



Mission-oriented R&I policies: In-depth case studies

Case Study Report

Delta Plan / Delta Programme (The Netherlands)

Arjen Goetheer
February 2018

*Research and
Innovation*

Case Study Report: Delta Plan / Delta Programme (The Netherlands)

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Arjen Goetheer



A Study coordinated by the Joint Institute for Innovation Policy



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1 Summary of the case study

Summary fiche	
Title:	Delta Plan / Delta Programme
Country:	The Netherlands
Thematic area:	Security & resilience, Climate change
Objective(s):	<ul style="list-style-type: none"> • Protect the Netherlands against flooding by the sea • Make The Netherlands resilient to climate change and the sea-level rise • Ensure a sufficient supply of fresh water
Main governing body:	Ministry of Public Works / Delta Commissioner
Timeline:	1953–2050
Budget:	<ul style="list-style-type: none"> • 1st Delta Plan: estimated budget at the start EUR 680 – 900 million • 2nd Delta Programme: over EUR 17 billion available in the Delta Fund (2017-2031) and appr. EUR 15 million annually for the National Water and Climate Knowledge and Innovation Programme (2015-2020)
Brief description of the case (250 words)	<p>The Delta plan originally dates from late 30s. After the North Sea flood of 1953 the initial plan has been revised and the new Delta plan was developed to protect the Netherlands against flooding by developing a series of construction projects to shorten the Dutch coastline with in total 700 kilometres. To be able to accomplish the mission research and technological development were needed to develop and build tailor made construction works and to take into account safety on the one hand and nature, tourism and the economy on the other hand. The Delta Plan was implemented after the 1953 flood, as a response.</p> <p>The recent Delta Programme started in 2010, to avoid a future flood. It originated from the advice of the 2nd Delta Committee. Besides the protection from flooding by the sea, the current Delta Programme (initiated under the 2nd Delta plan) aims to make The Netherlands resilient to climate change and ensure a sufficient supply of fresh water in 2100.</p>
Implementation and organisation (a brief description of the governance and policy instruments used)	<p>The first Delta Plan was governed by the Ministry of Public Works. Under the Delta Act (1958) the Ministry was responsible for the analyses, development and execution of the Delta plan.</p> <p>For the implementation of the Delta Plan the Ministry established a separate department in May 1956: the Delta Service. Given the complexity of the works many types of knowledge and expertise were needed. The Delta Service has been one of the largest and most complex services that has ever functioned within the Ministry.</p> <p>The Delta Act (1958) provided a framework with necessary flexibility for the execution of the projects that allowed that plans could be continually adapted during the realisation of the Delta Works. Public procurement was used as instrument to develop tailor made constructions (dams, (moveable) storm barriers, sluices).</p> <p>The successive Delta Programme is coordinated by an independent Delta Commissioner. The Commissioner, inaugurated in 2010 and supported by a small staff, is responsible for the formulation, actualisation and execution of the Delta Programme (including financial implications). The Commissioner is appointed for seven years and reports annually to the Dutch Government and Parliament on the progress of the Delta Programme.</p> <p>The implementation and the execution of the Delta decisions and formulated preference strategies are the responsibility of the responsible administrative division within the Dutch state (national government,</p>

