Figure 6: Complete trajectory of the Sterke Lekdijk project. In blue trajectory Jaarsveld-Vreeswijk and in pink trajectory Salmsteke [16] 20
Figure 7: Working field of HHNK in the province Noord-Holland. Trajectory 13.3 is around 20 kilometres in length and can be seen encircled. The picture is from 2015 and is outdated regarding the norms [17] 21
Figure 8: Map of the area Nederrijn and Waal with dike trajectories of WSRL and WRIJ. In orange and blue trajectory SSH and in green trajectory Spijk-Westervoort (27 km) from WRIJ [12], [18] 23
Figure 9: Division of trajectories along project Spijk-Westervoort. In orange the highest priority trajectory, in purple the second, and in yellow the third. 24
Figure 10: Current considered trajectory division for SSH. In light blue: Heteren-Drielse Dijk, purple: Drielse Dijk-Huissen, green: Huissen-Sterreschans, red: Sterreschans-Sprok, in total a length of 38 km. (underlaying image received from report pre-exploration [19]). 34
Figure 11: Three options of method implementation on the SSH project timeline, considering scenario 1 36

Figure 12: Process plate of WRIJ (Dutch). In green the technical track, in red the environment track, in blue the strategy track and added in yellow the entry test's work studios. 1

Table of Tables

Table 1: Requirements list for choosing experts 12
Table 2: Overview of interviewed waterboards and their projects. The highlighted projects are used later in the report as casus project (Chapter 3) 12
Table 3: Considered benchmarks 13
Table 4: Advantages and disadvantages of the entry test, used by HDSR and WS Fryslan 27
Table 5: Advantages and disadvantages of the trajectory approach, used by HHNK 27
Table 6: Advantages and disadvantages of the combined methods, used by WRIJ and Brabantse Delta 28
Table 7: Performance matrix and scoring of criteria on the methods based on results from the expert interviews 32

1. Introduction

1.1. Background

The Netherlands has a rich history when it comes to water management. With around a third of its surface area laying beneath mean sea level, the land is vulnerable to water from the sea but also from the rivers. Without any flood defences sixty percent of the land would be inundated frequently, affecting around 9 million people [1]. In hundreds of years the people have learnt how to fight the water, and in recent developments, also work together with the water and keep the land protected while considering human and ecological needs. A widely used and effective primary flood defence that has been around for many centuries are the dikes in the Netherlands. Dikes are visually inspected at least once a year by experts and thoroughly re-assessed on their safety every 12 years [2]. If a dike does not meet the strict requirements on flood safety set in the Water Act (Waterwet), an intervention must take place. Dike reinforcement projects can be large projects with much uncertainties and high stakes for a large variety of involved parties. In order to make sure large projects like this run smoothly the current 'Hoogwaterbeschermingsprogramma' (HWBP) was created in 2012. The HWBP consists of waterboards and Rijkswaterstaat and together they program projects [1]. The main goal of this program is to achieve the safety norm for all flood defences by 2050. These norms have been sharpened for all dike sections in 2017 [3].

To comply to the safety norm for all dikes it is expected that 50 kilometres of dike have to be reinforced each year. This is a big challenge and it requires an adequate project approach. It is, therefore, important for executors of dike reinforcement projects to start in time with defining the water safety, environmental assessment, risks and uncertainties of a project. Usually, a dike reinforcement project consists of three phases: exploration, plan implementation and realisation (combined also called the assessment chain). Sometimes a pre-exploration phase is executed if there is still much uncertainty in, for example, the water safety, surroundings or developments. In the exploration phase a design is established with focus on interests such as living and environment. From this exploration, potential solutions are defined and, together with stakeholders, the preferred plan is chosen: the 'preferred alternative' ('voorkeursalternatief'). In the plan implementation phase the design is further worked out in detail to comply to lawful procedures [4]. In the last phase the project is executed.

In this thesis two recently introduced methods that can be used around the (pre-)exploration phase, or before, in dike reinforcement projects are assessed with respect to each other, and to currently used methods. The first method is the 'entry test' ('ingangstoets'). The second method the 'trajectory approach' ('trajectaanpak'), which is a non-obligatory instrument that could be used as part of the entry test. The entry test has been introduced in 2019 by the program management of the HWBP. The goal of this test is to improve the stability and certainty of dike reinforcement projects [5]. The trajectory approach is an independent tool that can be used to construct an implementation strategy and determine globally the scope and costs of a project. If the trajectory approach is used, elements like water safety assessment, spatial opportunities, strategies that fits water safety assessment best, and the level of the project, are defined [6], [7]. These elements are all required during the entry test and therefore the trajectory approach could be useful. If the entry test is successfully completed, the program is added to the list of the HWBP and the project is eligible for subsidy. The goal of this thesis is to assess the added value of the entry test and trajectory approach with respect to currently used methods in dike reinforcement projects, by comparing the entry test, trajectory approach and previous methods to each other.

1.2. Study area

This thesis is conducted at waterboard Rivierenland (WSRL). WSRL is one of the 21 governmental water management bodies in the Netherlands. WSRL has jurisdiction in the middle of the Netherlands, between the river Nederrijn/Lek and Maas. The waterboard makes sure that this area is protected against floods from the many rivers that flow through. They are responsible for control, assessment and reinforcement of the dikes in the area. Besides protection, the waterboard is also responsible for the availability and quality of surface water [8]. Water levels are monitored because too high levels can cause floods and too low can cause drought problems for farmers, shipping and flora & fauna. Next to this the water must be clean for human use but also for plants and animals in the area. Lastly, WSRL is responsible for shipping and discharge of water, sediments and ice. Besides WSRL, other waterboards and the HWBP were involved in this research.

One of the projects from WSRL that was already on the program list before implementation of the entry test is the Sprok-Sterreschans and Sterreschans-Heteren (SSH) project. Until now, a 'pre-exploration surroundings' has been executed as step before the exploration phase. Because the project was already listed and the pre-exploration started, the entry test was not mandatory, but advised as a check on the project scope before the exploration phase. This project is located in the 'Kop van de Betuwe' and includes the assessment of dike ring 43-3 and partly 43-2 [9]. In Figure 1, these dike ring sections can be seen indicated orange and blue, respectively. From the nationwide water safety assessment, some parts of the dike scored within category D, which means they don't meet the lower limit conform WBI 2017[10]. A closer safety analysis was conducted in the pre-exploration to clarify the safety issue further. Next in de assessment chain an exploration phase takes place. The results from an exploration are insight of the study area and advice to WSRL's management.. With the advice WSRL can already early in the process map what the chances and challenges are [11]. More detail about this project can be found in Section 5.1.

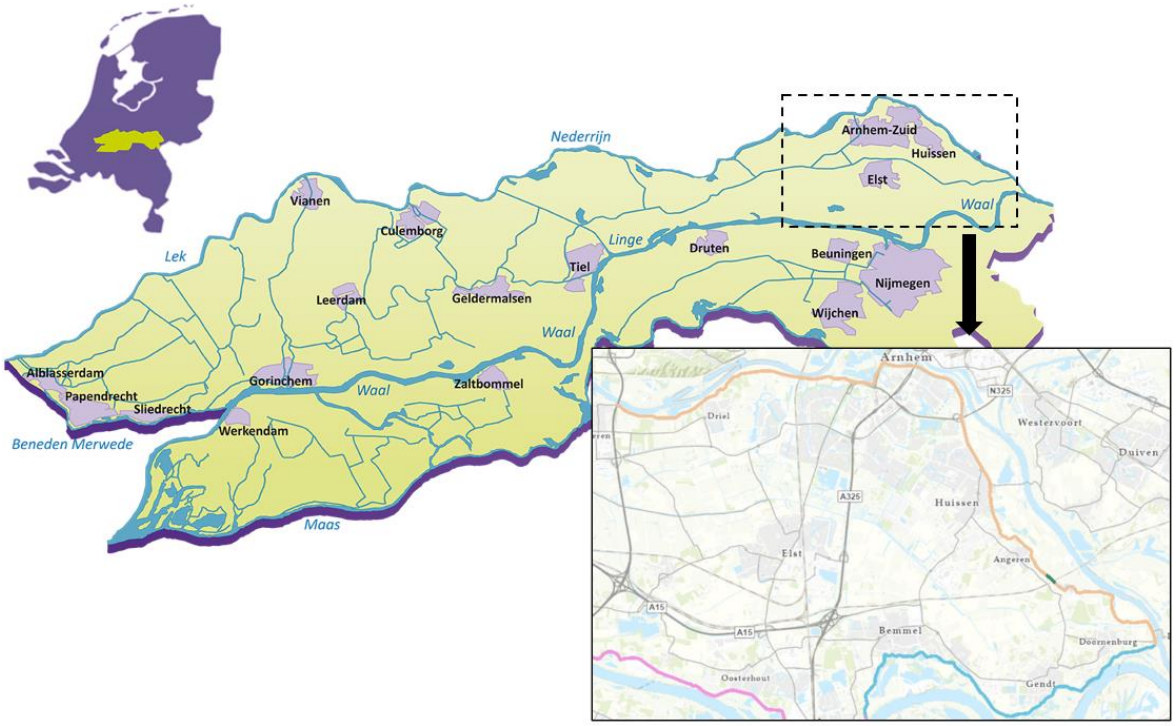

Figure 1: Working field of WSRL from the Nederrijn and Lek (north) and the river Maas (Meuse) in the south. On the top right the 'Kop van de Betuwe' is highlighted and the SSH project area in orange and blue [8]. *The image is received from WSRL within ArcGis software* [12]

1.3. Problem context

Before implementation of the entry test (ET) and trajectory approach (TA) there was barely any procedure for dike reinforcement projects to enter the HWBP list. Projects that were not yet prepared well got signed up and could get funded. These relatively 'unstable' projects were still very uncertain and it took long for these projects to take off, leading to delays and unnecessary costs. That is why a method is needed that makes sure project scopes including risks, uncertainties, cost estimates and spatial possibilities are defined early in the process, before they can get on the HWBP program list. It is expected that projects using the entry test are more stable programs, and prevent projects with high uncertainties in the area, planning, costs and risks to enter the program list.

The entry test is mandatory for all new programmed projects. When the entry test was introduced all projects already on the program could remain on the HWBP list and it was not yet mandatory to use the entry test, including project SSH. WSRL is however interested in using the entry test for SSH and learn from this project for their future projects, when the entry test would be mandatory to get on the HWBP list. WSRL, but other waterboards as well, do not have (much) work experience yet with the ET nor with the TA. Up until now only 7, voluntarily, entry tests have been finished in the Netherlands and there are no projects realised yet that used the test. Therefore, there is a lack of information on the implementation, experiences and long-term effect on the assessment chain. An evaluation group has been set up between multiple waterboards, including WSRL, that will evaluate the ET and TA and share their experiences. WSRL is wondering what the added value of the ET, the TA, or combination is. Additionally, they want to know what the consequences of using the ET and TA are for project SSH and future projects.

1.4. Goal and research questions

The goal of this research to assess the added value of the entry test and trajectory approach with respect to current methods in dike reinforcement projects, by analysing entry test, trajectory approach and current methods. Required information to reach this goal will be gathered mainly by experiences of waterboards and the HWBP. From the goal the main research question is formulated:

- **What is the added value and of using entry test and trajectory approach instead of currently used methods?**

In order to answer this question a total of 3 sub-questions need to be answered first:

1. What are the experiences of experts at waterboards with the current methods, entry test and trajectory approach?
2. How do the entry test, trajectory approach and current method score based on a benchmark analysis?
3. What are the consequences for the waterboard when using the entry test and/or trajectory approach for their (future) projects?

1.5. Report outline

First, in Chapter 2, the research methodology is described to obtain answers on the research questions. In Chapter 3, characterizations and relation of the entry test, trajectory approach and current method are defined, with respect to their use in projects. Then, in Chapter 4, a benchmark analysis is conducted where the different methods are compared and assessed. In Chapter 5, the consequences and added value of the methods are analysed based on the benchmark analysis results. Lasty, a critical discussion is given and the conclusions are presented. The appendix contains additional information to the research.

2. Methodology

To achieve the research objective and give answers to the research questions an adequate approach must be used. In this chapter the research approach is described.

2.1. Literature research

In this research project, the entry test, trajectory approach, and current methods in dike reinforcement projects are the main points of interest. Therefore it must be known, in detail, what these methods include and what not. This is partly done by literature research. Documents are available on the entry test and on trajectory approach and can obtained by use of websites of waterboards and the HWBP. The goal is to characterize and find the relation between the entry test, trajectory approach and current methods. In Figure 2 the ET and TA are placed within the current course of a dike development project. Usually, the water safety is assessed first. Using this information a strategy is can be determined using the TA and other aspects of the environment can be considered as well. Simultaneously, or alone, the ET can be started. Next, the project can be listed on the HWBP program and a (pre-)exploration is executed. The diagram is however not rigid and it is dependent on the project characteristics and waterboard's choices and goals how the trajectory approach and entry test are exactly filled into the assessment chain.

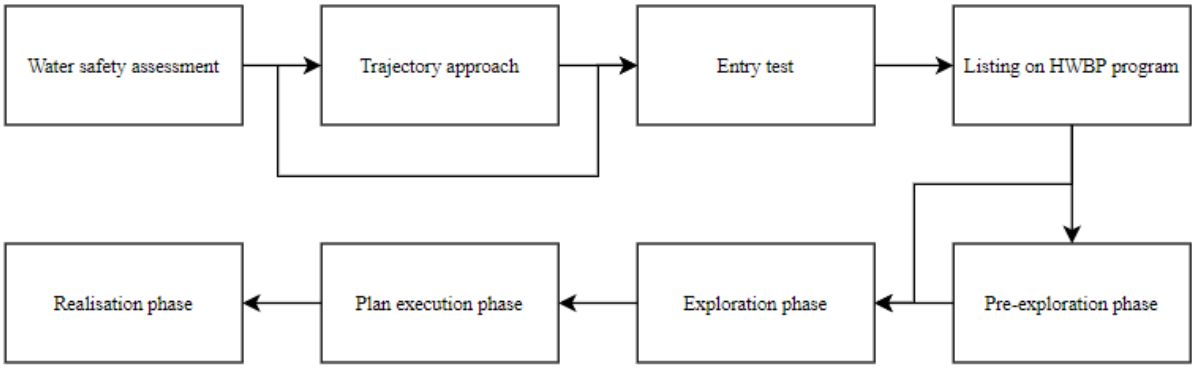

Figure 2: Rough course of steps in a dike development project. The emphasis of this diagram is at the start of the project, before the (pre-)exploration phase.

2.2. Interviews

To answer research question 1, two types of interviews are carried out along multiple waterboards and the HWBP. The first type focusses on getting to know ET, TA and currently used methods better, and learning about the policies within WSRL. The second interview considers substantive interviews about the methods used in a dike reinforcement project at a waterboard. For the first interview no decisive requirements were made to find the right experts. One person from the HWBP and one intern colleague from WSRL has been interviewed. In order to find the right persons for the second interview, a small requirement list is made that the expert should meet. This way most of it can be gotten out of the interview. The requirements are however depended on the required information. The requirements list can be seen in Table 1.

People meeting the general requirements and at least one of number 4-7 are suitable for an interview. At least one expert is interviewed about the ET, TA, combination or current method. The experts are asked about their experiences and about improvements and weaknesses of the

methods in a specific project. Besides it is asked what the influence of the methods has had on the execution time, costs and employees.

Using the requirements from the list, 6 experts have been chosen and interviewed with regard to method implementation in one of their projects. 2 experts that were/are closely involved in a project that used the entry test, 1 that used the trajectory approach, 2 that has used both and 1 about currently used methods. In Table 2 the projects are shown and what type of method has been used. In light grey is indicated which project is used as casus project in this thesis and elaborated further in Chapter 3.

Table 1: Requirements list for choosing experts

Types	# of experts	Number	Requirement
General requirements	6	1	Has experience in project management within the organisation and has been closely connected to a project
		2	Has knowledge on the processes used in dike reinforcement projects
		3	Has knowledge on at least one of the methods: ET, TA, combination or current method
Current method	1	4	Has cooperated, and was closely involved, in a dike reinforcement project before 2018
ET	2	5	Has cooperated, and was closely involved, in a dike reinforcement project that has used an entry test
TA	1	6	Has cooperated, and was closely involved, in a dike reinforcement project that has used a trajectory approach
Both ET and TA	2	7	Has cooperated, and was closely involved, in a dike reinforcement project that has used both the entry test and trajectory approach

Table 2: Overview of interviewed waterboards and their projects. The highlighted projects are used later in the report as casus project (Chapter 3)

Waterboard	Project	Trajectory approach	Entry test
HDSR	Jaarsveld-Vreeswijk	No	Yes
WS Fryslan	Schiermonnikoog	No	Yes
HHNK	Petten-Den Helder	Yes	No
WRIJ	Spijk-Westervoort	Yes	Yes
Brabantse Delta	Willemstad-Noordschans	Yes	Yes
WSRL	Tiel-Waardenburg	No	No

At the start of the internship I was invited to join an evaluation group about ET and TA, organised by WRIJ (Waterschap Rijn en IJssel). Right now, six organisations, mainly waterboards, joined this group: 'Hoogheemraadschap van Schieland en Krimpenerwaard' (WWSK), 'Hoogheemraadschap Hollands Noorderkwartier' (HHNK), 'Waterschap Vallei en Veluwe' (WSVV), 'Waterschap Rivierenland' (WSRL), 'Hoogwaterbeschermingsprogramma' (HWBP) and 'Waterschap Rijn en IJssel' (WRIJ). From each organisation one representative is actively cooperating in the group. The group discusses about the experiences they have by using the trajectory approach and entry test in their projects. Within this group questions about ET and TA have been collected and

shared, which I have used to interview the experts. Most of the experts have been contacted with use of this evaluation group due to the wide range of contacts within their organisation.

Because this research is conducted in times of the Covid-19 pandemic, all interviews are conducted online, by use of a meeting platform like Teams or Zoom. This brings disadvantages and advantages: the interview is less personal since you are not in the same room, on the other hand planning is easier, no trip is necessary and the interview can be recorded. The latter is only done if permission is given by the expert.

First, methods used before ET and TA are introduced. Used for this is literature, an interview from HHNK (Hoogheemraadschap Hollands Noorderkwartier) and an interview with WSRL about projects before 2018. (Table 2). It is important to define how WSRL, and other waterboards, prepared dike development projects before implementation of the TA and the ET. Second, the entry test and trajectory approach are described based on literature. Third, casus projects are used from multiple waterboards that used the entry test, trajectory approach and a combination of methods. Lastly, experiences from the experts are translated to advantages and disadvantages. The results can be found in Chapter 3.

2.3. Benchmark analysis and added value

Based on the interview results and literature research, a benchmark analysis is carried out to define which method score well on certain benchmarks. It is deliberately chosen to use the word benchmark instead of criteria since the trajectory approach and entry test have their own criteria embedded in the method that must be considered by the executors of the test. To prevent confusion, benchmark is used in this research to indicate the criteria to compare the methods to each other. It has been chosen to use a benchmark analysis because it has several advantages over informal judgement such as: it is more explicit, clearly communicable and the scores provide an audit trail [13]. The benchmarks from Table 3 are composed in consultation with WSRL and are considered to be the most important to take into account, but more could be defined. The benchmarks can be both quantitative and qualitative. In the first case they are compared on a numerical value, if they are qualitative they are scored based on a scale of 1 to 4 with use of expert experiences (Figure 3). The goal of the benchmark analysis is not to choose the best alternative, but rather create a scored overview of what is required when using ET and TA and define what the most important benchmarks are that should be considered. The results are shown in Chapter 4.

Table 3: Considered benchmarks

Nr.	Benchmark	Description	Qualitative or Quantitative?	Unit
1	Lead time	The average amount of time it takes to complete the method	Quantitative	Time (months)
2	Amount of employees	The amount of co-workers that is required to work on the method	Quantitative	Nr. of people
3	Time investment	The amount of hours the team spent additionally to their work on the method	Quantitative	Time (hours)
4	(extra) Financial cost	The amount of money that is spent (additionally) to execute the method	Quantitative	Money (€)
5	Ease of use	The clarity of the method and easiness to follow and execute	Qualitative	-
6	Administrative goals and ambitions	The possibility the method gives to integrate administrative goals and ambitions into the process	Qualitative	-
7	Preparation	Amount of preliminary work that has to be done before the method can take off	Qualitative	-

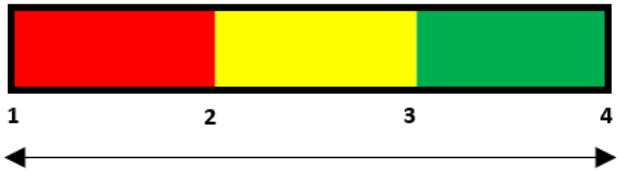

Figure 3: Scoring scale, where 1 indicates: benchmark is not to barely satisfied by the method, and 4 indicates: benchmark is completely satisfied by the method

2.4. Consequences and added value

After the benchmark analysis the consequences and added value are determined for project SSH and future projects of WSRL. For three different scenario's (only ET, only TA or combined) an overview is made what could be expected from WSRL if they choose to use one of the methods, or both. It is defined what still has to be done for project SSH in order to start with the methods and what effect (based on expert interviews) this has on their proposed project planning. Lastly an advice is given for project SSH and future projects regarding use of the methods. This is further worked out in Chapter 5.

3. Characterization of ET, TA and previous methods

This chapter describes the first step in this research process: characterization and relation of the entry test, trajectory approach and previous methods. The relation between the methods and the relation of the methods to the dike reinforcement trajectory are defined. Literature research combined with interviews give insight in these aspects.

3.1. Previous Methods

Design principles

In 2008 the first 'Design principles' ('Ontwerpuitgangspunten') from WSRL was constructed. Since, it has been updated regularly to fit the developments made over the years. The updated version from 2016 gives insight in the way WSRL prepared dike development projects and how they got projects on the HWBP program. It becomes clear that there was not a steadfast method projects could follow and projects were included on the list after a national assessment of primary flood defences. The result of the water safety assessment was enough for a project to get started. In total 69 nationwide projects have been added to the list for the period 2016-2021 consisting of 7 norm trajectories for WSRL. One year later the projects were planned (2017-2022). The involved norm trajectories can be seen in Figure 4. The choice was made purely on the urgency, or in other words, the distance of the trajectory to the norm. Due to the new 'Water Act' of 2017, WSRL decided to revise the listed projects where needed, based on new insights and developments [14].