	<p>provinces, municipalities and water boards). These divisions are represented in Delta Programme Steering Committee (chaired by the Delta Commissioner) as well as in the thematic and regional boards.</p>
<p>Observed / expected outputs, outcomes, and impacts</p>	<p>On the short term the Delta Plan contributed:</p> <ul style="list-style-type: none"> - to increased safety, because the Ministry of Public Works started quickly with the implementation of the first advice of the Delta Committee. Already in 1958, five years after the disaster, the first project (Storm barrier Hollandse IJssel) had been completed; - the establishment of the separate Delta Service department within the Ministry of Public Works in May 1956. This new department consisted of experts from various disciplines was created coordinate and execute the implementation of the Delta Plan. <p>In the short term the Delta Programme:</p> <ul style="list-style-type: none"> - resulted in a new Delta Law providing the legal framework for the independent Delta Commissioner to formulate, actualise and execute the Delta Programme, and the setup of the Delta Fund to secure continuity in finance for the cost of maintenance and development of new infrastructure. The Delta Law makes the execution of the Delta Programme less dependent from the short-term cycle of politics and provides institutional continuity; - the formulated Delta Decisions have been embedded in the National Water Plan as policy decisions by the Dutch government in 2014. In addition, the Delta Programme Agreement was signed in 2014 by the provinces, water boards, municipalities and the Minister of Infrastructure and the Environment to anchor the Delta Decisions and preference strategies in their own plans; - the establishment of the National Water and Climate Knowledge and Innovation Programme to stimulate joint-programming and connecting clients with contractors; - to be able to execute all measures sooner and with less budget research and innovation plays an important role in the Delta Programme. For this reason, new instruments are introduced, such as competitions to collect new ideas and solutions for challenges, solution focused public tenders to give contractors more room to suggest their own ideas and giving more weight in the evaluation of tenders to innovation than price. In addition, knowledge exchange and pilot projects and experiments are stimulated under the Stimulation Programme Spatial Adaptation. <p>In the medium term:</p> <ul style="list-style-type: none"> - the reconstruction and the realisation of the construction works initiated under the Delta Plan brought many jobs to the province of Zeeland. The province experienced a period of prosperity in the years after the flood, which led to decades of improvement in a few years; - for The Netherlands as a whole, the gross domestic product grew by 8.4% in the year of the disaster, an unprecedented high percentage. The national government increased consumption by ten percent and investments in 1953 were 60% higher than the year before. All this gave a powerful positive impulse to the Dutch economy. <p>In the medium term the Delta Programme:</p> <ul style="list-style-type: none"> - connected the policy domains flood risk and spatial adaption and thereby strengthened the coherence between the two domains; - the Delta Decision on flood risk management provided new and higher safety standards for flood risk management. The new standards are developed from a risk perspective: the standards are not only related

to the probability of a flood, but also to the consequences of a flood. As a result, the scale of the consequences determines the height of the standard.

Besides shortening the total length of the dykes by 700 kilometres and increasing the safety the **Delta Plan** had impact on many other aspects.

- the agricultural freshwater supply was improved. Because the border between freshwater and saltwater was moved further west, less freshwater was required to balance the freshwater-saltwater division. The excess water could be transported to the north of the Netherlands, in the direction of the IJsselmeer (IJssel lake), where extra freshwater was welcomed to improve the water conditions;
- the complete water balance of the Delta area was improved. Thanks to the construction of the major and auxiliary dams, it became possible to manipulate the streams in this area more easily. Different types of sluices made it possible to allow fresh water in, or polluted water out;
- the construction of the Delta Works encouraged traffic between the many islands and peninsulas. Large parts of the province of Zeeland had literally been isolated for centuries;
- the inland waterways shipping was supported by the Delta Works. In 1976, Belgium and The Netherlands signed a contract that would regulate the shipping between the ports of Antwerp and Rotterdam;
- the Delta Plan has influenced new development in the areas of nature and recreation. Although a number of nature reserves were irreparably damaged, as compensation, new nature reserves have emerged at different sites that are nowadays used for recreation;
- the Delta Plan increased the Dutch knowledge position in this area and strengthened export position of the industry.

Assessment of the main elements of mission-oriented R&I initiative¹

Directionality (links to societal challenges, industry transformation):	Yes , the successive initiatives can be linked to societal challenges: SDG 13 - Take urgent action to combat climate change and its impacts, SDG 6 - Ensure access to water and sanitation for all and SDG 15 - Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.
Intentionality (specific, well-articulated goals):	Yes , for the successive initiatives well-articulated goals were formulated (Delta Plan: Protect the Netherlands from flooding by the sea in 25 years; Delta Programme: Make The Netherlands resilient to climate change and the sea-level rise and ensure a sufficient supply of fresh water in 2100).
Clearly set timeline and milestones:	Yes , for the two successive initiatives a timeline and milestones were set (Delta Plan: completion in 25 years, Delta Programme timeline with milestones until 2050).
Mobilises public and private investments:	Yes , the two successive initiatives mobilised public and private investments, although the main funding source of the initiatives is public.
Focused on new knowledge creation (basic research, TRLs 1-4):	Yes , the two successive initiatives focused on new knowledge creation, although very limited in terms of the overall budget
Focused on knowledge application (applied research, TRLs 5-9):	Yes , the two successive initiatives focused on knowledge application (e.g. new materials and maritime vessels to build the Eastern Scheldt storm surge barrier)

¹ Assessment: Yes, To certain degree, No or Not known.