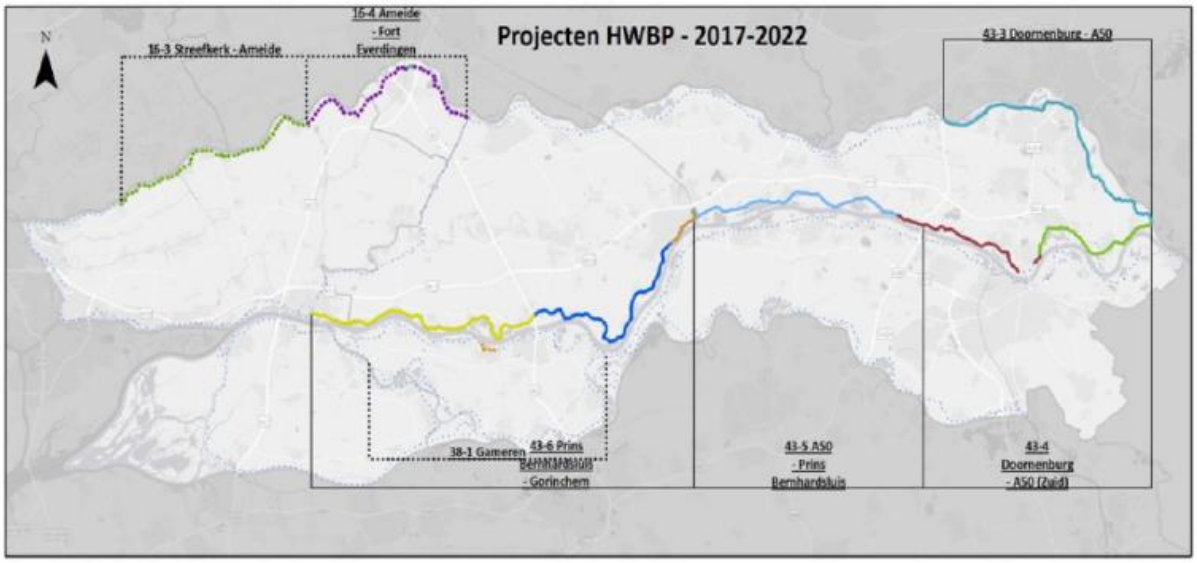

Figure 4: Listed norm trajectories of WSRL for the period 2017-2022 [12]

Interviews

From interviews with experts from WSRL and HHNK it was mentioned that in projects before implementation of TA and ET there was no need to conduct an inventory of the area, including stakeholders, chances and risks before the project started. If from a water safety assessment it became clear there was a reinforcement needed, a cost estimate was made and the program could be listed and funded. After confirmation the project could start with the exploration and only then the area would be inspected and stakeholders listed and contacted. This took a lot of time before

the plan implementation and realisation phase could start. As example there was a project from HHNK, where the exploration phase started in 2006. Only recently this project was finally finished after almost 15 years. There were other reasons that could have led to this delay, but a slow start at the beginning due to the lack of knowledge in the area could have added to this long execution time. Another project, from WSRL, namely Tiel-Waardenburg is currently close to the execution phase, which is intended to start in 2022. At the start of this project spatial developments were insufficiently considered and the safety standard, distance from the norm and the cost estimate were considered most important.

3.2. Entry Test

As mentioned in the Introduction the entry test has been introduced by the HWBP in 2019 to ensure a stable project program, before it can be listed. The need for a structured testing tool emerged when the trajectory approach was in the last phase of development and the HWBP realised that a testing method was needed to ensure well prepared projects in the program. The trajectory approach and entry test were developed independent from each other, but they are connected and add each other. The entry test is designed to give insight in the project assessment and in the definition of the project scope. The goal of the entry test is to 1) assess the stability of the project scope (safety assessment, environmental assessment, project risks), 2) advice the waterboard on the required next steps and 3) advice program management about access to the HWBP program. The program management organises the entry test. A project team with colleagues from the waterboard executes the entry test and follows a step by step approach consisting of preparation, execution, and advice & decision.

3.2.1. Preparation

The entry test kicks off with a start conversation between the program management and the waterboard. They discuss to what extend the entry test connects to the project and how the design will look like (number of experts and work studios). This decision defines the type of entry test: type A, B or C. In type A the expected average amount of time spent by an expert and chairman is around 20 hours. For type B 30 hours, and for type C the expected effort is 39 hours [15]. The decision is custom made and depends on the specific characteristics of the project. After this step the waterboard collects knowledge and information about the project area. Next, an expert team is composed with independent experts on different disciplines, like water safety and environment. The amount of experts and what type of expertise is included depends on the biggest challenges and ambitions of the project. For example, if a project includes spatial adaptations, experts with environmental expertise are picked. Experts for the safety assessment are often coming from the 'advisory team dike design' ('Adviesteam Dijkontwerp') and Deltares, experts from the environment assessment and project management are found within the community of the HWBP. In the next step the execution is prepared in work studios. In these sessions the experts come together with the waterboard and discuss the risks around the safety assessment, environmental assessment and project management.

3.2.2. Execution

From the work studio sessions the acquired information is analysed by the expert team. They plan a meeting with the waterboard to discuss the scope, planning, cost estimate and risks of the project. The expert team composes a conceptual advice in consultation with the waterboard.

3.2.3. Advice & decision

The conceptual advice is discussed with the HWBP program management and improved to a definite advice. Based on this advice the program management makes agreements with the waterboard about the programming of the project. The final step is the decision by the program management to allow the project to the program and add it to their planning.

3.2.4. Requirements

To do the entry test the following elements are required:

1. Water safety assessment, including spatial assessments and opportunities in the area
2. Globally the safety view over time (climate change, developments in the area etc.)
3. A strategy per norm trajectory that defines how the water safety assessment can be tackled best
4. Level of the project: fit-in, linking with other aspects, area development in combination with urgency.
5. Exchange of interventions (spatial, widening measures etc.)
6. Letter of intent is signed by involved stakeholders (if necessary)

All abovementioned requirements are treated in the trajectory approach and therefore connect to the entry test.

3.3. Trajectory Approach

The trajectory approach was developed and finished one year before the entry test, in 2018. After the sharpening of the safety norms in 2017 a new approach was needed to define a strategy that would help formulate improvement measures in flood mitigation problems and deliver the building blocks for spatial developments [7]. The goal of the method is to define an effective approach by defining an execution strategy per trajectory and define globally the scope and costs of these trajectories. Dike development projects often have to do with long dike stretches where it is not sufficient to define only one plan for the whole stretch. Waterboards can decide to split the stretch into sub-trajectories based on urgency, spatial developments, complexity, administrative goals & ambitions and organisational aspects. For every defined sub-trajectory a (slightly) different strategy is required since the safety assessment differs per trajectory. Not every part of the dike is prone to piping for example, so the approach strategy would differ from a dike trajectory prone to erosion. Besides, spatial development goals and integration can differ per sub-trajectory and need a different strategy. The project team should however not forget the broad picture of the total project area since spatial measures should still be connected and fit with each other and with the surroundings.

3.3.1. Procedure

If we zoom in to the trajectory approach the following phases can be identified: occasion and preparation, visualize challenges, determine strategy and follow-up process. For every phase it is shortly described what the most important steps and aspects are. The phases can be seen in Figure 5.

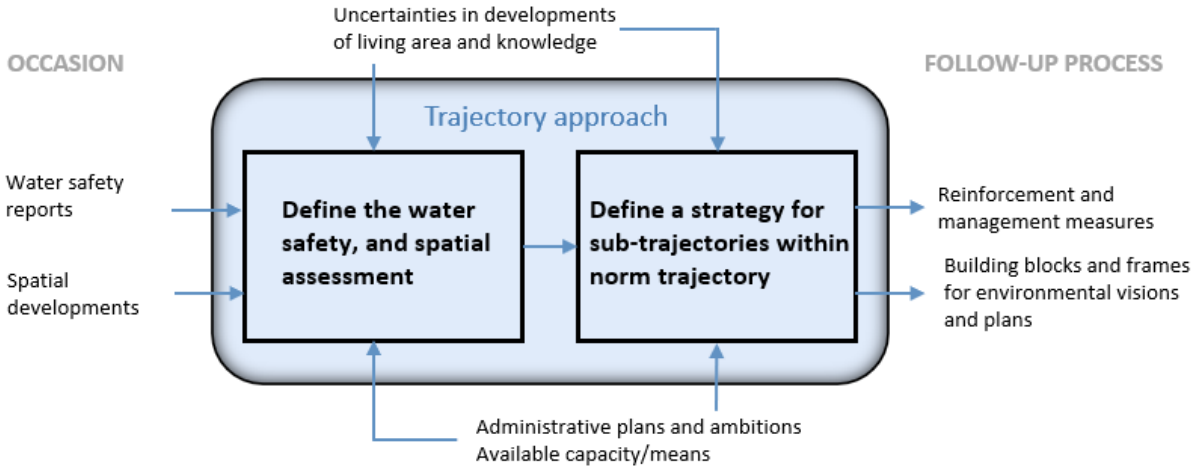

Figure 5: Flow process of the trajectory approach, according to the guideline [7].

Occasion and preparation

The urge for a trajectory approach often comes from a water safety assessment. A certain dike trajectory is not up to safety standards as set in the Water Act and it needs development. There are however other reasons like a maintenance or spatial assessment with linkage opportunity that drives dike reinforcement administrators to use the trajectory approach. In the development of a strategy there are uncertainties that could have influence on the definition of the strategy. The trajectory approach tries to identify uncertain developments in knowledge or in the surroundings. Because these developments can change over time it is needed to be revised once in a while. It is advised to use the same 12 year cycle as the legal assessment. Lastly, administrative ambitions and goals from the waterboard and stakeholders serve as input for the trajectory approach. The vision of the stakeholders serve as guidance in the definition of the approach. These visions often include themes like sustainability, energy, climate and circularity. As mentioned in Section 3.2.4 there are three levels of spatial integration that can be defined, based on the opportunities and complexity of the water safety assessment in the area. The simplest level concerns a fit-in, where the development is mainly led from a technical point of view and less from a spatial point of view. The second level focusses on linkage with the surroundings and integrating the landscape with the development. The last level concerns area development where spatial quality is the main pillar.

Visualization of challenges

In this step the safety-, and spatial assessments are defined in combination with their urgency. Lawful procedures to determine the failure possibilities of the dike on the failure mechanisms are leading for the safety assessment. To define the spatial assessment, exploration of the area is needed to identify the opportunities, size and urgency of the area. The visualization of these challenges form the base to define a strategy for dike reinforcement projects. The trajectory approach aims to achieve a well substantiated strategy by assembling insights early in the project. Part of this is the consultation of area partners that have a stake in the development project. Partners could be municipalities, provinces, environment administrators or other parties with a large stake in the area. By defining the strategy for the environmental management the 'Omgevingswet' ('Environmental code'), operative from the 1st of January 2021, is considered. This law says that a governing body should consider the important aspects of the physical living area and the corresponding interests, while keeping quality in the area [7].

Determination of fitting strategy/approach

Because the safety, and spatial assessment can vary within the same dike trajectory it could be better to divide the trajectory in sub-trajectories. The project also becomes clearer when smaller parts of a dike stretch are taken on rather than the whole stretch at the same time. The choice of dividing depends mainly on the local situations. Communication with partners can be optimized when dividing the trajectory in sub-trajectories. Considering a sub-trajectory reduces the risk of uncertainty and provides a more stable and clear project. It is a clear example of customization since the goal of a trajectory approach can differ as will become clear from the projects described in Section 3.4.2 and 3.4.3.

Possible considerations in defining sub-trajectories as given by the guideline are:

- Length of trajectory
- Effect of the water safety assessment (urgency assessment and spatial developments)
- HWBP guidelines
- Using municipal borders to decrease uncertain factors
- Management considerations and action perspective

Other aspects that belong to the elaboration of the strategy are globally: definition of possible measures, phasing of measures and put them in time perspective (short term, medium term, long term), coping with development uncertainties in the area and a reflection.

Follow-up process

After the approach it can be clear that a reinforcement is required. In that case the next step in the assessment chain can be taken. This can be a (pre-)exploration or start of the entry test. During these phases the scope is further sharpened and uncertainties are decreased. If no reinforcement is required yet, the management organisation is responsible for maintenance and monitoring. It could be the trajectory has not the highest priority but maybe more frequent check-ups are required to guarantee safety and condition of the dike. Lastly, the outcome of the approach is a strategy for the reinforcement approach and this can be helpful for defining environmental vision and improve planning with stakeholders [7].

3.4. Casus projects

In this section three casus projects are described in detail that used the ET, TA or a combination. Two other casus projects that have used the ET and a combination are shortly summarized in 3.4.4.

3.4.1. Project Jaarsveld-Vreeswijk

To get a better image of the implementation of the entry test a project from HDSR (Hoogheemraadschaap De Stichtse Rijnlanden) is used in this research. This waterboard used the entry test for project Jaarsveld-Vreeswijk (JAV), which is currently in the exploration phase. The project manager of this project has been interviewed on the experiences the waterboard encountered during the entry test. The results of this interview are processed in this section. The trajectory considers the reinforcement of the Sterke Lekdijk between Schoonhoven and Amerongen and is 55 kilometres long. JAV is part of this trajectory and covers 13 kilometres of the Sterke Lekdijk [16]. The trajectory approach was not explicitly used to come to this decision, since the approach was not familiar, but based on known problems in the area and dike length a trajectory division was made. For example a small trajectory of only 2 kilometres was prioritized, called Salmsteke (Figure 6). At that location there was a high urgency for developments in the floodplain and it was therefore decided to start there first.

Figure 6: Complete trajectory of the Sterke Lekdijk project. In blue trajectory Jaarsveld-Vreeswijk and in pink trajectory Salmsteke [16]

Working method

The area consists of urban area near Vreeswijk and rural area throughout with varying lengths of floodplain and countryside land. At first the project team considered these two area as different trajectories, because the dike looks different at these areas and other measures are required. Quickly it was decided however to combine them together and use an integral approach. Eleven landscape sections have been defined, based on different situations in the area like urban, recreational, rural, combined areas, etc… As described in the factsheet of the entry test, the project team defined linkage opportunities and involvement of the area. Since it was such in an early stage the project team decided not to research this in detail yet and postpone this to the exploration phase. It was communicated to the HWBP team what was known at the time and the details would be defined in the exploration phase. The expert team concluded that enough was known at this phase and the project team could proceed and finish the entry test.

Experiences and lessons learned

At first HDSR was hesitant when the HWBP approached them at the start of the exploration phase to perform a pilot entry test on the project. The project team was already busy with the project and they were afraid of the time investment. It turned out to be better than expected: regarding means nothing but a small time investment was necessary. The project team was already working on a plan of action for the exploration phase so a lot of aspects had to be investigated anyway and the entry test was a simultaneous addition to the process. Only a start meeting, two work studios and involvement of four project team members contributed to a total of approximately 50 hours of time investment.

What is unique about the whole trajectory of the Sterke Lekdijk is that HDSR set the goal to complete the project emission-free with use of electric or hydrogen driven vehicles. For this they contacted three contractors and made agreements for the coming 10 years to make this innovation happen. The entry test gave the waterboard the possibility to present this to the HWBP team and receive feedback and tips.

Another positive experience was that the project team got to know the HWBP better. Before the entry test, the HWBP acted mainly on the background and were not actively involved in the projects. With the entry test the HWBP team was able to ‘take a look in the kitchen’ of the waterboard project team. The communication between the teams resulted in clear goals from the HWBP to the waterboard and the other way around. Both teams could share their knowledge and

sharpen each other. For the HWBP it became clearer how dike reinforcement projects are managed and it is known to them now what can be expected from the project team and what not. The entry test can be seen as a logical moment to meet each other and discuss the first plans and course of action of the project.

What also was mentioned by the expert as a positive experience was the fact that the entry test gives clear requirements on what the project team should include. This makes it easier to construct a successful action plan and receive funding. Before, this was unclear or requirements were so broadly formulated that it could not be specified in the action plan. The formulation of requirements in the entry test did help with concretization the needs of the HWBP.

A point of improvement can be a more detailed process description of the entry test. Sometimes it was unclear what was expected from the project team at the work studios to deliver and show the HWBP team. If this was clear the project team could have prepared better and give the HWBP team more information. However, the entry test was new for both parties and they were both figuring everything out.

3.4.2. Project Petten-Den Helder

One of the projects that has used the trajectory approach is project Petten-Den Helder along trajectory 13.3 (Figure 7).Waterboard HHNK (Hoogheemraadschap Hollands Noorderkwartier) is responsible for this dike trajectory and has also conducted the trajectory approach here. All the information in this section is gathered from an interview with an expert working at the project from HHNK. He took part in the trajectory approach for trajectory 13.3 and was involved during the whole process. What is special about this trajectory is that the primary safety defence consists of naturally formed dunes, instead of man-made dikes. From the water safety assessment it became clear that this trajectory met all the safety standards and there was no need for reinforcement or development. However, the waterboard decided that still a trajectory approach would be conducted to gain experience for their own management department.

Figure 7: Working field of HHNK in the province Noord-Holland. Trajectory 13.3 is around 20 kilometres in length and can be seen encircled. The picture is from 2015 and is outdated regarding the norms [17]

Working process

Since there was no need for reinforcement, no entry test was needed. Besides, the project was listed on their own program: 'Verbetering Boezemkaders 2', so an entry test would not have been obligatory, because the HWBP was not involved. During the trajectory approach a small team of only 3 people from the department of Water Safety and Roads worked on the assessment of the area. They mapped all objects and stakeholders in the area that could somehow influence possible future developments in the area. This was done by defining short term and long term effects. Included in the short term effects were the construction of pipes and wires from a wind park on the north sea underneath the dunes to the land, construction of sand pits by Spot North Holland (Landschap Noord-Holland), possible relocation of beach pavilions seawards to enable sufficient dune regrowth, and a linkage opportunity of the reconstruction of the nuclear power plant in Petten, where sand can become available for use by HHNK. Long term effects included sea level rise, with subsequent reinforcements of the dune landscape, possibly more pipes and cables running underneath and salinization of the land behind the dunes land inwards. The team mapped all objects that could influence the safety of the area in the future. Examples are objects like old bunkers, non-detonated explosives from WOII and a shooting range of the military. After this they talked with stakeholders and discussed about their future plans with the area and how these plans can combine with possible plans of the waterboard. Besides extern stakeholders like municipalities, province, holiday resorts, villages, 'Natuurmonumenten' and the city of Den Helder, the team talked to internal experts at HHNK. Much knowledge is present within the organisation and the team alone did not have enough knowledge on all ongoing processes in the area. They talked to area- and object administrators, relation managers, environment managers, department heads, colleagues researching salinization etc… The process took the team around 6-8 months to complete. From the moment stakeholders were contacted and spoken to, the average time spent per week for the team was around 10-15 hours, with a maximum of 20 hours. This included making maps, taking photographs, reporting and talking to the stakeholders. Map-making and explanation of the objects in the area was done by looking at the dike sections. Every section is around 1 to 2 kilometres in length and every sections has been described in detail on the points mentioned above.

Experiences and lessons learned

The team discovered that involving spatial developments and tasks early in the process is valuable, but time-consuming. Because the team was small and there was no concrete task division, the mapping of the area took longer than expected. They know now, however, what the influence is from stakeholders and objects in the area on their action perspective. Additionally, they learned to work with an integral working method. The trajectory approach has given them clear insights of the complete area: what is present and what are plans of others and what are the risks on the plans of HHNK. In the guidance paper of the trajectory approach it is noted that from the safety assessment, a strategy is constructed. Since there was no safety assessment for this trajectory, the trajectory approach has not been followed 1-to-1 or completely walked through.

Recommendations

The team advised to continue the regular maintenance of the area in spring and autumn. If it becomes clear there is a reinforcement needed, the stakeholders and objects are already defined and the project could have an accelerated start. It is advised though for projects with a safety assessment to construct a complete project team with task division, since it can be time consuming. The final recommendation is that HHNK should be alert in keeping the information up-to-date. Right now they have made a current snapshot of the area, but over the years things

can change in the area. At this moment it is not yet clear how to do this, but it is important to think about this.

3.4.3. Combined project Spijk-Westervoort

The last project that is reviewed in detail for this research is project Spijk-Westervoort. This project is started by WRIJ (Waterschap Rijn en IJssel) and they are one of the first to combine the trajectory approach and entry test in their projects. Information about this project has been gathered by an interview with the environmental manager and project manager. This project is rather similar to project SSH in size and in environment. Both cover more than 25 kilometres of dike and both concern a large part of the Nederrijn, but on the opposite side (Figure 8).

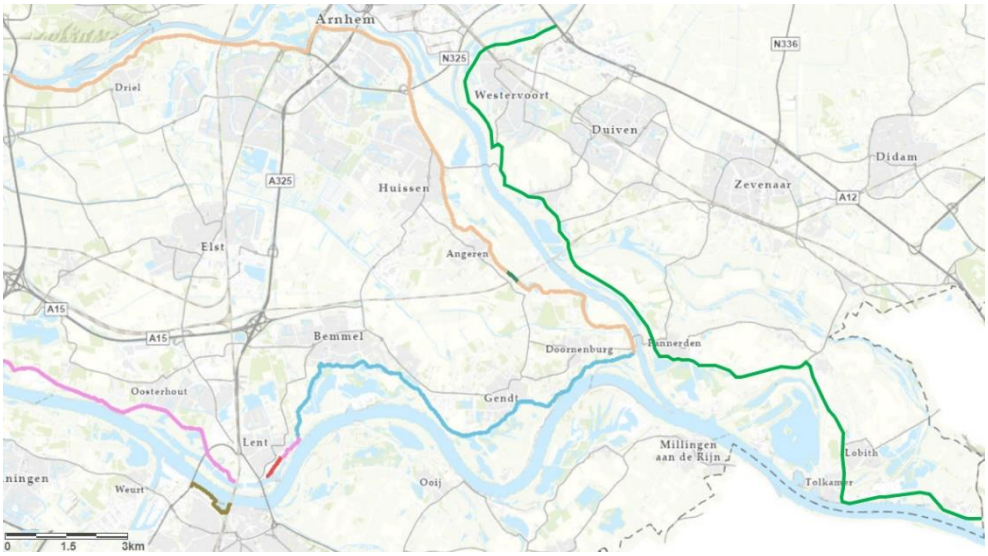

Figure 8: Map of the area Nederrijn and Waal with dike trajectories of WSRL and WRIJ. In orange and blue trajectory SSH and in green trajectory Spijk-Westervoort (27 km) from WRIJ [12], [18]

Trajectory approach

In February 2020 the trajectory approach started and at the end of 2020 it was finished and sub-trajectories were defined. In May 2021, WRIJ applied for subsidy for the pre-exploration phase at the HWBP. It is expected that at the end of September 2021 the pre-exploration is finished. The plan of action for the exploration phase should then also be sent to the HWBP. It is decided to execute a pre-exploration because from the trajectory approach it became clear that there are uncertainties that are taken into the exploration and they want to clarify them as best as possible. The result of the trajectory approach was a split in three sub-trajectories: Westervoort-Pannerdensche Waard, Pannerdensche Waard-Tolkamer, Tolkamer-Spijk (Figure 9) [18]. The choice of trajectories and their order was determined by the urgency of the trajectory and strategic uncertainties in the area. One of these uncertainties regarding water levels in the river is a possible retention area at Rijnstrangen in case of high waters. It is not yet determined if this area will actually be used as retention area so it brings uncertainty to the project.

Working process

During the trajectory approach the project team defined three different tracks that were considered separate from each other, so different people could focus specifically on their point of expertise. In total the team consisted of 8 people, among which a project manager, environmental manager, technical manager, senior policy advisor, contract manager and project management manager. The different tracks are divided in:

- Strategy
- Technic
- Environment

For every track they determined what from that point of view would be the priority and the decision of where to divide the trajectory in sub-trajectories. This resulted in three different sub-trajectory divisions that were confronted to each other in the form of a presentation. During these presentations of the tracks, the emphasis was on the point that the environment track only spoke from their aspect and the technic track only from their aspect. This somewhat awkward and unusual approach showed clearly what was most important for the specific tracks and what had the highest priority. Based on arguments and discussion of the different tracks and a multi-criteria analysis a trade-off was made to define the final trajectory division and priority.

Within the environment track things like linkage opportunities and spatial developments were considered. The strategy track includes river-related developments like discharge distribution and the connection with Germany. Besides this, it also includes uncertainties with HWBP programming and financing. From the base, they tried to answer the question if there is a financial difference between an integral reinforcement approach and an adaptive partial approach. The integral approach looked at all failure mechanisms including height and the adaptive approach included the uncertainties in the area that have influence on the dike in the future. This can lead to a strategy to reinforce based on the failure mechanisms but postpone heightening of the dike for later, when more is clear and more certain. The strategy track concluded that for now that the financial impact was not that big and there was no need to make a decision right now what approach to choose, but take it along to the exploration phase and decide then if a trajectory can better use an integral approach or the adaptive partial approach. The pre-exploration is also expected to help with this decision. It became clear though that there were two areas clearly prone to piping, so these areas have been shifted towards the highest priority sib-trajectory (as seen in orange in Figure 9). It is estimated that the trajectory approach costed around €100.000 per defined sub-trajectory, so in total €300.000.

Figure 9: Division of trajectories along project Spijk-Westervoort. In orange the highest priority trajectory, in purple the second, and in yellow the third.