Demand articulation (involves instruments for inducing demand):	Yes , the two successive initiatives articulated demand, e.g. with public procurement.
Multi-disciplinary (inter-disciplinary and/or trans-disciplinary):	Yes , the two successive initiatives are built upon multi-disciplinary collaboration
Joint coordination (multi-level and/or horizontal governance of policies/finance):	Yes , in particular the Delta Programme: all administrative divisions within the Dutch state (national government, provinces, municipalities and water boards) are involved and together priorities have been set.
Reflexivity (flexible policy design, timely monitoring):	Yes , the two successive initiatives have a flexible policy design, including monitoring mechanisms. For the Delta Plan the framework of the Delta Act provided the necessary flexibility for the execution of the projects that allowed that plans could be continually adapted during the realisation of the Delta Works. For the Delta Programme each year a new Delta Programme is published.
Openness (connected to international agenda and networks):	To a certain degree the two successive initiatives are connected to international agenda and networks (mainly on the scientific level). The focus of the initiatives is national, however with the intention to strengthen the expertise and know-how of the participating industry and thereby increase their international export position.
Involvement of citizens:	Yes , in particular the Delta Programme involves citizens, by organising the annual National Delta conference, regional meetings organised by sub-programmes as part of the participation process and by inviting citizens to submit ideas and opinions for the sub-programmes. Moreover, citizens can actively participate in projects of the Delta Programme that are at issue in their municipality or province.

2 Context and objectives of the initiative

2.1 Contextual factors and origins of initiative

Studies conducted in 1937 by Department of Public Works (Rijkswaterstaat) showed that safety in many parts of The Netherlands could not be guaranteed at times of storms and high sea levels. In the densely populated areas near the river mouths of the Rhine, the Meuse, and the Scheldt, it proved very difficult to build new dykes or strengthen the original ones. The first proposal was to close all the river mouths: the Western Scheldt the Eastern Scheldt, the Haringvliet, and the Brouwershavense Gat. This proposal was christened 'the Deltaplan'. In 1950, the first river mouths of the Brieles' Gat and the Botlek were closed. The Brielse Maas became a freshwater basin. This not only made the area safer, but it also provided Voorne with a freshwater supply. The plan was to build the remaining dams in the following decades. The infamous flood of 1953 prevented this from happening. Nearly two thousand people died and more than 150 000 hectares of land were flooded. People soon became aware that something had to be done, and very quickly. Twenty days after the flood of 1953, the Delta Committee was inaugurated. The Committee gave advice about the execution of the Delta plan, that would, in the long run, increase the safety of the Delta area.

Although safety was the number one priority, the seaways De Nieuwe Waterweg and the Western Scheldt would have to stay open, because of the economic importance of the ports of Rotterdam and Antwerp. In order to be able to build dams in the rivers' mouths, some auxiliary dams were built in the Zandkreek, the Krammer, the Grevelingen, and the

- Haringvliet sluices (1971) and Brouwers dam (1972);
- Eastern Scheldt storm surge barrier (1986);
- Maeslant storm surge barrier (1997).^{3, 4}

The second Delta Committee (2007) advised the Dutch government that the protection of The Netherlands against flooding by the sea was a permanent mission and therefore required ongoing attention and action. Following the advice of this committee the mission of the current Delta Programme is to make The Netherlands resilient to climate change and the sea-level rise and to ensure a sufficient supply of fresh water in 2100.⁵

The milestones of the Delta Programme are:

- Appointment of the independent Delta Commissioner (2010);
- Approval of the Delta Law with legal agreements on the Delta Programme, including the setup of the Delta Fund to secure continuity in finance for the cost of maintenance, development (new) infrastructure (2012);
- Agreement on the five "Delta decisions", translated into preference strategies with measures. For the implementation of these strategies three specific Delta Programmes have been formulated: Flood Risk Management, Fresh Water and Spatial Adaption (2014);
- Start of the National Water and Climate Knowledge and Innovation Programme (Nationaal Kennis- en innovatieprogramma Water en Klimaat (NKWK)) (2015).

³ <http://www.deltawerken.com/Deltawerken/16.html>

⁴ The Maeslant storm surge barrier was not part of the original Delta Plan.