Entry test

WRIJ was the first waterboard that got approached by the HWBP to conduct the entry test for one of their projects: Spijk-Westervoort. WRIJ agreed to the proposal and started the entry test for Spijk-Westervoort.

Working process

It was decided to combine the course of the entry test with the procedures from the trajectory approach into a, how it was called, process plate. This diagram included a flow in time with tasks and procedures that had to be done over time. During the process, this plate was always referred to. Not only internally, but also externally and towards the assessment team of the HWBP. This method was considered as pleasant by all involved parties. It was clear what had to be done and what was required before it could be done. The process plate can be seen in Figure 12 in Appendix A. At the start the three tracks defined during the trajectory approach can be noticed. In green the technic track, in red the environment track and in blue the strategy track. Together with the first work studio (yellow) the first version of the trajectory division, priority & strategy is determined. From here the project team validated the partners, scope & risk, administrative tuning and stocktaking (middle four blocks). During a second work studio the first version is updated to the new insights and information. From here the plan is slightly changed in an iterative process and finally towards the scope exploration. The blue box with adaptive strategy is taken into the exploration phase and has therefore a loose end. This type of process is intended to be used for the upcoming entry tests as well and it is expected that it will proceed even better because they have experience now with this way of working. This is confirmed by the project team working on another trajectory, namely Doesburg-Zutphen. They followed the same process for the trajectory approach and entry test and got useful feedback from the assessment team and the final results were positive and comparable to the results of Spijk-Westervoort.

During the first work studio of project Spijk-Westervoort, the project team presented from each track perspective how they came to the trajectory division and priority. The assessment team of the HWBP questioned the team on their choices and argumentation and this gave logical and clear insight in the project and how to proceed. The earlier in the process the assessment team is up-to-date on what the plans are the better they are able to plan meetings and opportunities for consultation. The combination of a structured trajectory approach and a solid safety assessment made the collaboration with the HWBP expert team a great success. There was one point of improvement however noticed by the project team. The work studio sessions and assessment were highly technical oriented. The assessment team of the HWBP was able to question and be critical about the technical side of the project, but was rather neutral and in agreement with all the other plans, regarding environment for example. The safety aspect does contain a lot of possible risks and uncertainties so it is important to put time and effort to identify and coop with them, but within environmental tasks there can also be important and major risks and uncertainties that may slip through if the focus is mainly on the technical side. The same was experienced for project Doesburg-Zutphen.

Experiences and recommendations

As becomes clear from the previous section, more experts on environmental challenges could be included in the HWBP team to bring more balance to the entry test. This may be hard because there is much freedom in ‘the environment’ and it is a rather comprehensive and sometimes vague concept, but more attention to this topic should help improve defining chances in the environment.

Another important aspect that was noted is the involvement of the organization management in the dike reinforcement process. A result of the trajectory approach could be a postponing of a part of the trajectory by multiple years, because the urgency is not high enough. For those years it means there are still management tasks and some points might need more attention during these years. It is important to involve them early in the process and give them perspective until the reinforcement. Similarly, the composing of a team is dependent on the tasks and timeline of the project. If there is a smaller project with a less big task and little priority, and the reinforcement is still years away, a smaller team consisting of mainly management could be assigned rather than a complete project team.

The project team did not experience a serious increase of time effort by using the trajectory approach and entry test. Only some meetings took some additional time. Key in this is proper communication and process planning between the project team and the expert team. Everyone is familiar with the process and no tasks are done twice. Having this clarified early made it possible there were not much additional meetings required. The main recommendation is that the work should not be underestimated. In total it will costs time and money and active involvement from all parties is required in order to make it work. At the start, the project team thought that it could be mainly executed as a desk study, but active communication and cooperation has proved to be crucial.

The last point of attention goes to the involvement of stakeholders in the project. Administrative stakeholders like provinces and municipalities were involved during the trajectory approach and entry test. Non-administrative stakeholders were however not yet informed because the goal of the trajectory approach was to split the trajectory in parts and the involvement of non-administrative stakeholders would not add much in the decision-making and could cost a lot of valuable time. Besides, it is not yet clear what kind of plans there are with the area so there is nothing yet to inform people about. To prevent making incorrect expectations it was therefore chosen to not include these stakeholders yet. After the exploration phase, when the preferred alternative is presented, then is the moment to go out in to area and contact stakeholders what the proposed plans are.

3.4.4. Other projects

Besides the three described projects there are two other projects from different waterboards that were interviewed (Table 2). One is from WS Fryslan, who used the entry test for one of their projects, the other from the Brabantse Delta, who used a combination. They are shortly described here.

WS Fryslan: Schiermonnikoog

This relatively small (4 km) and isolated project started the pre-exploration in 2021 and the exploration is expected to start in 2022. The entry test was started in autumn 2020 and took 3 months to finish. A trajectory approach was deliberately not used since it was rather unknown what it exactly was. From the entry test two main recommendations were given by the HWBP team: 1) execute a 'knikpunt analyse' (tipping point analysis) and 2) analysis of the surroundings. Normally, these tasks are not necessary or take place in the exploration phase. Because these tasks are shifted towards the front this meant €0.5 million was needed to do so. Since no project was yet defined, normally these costs are on account of the waterboard, but since they would normally take place in the exploration phase it could be funded, in consultation with the HWBP. The course of the entry test was clear, but it turned out to be difficult to make a cost estimate, since it is so early in the project. Also, it was not clear what sort of product was expected to be delivered. This communication could be improved.

Brabantse Delta: Willemstad-Noordschans

In this 10km trajectory with a 7km long reinforcement task, both entry test and trajectory approach were used. What is special is that the trajectory approach was conducted after the entry test, rather than before. This was chosen because the waterboard thinks conducting a trajectory approach so early is not useful because there is no project yet and there are many uncertainties. First, they want to have clear what the precise task is before they contact environmental partners. The standard stocktacking together with their 'Project Start Document' was enough to finish the entry test. In this document the preconditions, planning and cost estimate are presented. For the Brabantse Delta the entry test was mostly a motivation to make their Project Start document complete. It was also useful that someone internally from the HWBP was working together with the project team. This had a positive effect on clarification, from both sides.

3.4.5. Advantages & Disadvantages

In the following three tables (Table 4, Table 5, Table 6) an overview of advantages and disadvantages, following from the expert experiences, are presented for the entry test, trajectory approach and combined methods, respectively. It can be noted that advantages and disadvantages of currently used methods are not included. This is because there was no clear method before implementation of the entry test and trajectory approach, besides, experiences from expert interviews turned out to be shallow and there was not much clarification about the way of working before 2018. That is why it has been chosen to only include the entry test, trajectory approach and a combination of methods in the remainder of this research.

Table 4: Advantages and disadvantages of the entry test, used by HDSR and WS Fryslan

Method	**Entry test**	
	HDSR	WS Fryslan
Advantages	-Overlapping tasks -Small time investment (~50 hours) -Close contact with the HWBP -Clear list of requirements -Not many people required	-Helps the project have an accelerated start -Barely any additional costs, rather a shift of costs from the exploration -In consultation with HWBP a lot is possible -HWBP gives useful feedback, tips and advice
Disadvantages	-Process during work studios not always clear (better preparation possible)	-Desired product not always clearly described by the HWBP team -Mainly technical approach

Table 5: Advantages and disadvantages of the trajectory approach, used by HHNK

Method	**Trajectory approach**
	HHNK
Advantages	-No mandatory tool (free in decision-making) -Delivers a strategy on trajectory level -Ongoing parallel processes in the area are defined and considered -Plans of area partners become clear -Can be executed without reinforcement task -Gives an accelerated start of the project
Disadvantages	-No mandatory tool (no pressure or need) -Approach is to own input (can lead to ambiguity) -No guiding from HWBP or other expert organisation -Can take much time -Yet unclear how to keep up-to-date

Table 6: Advantages and disadvantages of the combined methods, used by WRIJ and Brabantse Delta

Method	**Combined ET and TA**	
	WRIJ	Brabantse Delta
Advantages	-No unexpectedly large extra time investment necessary -Allows a structured and integrated project approach -Early image of plans of administrative stakeholders (like municipalities and provinces)	-Inventory and ongoing processes of the area, next to the safety assessment, sufficient to finish ET -HWBP gives targeted advice what is required and in which phase -Gives pressure to work accurately ('stok achter de deur')
Disadvantages	-Focus mainly technical -Took some time to make a planning for both the waterboard and the HWBP team (process plate) -Too early in the process to consider non-administrative stakeholders	-Medium time investment (~100 hours) -TA too early in the assessment chain -Focus mainly technical

4. Benchmark Analysis

Based on literature and expert opinion and experience, a benchmark analysis is conducted. To prevent confusion benchmark is used instead of criteria, since TA and ET both have their own embedded criteria. In this thesis, the differences between the methods themselves is researched by using benchmarks. The analysis consists of quantitative and qualitative benchmarks, which require some side notes in order to clarify certain outcomes presented in Table 7.

4.1. Quantitative benchmarks

Lead time

The lead time as indicated by the expert from HDSR was 3 months. The expert from WS Fryslan indicated the time only as time investment by the waterboard's project team. The lead time by HHNK was 6-8 months, double the time as expected. This is explainable by the small team and a bigger task than expected. Since there was also no reinforcement task there was also less pressure to finish fast. The long lead time is also relatable to the goal of HHNK, which was to make photos and maps of all objects that have possible influence on future reinforcement. This turned out the be a time consuming process. The total lead time of WRIJ was 10 months, from start of the trajectory approach until the final assessment of the entry test. This included considerable planning work between the project team of WRIJ and the HWBP team. The expert from Brabantse Delta indicated a smaller lead time, 5 months. The major difference here is that the sub-trajectory division was determined based on the water safety assessment and no other scenarios were considered, as WRIJ did. This part took WRIJ the longest time and the difference in lead time can most likely be related to this. Using the trajectory approach before the entry test, with the goal to define an optimal sub-trajectory division based on multiple points of view can therefore be considered time consuming.

Amount of employees

The amount of employees in the project team who were responsible for the execution of the methods did differ slightly from waterboard to waterboard. There seems no clear relation between the amount of employees and the scale of the project or the type of method used. Most likely, it depends on the waterboards goals, capacity and available expertise who are selected and how many people. The functions of the employees differ but it becomes clear that at least the following functions are involved in the teams:

1. Project manager
2. Environmental manager/or relation manager with expertise about area partners and ongoing processes
3. Technical manager
4. Policy advisor

Time investment

The time investment is formulated as the total amount of hours that the project team has put into the method. From the interviews these are mostly: a start meeting, work studios, interim meetings internally (within project team) or externally (with HWBP or other organisation). The time investment of the entry test of HDSR is 50 hours (10-15 hours per employee). This is a little less than the expected time investment of level A entry test, which is estimated as 20 hours per expert (Section 3.2.1). As mentioned by the expert, overlapping tasks and clear requirements may

have contributed to this smaller time investment, even though it was also indicated that the process of the work studios was not always clear. The increased time investment of the combined approach by the Brabantse Delta seems a logic consequence due to the fact that the methods had to be integrated with each other, leading to more work. The most notable result is the big time investment of HHNK. As explained already before, this is due to the long, unexpected lead time. The expert mentioned an average time investment of 15 hours per week by the team. Considering 7 months of lead time, so 28 weeks, this equals to a total of 420 hours. This can be related to the goal of the trajectory approach of HHNK: map the whole project area.

(extra) Financial cost

From WS Fryslan it became clear that the tasks performed during the entry test costed them 0.5 million, but it must be noted that this is expected to be a 80 to 100% shift of costs from the exploration phase to the initiation phase and, additionally, it was funded by the HWBP. These costs were relatable to an executed tipping point analysis and analysis of the surroundings, as mentioned in Section 3.4.4. The only other indicted financial cost was mentioned by the expert from WRIJ. He mentioned a cost of 0.3 million, mainly relatable to internal hours and a technical assignment granted to an external organisation, HKV, of €55.000. Furthermore some small expenses for organisation and facilitation (conference rooms etc.) were required. These expenses are not specifically project dependent and can be applicable to every project using the combined approach. An additional cost of around up to 0.5 million for either the entry test or combined method is therefore a considerable consequence for waterboards. However, the obtained 'blueprint' and experience leads to a more efficient way of working for a second project, which can decrease the financial costs. This was the case for project Doesburg-Zutphen of WRIJ. The same approach was used and in this project the costs were lower, since the approach from Spijk-Westervoort could be re-used.

4.2. Qualitative benchmarks

The most right columns in Table 7Table 7 indicate the qualitative benchmarks and the final scores from the expert interviews. It is chosen to use the same weights per benchmark, since no explicit preference for one or the other benchmark has been spoken out. They are all weighed as 1. It must be noted that for 'preparation' a high score is positive but indicates little preparation work. A 1 indicates much preparation work and is therefore considered as a negative influence on the score and a 4 very little to no preparation.

Ease of use

The ease of use is a benchmark that indicates to what extend the method is logic, understandable, and executable. The entry test has been scored on 3.0, on average, (HDSR: 2, WS Fryslan: 4). HDSR indicated that the process of the test, especially at the work studios, was sometimes unclear for them. Communicating so closely with the HWBP was advantageous though for the continuation of the project. For WS Fryslan the approach was clear. The expert joined during the second work studio and the two teams were very well prepared and tuned to each other. The agenda was clear, what was asked was clear and the delivered material fitted what was expected from the waterboard. Only the description of the product that had to be delivered was not very clear. Still a score of 4 is given since the method itself was considered as clear and easy to implement. The score of the trajectory approach in the project from HHNK is a 3. This is mainly determined by the fact that the waterboard was very free in the decisions it made. No strategy was required for the rest of the project because there was no safety task. The combined methodology was scored a 3.5 on average (WRIJ: 4, Brabantse Delta: 3). For WRIJ it was searching in the beginning to come up with a proper approach to run through the trajectory approach and combine this with the entry test. This took time and effort but they are very satisfied with the result and when the

process plate was constructed it was easy for all partners to follow the process and deliver their parts in time. Therefore a score of 4 is given. Brabantse Delta was searching as well at first what information had to be delivered and to what extent it was satisfactory. Someone from the HWBP was guiding the team and this was considered a good check on the information they wanted to deliver.

Administrative goals & ambitions

Waterboards and other organisations can have their own goals and ambitions that drive them and have influence on their decision-making. For example: the project from HDSR strives to execute the reinforcement without any emission of fossil fuels. These kind of ambitions can substantially influence the course of the project and are therefore important to consider (preferred early in the process). This benchmark measures the capability of the methods to consider the administrative goals and ambitions of the waterboard, and to what extend the method pays attention to them. The entry test scored a 2.5 on average (HDSR: 3, WS Fryslan: 2). HDSR indicated that the entry test helped them to define spatial integration and linkage opportunities. It also became clearer on what points they would be assessed, which made it easier to construct a focused plan of action and therefore more successful subsidy application. WS Fryslan indicated that things like sustainability ambitions were not necessarily mentioned in the entry test, while it could have major consequences on costs, planning and complexity. It is considered in conversations and the HWBP is open for it, but it has not yet gotten a place in the entry test. A score of 3 is given for the trajectory approach executed by HHNK. The waterboard put much effort in defining stakeholders, future developments and objects. The trajectory approach gave them room for this. Since there was no reinforcement required so therefore no strict deadline with high pressure it was possible to map the area with so much detail. If there was however a reinforcement required it is most likely this will be hard to achieve. The score for the combination of methods is 1.5 (WRIJ: 2, Brabantse Delta: 1). WRIJ explicitly put much time on how to combine their goals and ambitions with the methods. It is indicated that the methods lean towards the consideration of goals and ambitions for others, rather than on their own and that this way their goals and ambitions may get out of sight. Brabantse Delta did not experience an added value of the contribution of the methods to their goals and ambitions. Administrative goals are taken into consideration in the plan of action. There was attention for example sustainability and climate robustness but not as early in the process as the entry test or trajectory approach.

Preparation

The preparation can be described as the preliminary work that has to be done before a method can be started with. This could be the safety assessment, mapping of stakeholders, field research, soil research etc. The benchmark is scored as follows: The more preparation (leading to more time investment and probably higher costs) is needed, the lower the score. Otherwise a high score would indicate a positive effect on the total score, which is considered not true in this case. As little preparation, while achieving the desired results, is considered as a positive contribution to the score. The average score for the entry test is 2.5 (HDSR: 3, WS Fryslan: 2). HDSR has experienced some preparation, mostly regarding the water safety assessment. The project started before the new safety norms implemented in 2017, so this had to be done again by using the new norms. By the HWBP team it was asked how the linkage opportunities looked like in the area, but since it was so early in the process it was decided not to look into them yet, but do this during the exploration phase. Furthermore, actions that had to be done for the entry test were required to be done anyway, so there was not much more needed to be done in addition. For WS Fryslan the safety assessment was also considered as most important preparation. Also some prior knowledge about the surroundings was researched by the relations manager. He looked at

current projects and initiatives in the area. During the entry test, the HWBP team recommended a 'knikpunt analyse' and analysis about the surroundings. This was a large, additional element to the preparation of the project and therefore appraised with score 2. The score for the trajectory approach of HHNK is 3. HHNK has spent much time on the trajectory approach itself, but there was not much required as preparation. They started directly after the water safety assessment was completed, and no reinforcement was necessary. The same holds for WRIJ and their project. The total score for the combined methods is 2.5 (WRIJ: 3, Brabantse Delta: 2). Much time and effort was spent at defining a proper strategy to run through the entry test as best as possible, but not much preparation was required besides the water safety assessment. Most of the preparation work is dedicated to the pre-exploration and exploration phase. Brabantse Delta has executed the safety assessment and they constructed the 'Project Start Document', where preconditions, planning and cost estimates are presented for the project.

Table 7: Performance matrix and scoring of criteria on the methods based on results from the expert interviews

		Distance	**Quantitative benchmarks**				**Qualitative benchmarks**			
Method	Interview	Length (km)	Lead time (months)	Amount of employees	Time investment (hours)	(extra) Financial costs (Mil)	Ease of use	Administrative goals & ambitions	Preparation	Average
ET	HDSR	13	3	4	-	-	2	3	3	**2.7**
	WS Fryslan	4	-	6	50	0.5	4	2	2	
TA	HHNK	20	6-8	3	420	-	3	3	3	**3.0**
ET & TA	WRIJ	27	10	8	-	0.3	4	2	3	**2.5**
	Brabantse Delta	10	5	5	100	-	3	1	2	

In general, all methods are indicated as easy to use, ranging from 2-4. Administrative goals and ambitions are in most methods also satisfied and considered. Only the expert from Brabantse Delta experienced no additional contribution of the entry test in the consideration of their administrative goals and ambitions. There was attention for sustainability, climate robustness, etc., but not additionally compared to projects without entry test, hence a score of 1. Preparation works are mainly uniform and indicate a small to moderate amount of preparation. Most preparation works are: water safety assessment and preliminary knowledge of what is going on in the area (important area partners, risks, opportunities etc.). Combining the qualitative scores the following result comes out: ET & TA combined: 2.5, Entry test 2.7, Trajectory approach: 3.0. On average, the trajectory approach, although only executed alone by one, is more time consuming than the entry test. Regarding the ease of use, administrative goals and ambitions and preparation, both methods are alike and the experiences rather equal to each other. The combination method is experienced as more time consuming and requires more employees. Despite this, the ease of use, after defining a planning, is considered as more than sufficient. Also no more additional preparation work is required when comparing to only the entry test or trajectory approach. The only lack compared to the separated methods is the attention given to administrative goals and ambitions. Apparently, no additional attention is given to this aspect compared to situations without the entry test or trajectory approach. As said however by experts, the HWBP is interested in new and innovative goals and ambitions and is open minded towards them.

5. Consequences and added value

In this final chapter the consequences for WSRL are determined for their project SSH and possible projects in the future. First some more detailed information about project SSH is given, then the consequences are formulated, and lastly, an advice/proposal for SSH is given as well as for possible future projects.

5.1. Project Sprok-Sterreschans-Heteren (SSH)

At the start of 2018 it was decided to do a pilot pre-exploration for project SSH. This decision was made in response to the new Deltaprogram 2018, which states that the approach of the HWBP should be to create social added value on the surrounding area [19]. The pre-exploration has been executed by WSRL and the Province of Gelderland. Together they identified area partners, linkage opportunities, developments and bottlenecks. Besides, parallel processes from other stakeholders in the area have been identified, like IRM, Dijkenvisie and highway A15. Identifying these processes early, gives the waterboard and the other party the opportunity to adjust their statements and where possible integrate them or maybe decide not to at all. In total 8 involved (governmental) partners (including WSRL) have been asked what themes regarding the surroundings they deemed as most important. Besides themes, also ambitions in the area have been discussed with the Province and Staatsbosbeheer. Next, using an analysis from the most important issues and ambitions from the partners it was decided what chances and risks there are in the area. Combining this gathered information a strategically logic sub-trajectory division was made. In October 2018 the project was divided in three sub-trajectories: Sprok-Sterreschans, Sterreschans-Drielse Dijk, Drielse Dijk-Heteren [19].

In more recent developments one addition to this division was made between Sterreschans-Drielse Dijk, namely Huissen. From here onwards the area around the river becomes urban and there is less room for the river. Because of this the characteristics of the dike change accordingly, which could require a different reinforcement strategy. This is why this new sub-trajectory was defined. The trajectory division as of now can be seen in Figure 10. Within this division multiple scenarios have been created that look from different points of view:

1. An urgency and knowledge development perspective
2. An equal cost allocation perspective
3. A capacity (same project teams) perspective
4. A surroundings and linkage opportunities perspective

Looking from these perspectives and also focusing on them alone looks like the approach from WRIJ in project Spijk-Westervoort (Section 3.4.3), where they defined tracks to look into a possible trajectory division. At the moment, only scenario 1 has been slightly worked out in more detail. Considering the urgencies of the trajectories the order of execution would be:

1. Drielse Dijk-Heteren
2. Sterreschans-Huissen
3. Sterreschans-Sprok
4. Huissen-Drielse Dijk

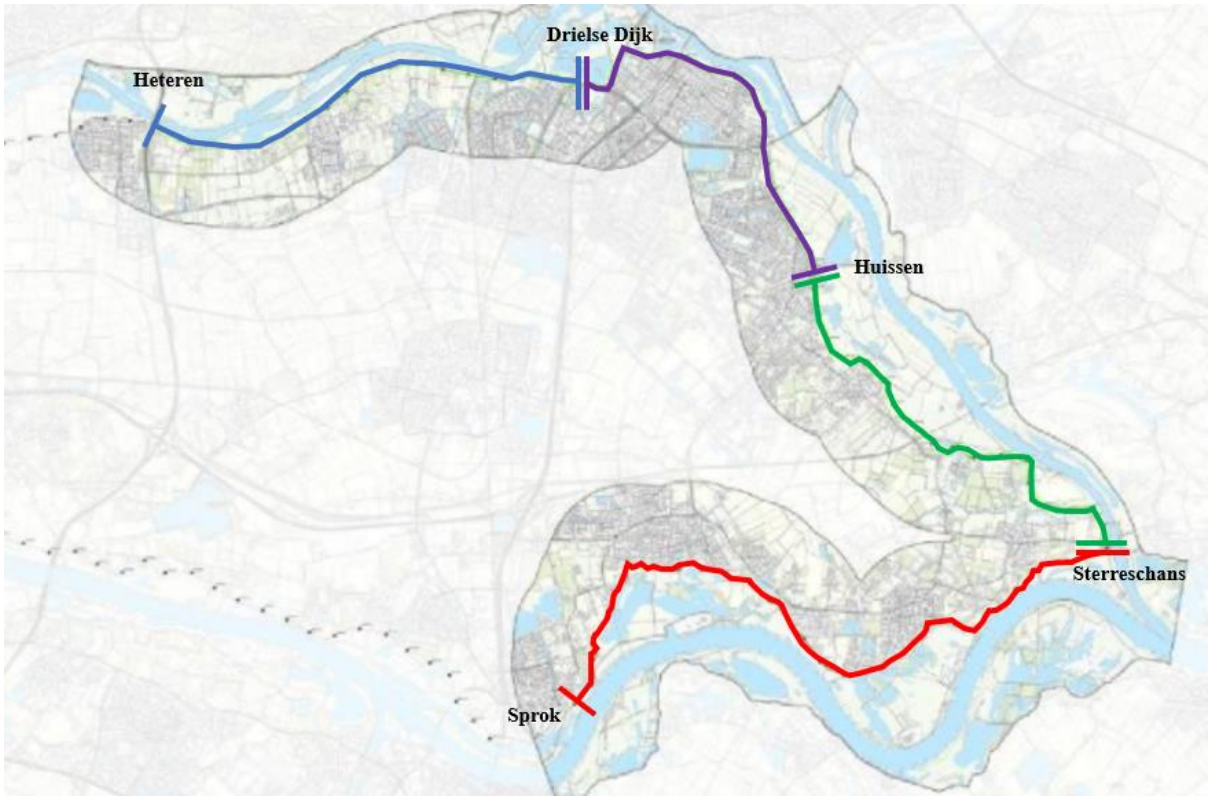

Figure 10: Current considered trajectory division for SSH. In light blue: Heteren-Drielse Dijk, purple: Drielse Dijk-Huissen, green: Huissen-Sterreschans, red: Sterreschans-Sprok, in total a length of 38 km. (underlaying image received from report pre-exploration [19]*).*

5.2. Consequences SSH

Using the expert experiences, advantages and disadvantages , for every method, possible consequences for project SSH are determined. The goal is to give insight in how the choice of using one of the methods, or both, has influence on the course of the SSH project. This is hypothetical and based on prior projects mentioned is this thesis.