⁵ Deltacommissie (2008). Samen werken met water. Een land dat leeft, bouwt aan zijn toekomst. Bevindingen van de Deltacommissie 2008. Den Haag: Deltacommissie



Figure 2: Overview Delta Programme⁶

⁶ Ministerie van Verkeer en Waterstaat, Ministerie van Landbouw, Natuur en Voedselkwaliteit, Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (2010). Deltaprogramma 2011. Werk aan de delta. Investeren in een veilig en aantrekkelijk Nederland, nu en morgen. Den Haag: Ministerie van Verkeer en Waterstaat, Ministerie van Landbouw, Natuur en Voedselkwaliteit, Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer

3 Resources and management

3.1 Governance and management model

The first Delta Plan was governed by the Ministry of Public Works. Under the Delta Law (1958) the Ministry was responsible for the analyses, development and execution of the Delta Plan. The Ministry established a separate department in May 1956: the Delta Service. Given the complexity of the works, many types of knowledge and expertise were needed. The Delta Service has been one of the largest and most complex services that has functioned within the Ministry.

The Delta Law provided a framework with necessary flexibility for the execution of the projects that allowed that plans could be continually adapted during the realisation of the Delta Works. Detailed proposals, including budgets, for the complex construction works approved by Parliament.⁷

For the execution of specific construction works, private sector actors were involved. For instance, the construction of the Eastern Scheldt storm surge barrier was so large and complicated that it could not be done by the Ministry of Public Works or by a single contractor. No contractor could promise to finish the dam for a fixed price within the agreed time. Therefore, a so-called 'framework contract' was chosen. This contract consisted of a general framework that could be completed later. In 1977 the Ministry of Public Works signed a contract with the consortium "De Oosterschelde Stormvloedkering Bouwcombinatie V.O.F." (DOS construction). The combination was formed on 1 September 1976 by a team of contractors consisting of 11 private partners.

Under the new Delta Law, the development of the Delta Programme, the coordination of the implementation and execution is the responsibility of the Delta Commissioner. The Commissioner chairs the Delta Programme Steering Committee formed by representatives of administrative divisions within the Dutch state (national government, provinces, municipalities and water boards) as well as representatives of the sub-programmes. On a regular base there are contacts with research organisations, as well as civil organisations and the industry.

With a participative process consisting of regional meetings sub-programmes were developed and the so-called Delta Decisions were formulated and translated into preference strategies. The Dutch government embedded the Delta Decisions in the National Water Plan as policy decisions in 2014.

In addition, representatives of the provinces, water boards, municipalities and the Minister of Infrastructure and the Environment signed the Delta Programme Agreement to anchor the Delta Decisions and preference strategies in their own plans (2014).⁸

Each year the Delta Commissioner reports to the Dutch Government and Parliament on the progress of the Delta Programme.⁹

⁷ NYFER (2008). 'Het hoofd boven water'. Tweehonderd jaar investeren in waterwerken. Utrecht: NYFER

⁸ <https://www.deltacommissaris.nl/deltaprogramma/wat-is-het-deltaprogramma>

⁹ <https://www.deltacommissaris.nl/deltaprogramma/achtergrond-deltaprogramma>

The National Water and Climate Knowledge and Innovation Programme, a joint programme of government authorities and knowledge institutes and the industry, aims to elaborate on knowledge issues and innovations identified in the Delta Programme. Together the partners work on pilot projects, thematic issues and long-term developments.¹⁰

3.2 Financing model

The total budget of the Delta Plan was estimated at 3.3 billion guilders (EUR 680 – 900 million) in 1958. That corresponded to 20% of the GDP of the country at that time. It was a huge amount for the country in reconstruction, even though the amount could be spread out over 25 years. The actual total cost of the Delta Plan is estimated at around EUR 5 billion (inflation-adjusted), three times as much as the original estimated.

To be able to accomplish the mission, research and innovation were needed to develop the construction works. For instance, new methods needed to be developed to be able to close the sea arms, also new materials and equipment were needed, as well as new research needed to be carried out to study the impacts on water flows, water quality, environment, nature development, etc.^{11, 12}

The Delta Plan was mainly financed by the National Budget. The Marshall aid contributed 400 million guilders. The discovery of natural gas in 1959 also made a significant contribution to the financing of the Delta Plan. For example, the Eastern Scheldt storm surge barrier has been paid with the natural gas revenues.¹³

The 1st Delta Committee provided first indications on the required investments for each of the construction works in their interim and final advice.¹⁴