5.2.1. Entry test only

To go through the entry test the elements as mentioned in section 3.2.4 are required:

1. Water safety assessment, including spatial assessments and chances in the area
2. Globally the safety view over time
3. A strategy per norm trajectory that defines how the water safety assessment can be tackled best
4. Level of the project: fit-in, linking with other aspects, area development in combination with urgency.
5. Exchange of interventions (spatial, widening measures etc.)
6. Letter of intent is signed by involved stakeholders (if necessary)

The water safety assessment has been finished and it is clear for piping and macro stability inwards where the critical parts of the dike are. Per dike section of 100 meters it has been researched and determined if the norms are met. During talks with colleagues it became clear that for a clear visualisation and communication of the safety assessment it is necessary to create a graph with failure possibilities for every dike section. With this graph it also becomes clear if there are larger sections prone to failure or that this is scattered along the dike length. This can have influence on the decision for trajectory division and order of reinforcement. Due to the pre-exploration there is much known already about the partners, ambitions, risks and (linkage)

opportunities in the area. From the expert interviews, these are aspects that are expected to be considered by the waterboard during the entry test. Some of this information may be out dated after 3 years, and no updates on the area have been executed meanwhile. For the entry test, updated information is required so a new, similar, environmental analysis as in the (pre-)exploration is recommended.

To comply to the second requirement the safety assessment over time must be clear. WS Fryslan has done this after recommendation by the HWBP. They executed a tipping point analysis for over 25 and 50 years. In a break point analysis the time of failure, or the time that a mechanism does not meet the norm anymore, is found out. This can be done for every consecutive year, but since it is unlikely that a failure mechanism suddenly does not meet the norm anymore, it can be done with a larger time step (as WS Fryslan did). WSRL has however indicated that for the next 50 years, the height of the dike suffices the norms. Only in the ground some uncertainties remain about the influence on the dike safety. Additional attention to these uncertainties can be researched. Besides this, climate change could be an important factor to have influence on the long term safety assessment. Rising water levels, droughts, excessive rainfalls have potential influence on the dike and could therefore be considered as well.

The third requirement is partly covered already by the pre-exploration. An image about the different trajectories and their division for one scenario is made. Choices are however without any obligation yet and nothing is for certain. It can be decided to dive further into the first scenario (looking from an urgency and knowledge development point of view) and work it out more in detail. The other three scenarios (Section 5.1) can also be looked into or even new ones defined, by using the trajectory approach. The scenarios can be further worked out and presented internally, but also in one of the work studios during the entry test. WRIJ has experience with this and can be consulted for substantive information.

The fourth requirement can be determined when updated plans of area partners are defined and it is known where linkage opportunities lie. From the expert interviews, the fifth requirement is important since in most project teams going through the entry test a relation manager, or environmental manager, is included that is known with ongoing processes in the area, and where they can connect to the reinforcement project. The sixth requirement mainly relates to policies and only applies when necessary.

5.2.2. Trajectory approach only

The trajectory approach has only been used on its own by one casus project of HHNK. Since the goal of the trajectory approach and the project specifications (dune area, no reinforcement task) differ much from project SSH, it is not advised to only use the trajectory approach. Besides, the entry test becomes mandatory, and it would be most useful to gather experience by going through a project for which it is not yet mandatory. The trajectory approach seems to have more use on its own when there is no reinforcement task, and other goals have priority in the area: for example mapping of the area to prepare for future reinforcement.

5.2.3. Combination of ET and TA

From experts, the combined methodology of ET and TA gives positive results and are well adaptable to each other, if beforehand time is invested in defining a structured planning. Intern results of the trajectory approach can be presented during the entry test, receiving immediate feedback, tips and improvements after which the strategy can be optimized. Since already a preliminary strategy is determined based on different scenarios, mentioned in Section 5.1, it would be a considerable option to work this out in further detail for SSH.

5.2.4. Planning SSH

There are multiple options to plan the entry test and trajectory approach in the assessment chain. Considering the most obvious scenario at the moment, scenario 1, an entry test could be executed right before the exploration phase. Most of the executed entry tests by other waterboards have been executed at this moment (or before a pre-exploration phase) and is therefore a considerable option. One problem arises if scenario 1 is executed, namely, the exploration phases of the four sub-trajectories are 2 years (expected) apart and it is most likely that the situation of the area will change. This may lead to other safety tasks, environment involvement, linkage opportunities, risks, chances, etc… This may require an entry test at every start of the sub-trajectory exploration phase or after a certain amount of years. This brings some disadvantages like a bigger time investment and likely higher costs. At least the knowledge of the area must be kept up-to-date somehow, as indicated as important factor by the expert from HHNK. Another option is to combine the methods and look at other scenario's in more detail using a trajectory approach. Most likely the lead time will increase, but more suitable scenarios may be created and a better strategy developed. In Figure 11 the options are visualized in the expected assessment chain of WSRL. It is assumed here that the lead time of the methods does not lead to delay, since expert indicated that tasks are executed mostly simultaneously with the normal to be performed tasks. This is also emphasized by multiple experts but of course a small delay could be calculated. Only a combined methodology could lead to some small delay since it was noticed by the experts that this option can have a lead time of 5-10 months. Assumed in the figure is a mean lead time of 8 months started 4 months before 2022, thus leading to a 4 month delay in 2022. However, indicated by WS Fryslan, the entry test gives an acceleration start to the project which would indicate a faster execution of the (pre-)exploration phase. If this will be the case for the casus projects is still unknown since no (pre-)exploration is completely finished after use of one of the methods.

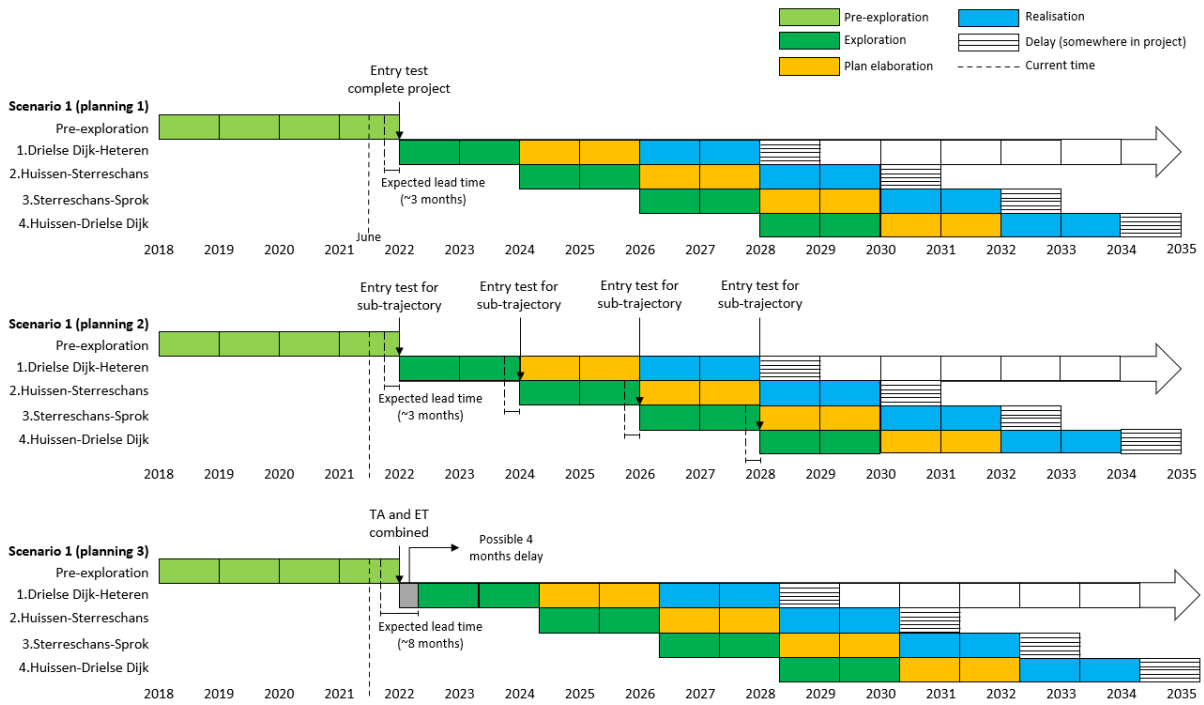

Figure 11: Three options of method implementation on the SSH project timeline, considering scenario 1

5.3. Advice

In the last part an advice to WSRL is given based on the results from this research. This is an advice based on the findings of this research and considers project SSH, projects in general and gives a little eyesight for future projects.

Project SSH

1) The report of the pre-exploration offers useful information that is required during an entry test and also considers dividing the project into strategic sub-trajectories, which is one of the goals of the trajectory approach. Although the document is from 2018, the information is a good base to start from. The defined ambitions, issues and planning should be revised if they are still relevant and up-to-date (maybe some partners have different plans now). When this is clear, with also a look through to the future plans (uncertainties), it should be sufficient information about the surroundings to start the entry test.
2) Much preliminary work has already been done, but not yet casted into a presentable display. Results from the safety assessment requires to be transformed into a presentable overview and it must be clear where the weakest points of the dike are and how this will influence the reinforcement strategy.
3) The combination approach of entry test and trajectory approach can be most useful if WSRL wants to consider the other scenarios in more detail, create new ones or develop scenario 1 more into a reinforcement strategy. Since a start has already been made it is not likely it will take a lead time of the expected 8 months.
4) The requirements of the entry test are for a part already considered or even close to achieved. What seems to be missing is a look at possible changes for the future. Considering scenario 1, the project takes at least 12 years, in which much can change (standards, plans of area partners, safety assessment, risks, climate influences etc…). It can become a challenge to keep information up-to-date during this time and therefor important to keep in mind.
5) All of the abovementioned points can be discussed in consultation with the HWBP, this may give clarity. During the interviews the HWBP has proven to be a good consult and is clear in what should be achieved during the entry test. Besides, multiple waterboards possess useful experience already with the test and can clarify even more about the insights of the test from their point of view.
6) For future projects, that are mandatory to use the entry test, findings from SSH would be very useful if it is decided to execute. If experience has been gained during the meetings with the HWBP it will become clear what is wanted from the waterboard and this will definitely give more clarity how to prepare for future projects.