For the implementation of the Delta Programme the 2nd Delta Committee estimated that on average EUR 1 to 1.5 billion is needed to be available for the requested investments annually until 2100. Based on this estimation the total cost of the implementation of the Delta Programme would sum up to EUR 90 to 135 billion.¹⁵ Based on the formulated Delta Decisions new standards for flood risk have been developed (i.e. probability x consequence). These new standards resulted in adjusted measures at lower cost. The estimated costs of the measures to meet the new standards amount to EUR 26 billion until 2100.¹⁶

To be able to execute all measures sooner and with less budget research and innovation play an important role in the Delta Programme and is stimulated on sub-programme level. To foster knowledge exchange and innovation the joint initiative for the National Water and Climate Knowledge and Innovation Programme has been initiated by the Delta

¹⁰ <https://waterenklimaat.nl/>

¹¹ <http://www.deltawerken.com/Deltawerken/16.html>

¹² NYFER (2008). 'Het hoofd boven water'. Tweehonderd jaar investeren in waterwerken. Utrecht: NYFER

¹³ NYFER (2008). 'Het hoofd boven water'. Tweehonderd jaar investeren in waterwerken. Utrecht: NYFER

¹⁴ Deltacommissie (1954). EINDVERSLAG EN INTERIMADVIEZEN. Den Haag: Deltacommissie

¹⁵ Deltacommissie (2008). Samen werken met water. Een land dat leeft, bouwt aan zijn toekomst. Bevindingen van de Deltacommissie 2008. Den Haag: Deltacommissie

¹⁶ Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken (2017). Deltaprogramma 2018. Doorwerken aan een duurzame en veilige delta. Den Haag: Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken

Commissioner and other stakeholders. The programme has an annual budget of appr. EUR 15 million for the period 2015-2020 and is funded by the partners.

The funding for the Delta Programme is mainly financed by the National Budget. Water boards, provinces and the municipalities also contribute financially as well as with other resources (such as coordination activities) to the Delta Programme, its sub-programmes, research studies or other measures. The contribution of these administrative bodies depends on their regional interests.

Based on the tentative extrapolation of the Delta Fund (see Figure 3) approximately 66% of the budget (EUR 1.1 billion) for 2017 is available for investments primarily in flood risk management and freshwater supplies. The remaining budget is available for management, maintenance and organisational costs as well as several tens of millions for investments in water quality.¹⁷