Considering the above, I would recommend to execute the entry test for SSH, since experiences of other projects have been positive and it helps defining the project scope, in an iterative process together with an expert team. Use of the trajectory approach can help substantiate choices during the work studios of the entry test and it is also good to combine with the entry test. A structured planning with the expert team should be created to keep an overview with tasks to be performed, as shown by WRIJ. This can take some time, but can pay off after. Since already scenarios have been defined and a preliminary trajectory division is made, I recommend to work this out further and intertwine with the entry test. WRIJ can be consulted since they have two projects that have finished a combination of the tests. In the casus projects, the HWBP has also been a helpful source with expert opinion. I advise to contact the HWBP about a start meeting and discuss at what point the project is right now. With the safety assessment finished, and the considered trajectory

division, cost estimate, uncertainties, risks and linkage opportunities partly complete, it seems like a good starting point to get in contact with the HWBP for the next steps.

General projects

7) Since the entry test becomes mandatory for future listed projects, I advise waterboards to properly document the entry test, if executed voluntarily, so it is known what to expect next. For waterboards that have no experience with the entry test, it could be useful to contact other waterboards that have. During the expert interviews I discovered that all experts are transparent and are willing to contribute to help clarify unclarities regarding the entry test.
8) Based on the (scarce) information on the trajectory approach alone, I would not recommend using this method alone when there is a reinforcement task. On its own, it seems to have more use when there is another task with priority, like an environmental task. It is then up to the waterboard how to implement the trajectory approach, just as HHNK did.
9) I recommend the combined method approach in case of a relatively long trajectory, where sub-trajectories have to be defined in order to make the project executable. The combination gives perfect possibility to construct a strategy and have this validated by experts from the HWBP team. This can give a good starting position for the (pre-)exploration phase, where more details can be included.

6. Discussion

In this chapter limitations and other considerable mentions that come with the results of the research are presented.

First of all, the scores on the benchmark analyses should be read with caution. Since there are only few waterboards and few methods finished the amount of experiences and results is still very little. Due to time restriction and lack of amount of finished tests, the amount of interviewed experts is too low to jump to certain conclusions. For example, only 1 expert has been interviewed that has had experience with the trajectory approach alone. For a broader image more should be interviewed. This also holds for the entry test and the combined approach, where for both 2 experts were interviewed.

The second point considers the wide range of variability within the approaches of waterboards for their projects. Every project is different from the other and every waterboards has different ideologies on how to approach the project. This leads to the fact that scores in the benchmark analysis cannot be easily compared to each other, without knowing de project specifications. Comparison can be hard due to the fact that there are many factors that influence the decision making in a project.

Another point considers the need of the entry test to be mandatory, or not. Although a mandatory approach can scare at first, as indicated by most experts, it turned out useful and less time consuming than expected. I think it is important that in the whole country the same rules apply, and achieve consensus about the working approach of dike reinforcement projects. This can make consultation between waterboards and with the HWBP easier, since every project has used a similar approach. Therefore, I am in favor of the entry test being mandatory, since it motivates to define a clear project scope, while investing not much additional time compared to no entry test.

I think it is good to have the trajectory approach as non-mandatory tool, since the use is very variable and up to waterboards to determine the exact implementation. It could however be more clarified within the course of the entry test, which may increase the clearness. On the other hand, indicated by colleagues of WSRL, a definite step-by-step approach is also not desired since the waterboard wants to have freedom in deciding what they think is best for their projects. Different approaches and different strategies between different waterboards also gives opportunity to learn from each other and optimize.

As recommendation, results of completed entry tests and trajectory approaches during other phases in the assessment chain are required to get a broader image on the effect of the methods. In this research only the direct consequences on the short term are defined with only a little preview on the long term of dike reinforcement projects. None of the projects mentioned in this research have finished the (pre-)exploration phase after one of the methods, making it yet unclear what the effects are exactly. Besides it is unknown if the use of the methods has influence on the plan implementation phase or realisation phase. Follow-up research could be useful after each of the three phases (exploration, plan implementation and realisation) to determine if the use of the entry test and/or trajectory approach has had influence on the long term of a project.

7. Conclusion

From the results achieved in this research the following conclusions can be drawn on the research questions:

- What are the experiences of experts at waterboards with the current methods, entry test and trajectory approach?

Six experts have been interviewed about the reinforcement methods: one about current methods (WSRL), one about the trajectory approach (HHNK), two about the entry test (WS Fryslan, HDSR) and two about a combined methodology of ET and TA (WRIJ, Brabantse Delta). From the currently used methods not much is known:, there was no definite method before implementation of the entry test, so before 2019. Way less information was required and there was much less attention to factors involving the project besides the water safety. If from the water safety assessment it became clear the dike was not up to the safety standards regarding the failure mechanisms, the project could be list on the HWBP program started after. Little was yet known about the surroundings and how to connect that information to the reinforcement strategy, risks, uncertainties, chances and area partners. This often led to projects having a hard time getting off the ground and with subsequent delays. Due to lack of information about the current methods, it was left out in the analysis of the methods.

Experts were positive about the entry test although the method was new for everyone and from both the waterboard and the HWBO there were some unclarities at the start but these disappeared in the course of the test. Close communication with the HWBP, expertise criticism and tips and feedback were considered most positive. After completing the entry test the (pre-)exploration phase has an accelerated start and a rough planning is made for the coming years, which results in a more stable project start, experts emphasise. The trajectory approach is considered a useful tool to define a reinforcement strategy, including the division of the trajectory into sub-trajectories. The range of possibilities is large and it is up to the waterboard how to execute. This gives freedom but also ambiguity, the guideline gives no clear plan but rather an overview of the goal described in processes. From expert experience, the trajectory approach can be time consuming because the method implementation is up to the own waterboards choices.

- How do the methods score based on a benchmark analysis?

In general, all methods are indicated as easy to use, ranging from 2-4. Administrative goals and ambitions are in most methods also satisfied and considered. Only one expert experienced no additional contribution of the entry test in the consideration of their administrative goals and ambitions. Some projects experienced a small additional financial cost, but this is project specific and is not applicable to all. Waterboards can keep in mind that a financial cost as effect of one of the methods up to 0.5 million is possible. Preparation works are mainly uniform and indicate a small to moderate amount of preparation. Combining the qualitative scores the following result comes out: ET & TA combined: 2.5, Entry test 2.7, Trajectory approach: 3.0. On average, the trajectory approach, although only executed alone by one, is more time consuming than the entry test. Regarding the ease of use, administrative goals and ambitions and preparation, both methods are alike and the experiences rather equal to each other. The combination of ET and TA is experienced as more time consuming. Despite this, the ease of use, after defining a planning, is considered as more than sufficient. Also no more additional preparation work is required when comparing to only the entry test or trajectory approach.

- What are the consequences for the waterboard when using the entry test and/or trajectory approach in a current project (SSH) and for future projects?

For one of the current running projects (SSH) a lot of preparation work has already been done in a pre-exploration phase. This is a good point to start from to go through an entry test, since much information is already acquired during this phase, although it could be outdated. It is expected that WSRL should define more what the influence of future developments could be on the project, since the project is large and can easily take more than 12 years. This brings the major challenge of keeping information up-to-date during this time. This was indicated as an important but yet still unclear point by some experts and therefor important to consider. The average lead time is expected for this project when executing the entry test: 3 months. If the waterboard decides to combine the entry test and trajectory approach they could define more scenario's and different points of view to define a reinforcement strategy. Since a start has already been made it is expected that this can be done in less than 8 months. In the current project planning of SSH this would mean a delay of several months, if the methods are executed just before the exploration phase, but as mentioned by experts, the project is able to have an accelerated start and may end the exploration phase earlier. Prove of this is however not yet available, since no project that used ET, TA or a combination has passed that phase yet.

From the four sub-questions the main research question can be answered:

What is the added value of using entry test and trajectory approach instead of previously used methods?

Very early it became clear that there was much vagueness about a previously used approach. No process was really defined and the approach was very dependent on the water safety assessment. The entry test and trajectory approach changed this trend. The water safety assessment remains the most important leading factor, but there is a steadfast approach with formulated requirements that the waterboard must meet in order to get a project on the program, while this happens in cooperation with the assessment team. For a relatively small time investment, the project scope gets defined in more detail before the project even starts, giving the opportunity to have an accelerated start. It should also not be considered as a 'test', but rather a critical assessment of the project plans in addition with advice and tips on how to proceed. The added value can hardly be expressed in a single value or single sentence, but it is definitely a way more structured approach than before and it looks like the successes of finished tests emphasize this.

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Appendix A: Process plate of WRIJ

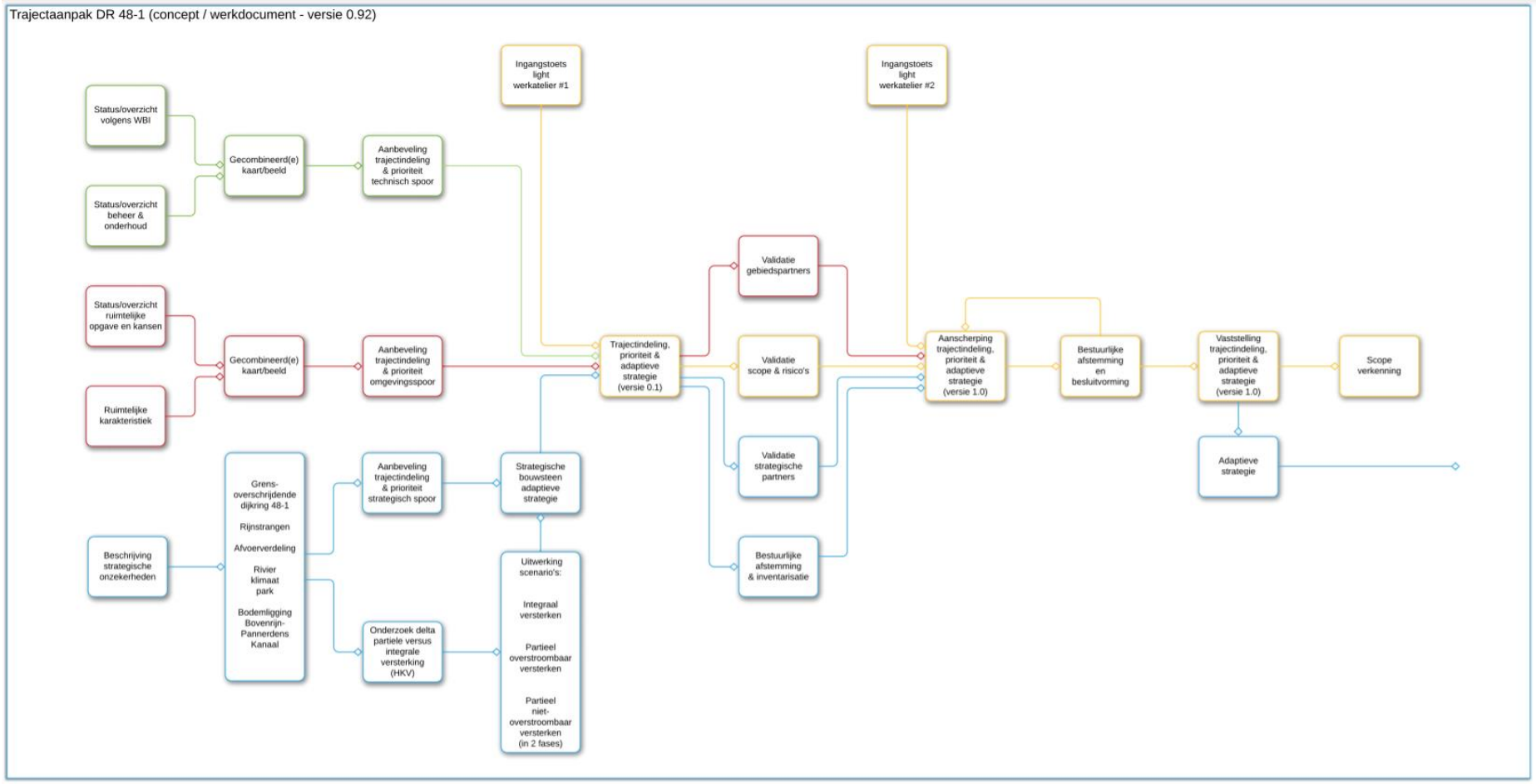

Figure 12: Process plate of WRIJ (Dutch). In green the technical track, in red the environment track, in blue the strategy track and added in yellow the entry test's work studios.