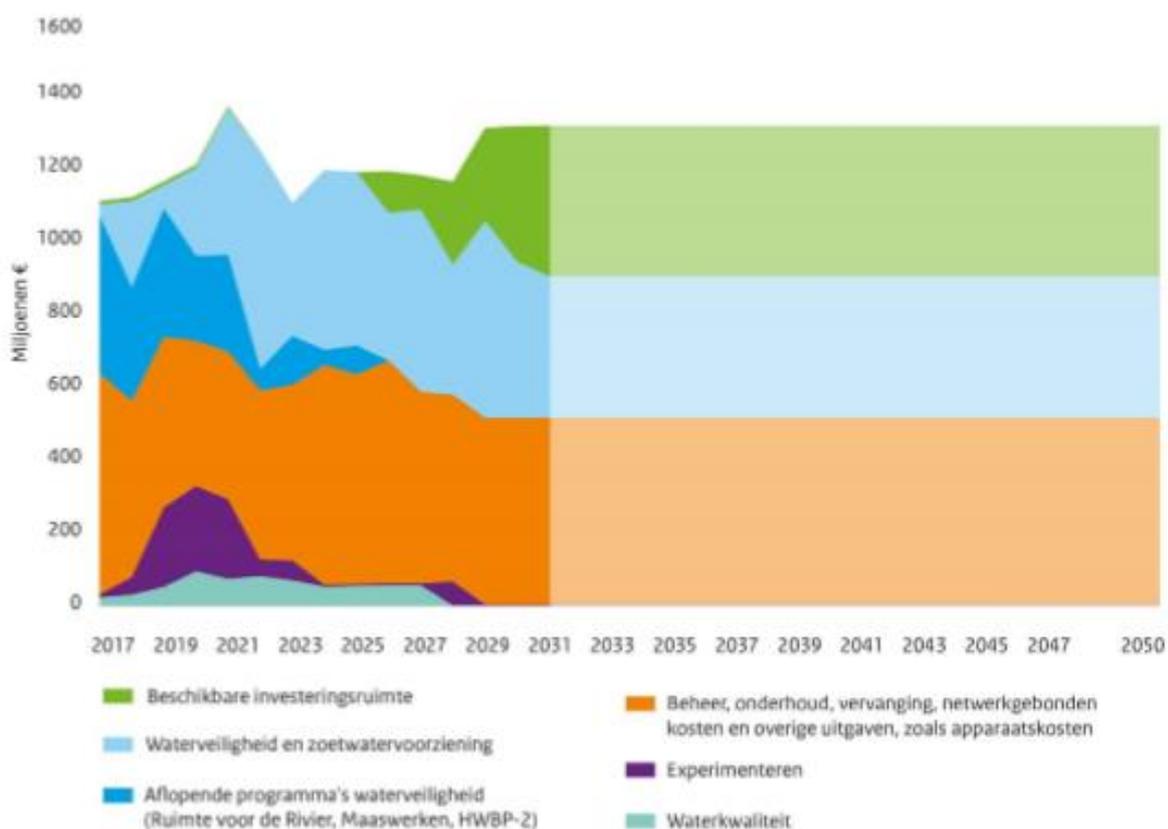


Figure 3: Tentative extrapolation Delta Fund¹⁸

3.3 Key actors involved in the initiative

Delta Plan

¹⁷ Measures to improve water quality are funded under the Delta Fund, but these measures are not part of the Delta Program.

¹⁸ Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken (2017). Deltaprogramma 2018. Doorwerken aan een duurzame en veilige delta. Den Haag: Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken

- *Ministry of Public Works*: responsible for protection of the Netherlands from flooding. The insecure situation was already acknowledged in the 1920s by the ministry. It had carried out several risk analyses and developed measures to close inland waterways from the sea. Due to the economic crisis in the 1930s, the second world war and following economic reconstruction, available budget was very limited. After the flood in 1953 the Ministry was responsible for the analysis, development and execution of the Delta Plan. The Ministry established a separate department in May 1956, the Delta Service department consisting of experts from various disciplines, for the implementation.¹⁹
- *1st Delta Committee*: state committee inaugurated by the Minister of Public Works on 18 February 1953 to advise the Minister on necessary measures to prevent a second flood. The committee consisted of 14 experts (12 civil engineers, an agricultural engineer and an economist) and delivered four interim advisory reports and a final fifth advisory report.

Delta Programme

- *2nd Delta Committee*: a state committee inaugurated by the vice minister of the Ministry of Public Works and the Minister of Interior on 7 September 2007 (committee of sustainable coastal development) to advise on 1) the consequences for the Dutch coast of the expected sea level rise, 2) the drainage of the major Dutch rivers and other climatic and social developments up to the 22nd century, 3) possible strategies for sustainable development of the Dutch coast and 4) the added value of these long-term strategies for the hinterland and society. The Committee consisted of people from different disciplines such as science, industry and public administration and examined not only the expected rise in sea level and other climatic developments, but also social, ecological and economic developments that are important for the physical layout of the Dutch coast and published her advice "*Samen werken met Water*" on 3 September 2008.²⁰
- *Delta Commissioner*: senior independent government official to formulate, actualise and execute the Delta Programme (including financial implications), appointed in 2010. The Commissioner, supported by a small staff, is appointed for seven years and reports annually to the Dutch Government and Parliament on the progress of the Delta Programme.²¹

3.4 Monitoring system and evaluation of the initiative

With half-yearly reports the Ministry of Public Works informed Parliament on the progress of the different ongoing construction works initiated under the **Delta Plan**, including updates on the financial aspects. The reports provided detailed insights on the technical issues that arose and the solutions that were formulated, the findings of research projects and how they were implemented, as well as budget issues.²²

The original plan for the Delta Plan of 1957 was changed in 1976. Despite the fact that first activities to close the Eastern Scheldt had been started in 1967 and already 5 kilometres (of the in total 9 kilometre) of dams had been closed, the original plan had to be fully

¹⁹ NYFER (2008). 'Het hoofd boven water'. Tweehonderd jaar investeren in waterwerken. Utrecht: NYFER

²⁰ <https://www.deltacommissaris.nl/deltaprogramma/achtergrond-deltaprogramma>

²¹ <https://www.deltacommissaris.nl/deltaprogramma/achtergrond-deltaprogramma>

²² An example is progress report nr. 9 (July-December 1980): <http://publicaties.minienm.nl/download-bijlage/39189/oosterscheldewerken-voortgangsrapportage-nr-09.pdf>

revised. The reason for the change was the societal protests against the plan to close the Eastern Scheldt. In 1967 a group of fishermen started with their protest against the closure, quickly followed by environmental groups and national politicians. The protestors claimed that in particular the environmental impact of the closure would be devastating for the unique ecosystem of the Eastern Scheldt and demanded that the plan should be reconsidered.²³

In 1973, a new (progressive) government came to power. The government appeared to be sensitive to the arguments of the protestors and installed the Eastern Scheldt Committee to advise on possible alternatives for a closed dam. The Committee presented its advice for an open surge barrier in 1974. As a result, the construction works needed to be fully revised, even some parts of the dam had to be taken away. The construction of the open storm surge barrier started in 1976. On 4 October 1986 the Eastern Scheldt storm surge barrier was officially opened. The total cost of the barrier was six times higher than initially budgeted.²⁴

The Delta Commissioner reports annually to the Dutch Government and Parliament on the progress of the **Delta Programme**, including a schedule and an overview of the costs.²⁵

In the first half of 2016, the Delta Law was evaluated by an independent committee. This evaluation was commissioned by the Minister of Infrastructure and the Environment. The evaluation committee judged positively on the approach, governance and working method of the Delta Programme. The national and inter-administrative approach has proved to be crucial for the support and trust in the Delta Programme. The joint knowledge development - joint fact finding - was also decisive in the approach. According to the committee, a major challenge is the transition from planning to implementation. In 2020, a new external evaluation of the Delta Programme is foreseen.²⁶

Because of the deep uncertainty surrounding climate change, the broad impacts it is expected to have, the need to take action before the problem has fully taken shape and the need to be able to adjust plan in the light of new and expected developments learning and adaption are key features of the Delta Programme. The preference strategies are developed according to the principles of adaptive delta management (ADM), meaning that they are adjusted on time if developments require this (adaptive) and linked to other interests (shipping, nature, recreation, cultural heritage) as much as possible (integral). To be able to systematically monitor and evaluate the progress and effectiveness of the agreed measures as well as to measure how developments are taking place, to know what the consequences are for the chosen strategies and how to act accordingly a system of 'measuring, knowing, acting' (in Dutch Meten, Weten, Handelen; MWH) is currently being developed. This systematic approach will inform all involved stakeholders on 'input', 'output', 'outcome' and 'learning'.²⁷

²³ Ministerie van Verkeer en Waterstaat (1973). Nota Oosterschelde. Den Haag: Ministerie van Verkeer en Waterstaat

²⁴ <https://www.anderetijden.nl/aflevering/89/Beter-ten-halve-gekeerd>

²⁵ <https://www.deltacommissaris.nl/deltaprogramma/achtergrond-deltaprogramma>

²⁶ <https://www.deltacommissaris.nl/nieuws/nieuws/2016/07/01/evaluatie-deltawet-samenwerking-partners-deltaprogramma-succesvol>

²⁷ Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken (2015). Deltaprogramma 2016. Werk aan de delta. En nu begint het pas echt. Den Haag: Ministerie van Infrastructuur en Milieu & Ministerie van Economische Zaken

3.5 Level and type of citizen engagement in the initiative

During the 1st **Delta Plan**, citizen involvement was very limited. However, this changed in 60s and 70s. Initially the Eastern Scheldt would be closed. That would have been the best way to increase safety for the inhabitants. Initiated by fishermen and later backed by various social forces, including environmental groups and politicians, a campaign started against the closure of the Eastern Scheldt. They emphasised that people's safety was important, but that other aspects also had to be taken into account in the decision-making. The unique salt water environment in the Eastern Scheldt was one of them. After considering the importance of water quality, the environment, nature development, fishing, recreation, agriculture, shipping and industry, the decision was made to build an open defence. The choice for an open defence with the Eastern Scheldt storm surge barrier became a turning point in thinking about water. The new policy approach that emerged taking into account as many aspects as possible is called 'integrated water management'.²⁸

Several activities were initiated to communicate and disseminate outcomes of the Delta Plan to citizens and stakeholders. The broad public has been informed on the progress of the Plan: successful completion of complex delta works was broadcasted on national television. Furthermore, the work on the construction was often covered in the news (newspapers, radio, national television, etc.).²⁹

Where the Delta Plan was merely focussed on passive participation of citizens, its successor the **Delta Programme** implemented several measures to engage citizens more actively. Citizens were actively invited to contribute to the Delta Programme on various occasions, including via civil society organisations. All sub-programmes have organised (regional) meetings in recent years for the participation process. Citizens could submit ideas and opinions for the sub-programmes. In addition, a formal consultation procedure was followed for (the successor of) the National Water Plan from September 2014 to 2015. Moreover, citizens can actively participate in projects of the Delta Programme that are an issue in their municipality or province.³⁰

The Delta Programme has organised its communication and dissemination to citizens and stakeholders in different ways. Citizens and stakeholders can participate during the annual one-day National Delta conference organised on the first Thursday in November by the Delta Commissioner. Next to the discussion on the progress of the Delta Programme, the aim of the conference is to connect people from civil society organisations, industry, science and government authorities working on the Delta Programme and thereby to strengthen ties and stimulate knowledge sharing. The conference held on 2 November 2017 was attended by 1500 people.

In addition, the annual report of the Delta Commissioner and the new Delta Programme are published online on the webpage of the Delta Commissioner. Interactive graphs of the

²⁸ <http://www.deltawerken.com/Dam-of-kering/191.html>

²⁹ NYFER (2008). 'Het hoofd boven water'. Tweehonderd jaar investeren in waterwerken. Utrecht: NYFER

³⁰ <https://www.deltacommissaris.nl/deltaprogramma/vraag-en-antwoord/er-wordt-samengewerkt-met-allerlei-overheden-maar-hoe-kunnen-burgers-meedenken-meepraten-over-het-deltaprogramma>

Delta Programme are also available on this webpage, as well as background information and news updates.³¹

4 Policy instruments and wider policy mix used for implementing the initiative

4.1 Description of the R&I policy instruments used for implementing of the initiative

The following policy instruments were used to make the implementation of the **Delta Plan** possible:

- The framework structure of the Delta Law to create the necessary flexibility for the execution of the projects (law came into force in 1958);
- Private tenders to repair and raise the dykes;³²
- Framework contract to develop and build the Eastern Scheldt storm surge barrier: under the framework contract private was issued for specific parts of the construction, after which the contractors would make an offer. The parties, the Delta Service and the contractors would then together negotiate the final terms. The framework contract was the preferred contract form in 1975 to ensure the quality, flexibility and planning requirements;³³
- The Delta Service was responsible for the overall coordination of the planning and the construction process, including the alignment of the work between different contractors.

The following policy instruments are used for the implementation of the **Delta Programme**:

- Delta Law providing the legal framework for:
 - an independent Delta Commissioner to make the execution of the Delta Programme less dependent from the short-term cycle of politics and to ensure the required measures to protect The Netherlands against the consequences of climate change are implemented on time;
 - a special Delta Fund to secure continuity in sufficient resources for the requested investments;^{34 35}
- Cross-project explorative studies (in Dutch: ProjectOverstijgende Verkenningen, POVs) combining the development of promising (product) innovations with the actual application of new knowledge. Within the sub-programme Flood Risk Management this instrument is used to improve knowledge sharing and develop cheaper and faster solutions;³⁶
- Public procurement to design and implement the Delta Programme measures: public tenders are issued for infrastructure works on local, regional or national level;

³¹ <https://www.deltacommissaris.nl/nationaaldeltacongres>

³² Vrije Universiteit (1990). Uitvoering en uitbesteding. Ontwikkelingen in de organisatie van waterbouwkundige werken bij de Rijkswaterstaat. Amsterdam: Vrije Universiteit Amsterdam

³³ <http://www.polderpers.nl/onderhandelingen-grote-zeven-acht-miljard-oosterschelde-3/>

³⁴ Deltacommissie (2008). Samen werken met water. Een land dat leeft, bouwt aan zijn toekomst. Bevindingen van de Deltacommissie 2008. Den Haag: Deltacommissie

³⁵ Twist van, M., Schulz, M., Steen van der, M. & Ferket, J. (2013). Een kroniek van de instelling van een regeringscommissaris voor de Nederlandse delta. Den Haag: NSOB

³⁶ <http://www.hoogwaterbeschermingsprogramma.nl/Projecten/Projectoverstijgende+Verkenningen+POV/default.aspx>

- Stimulation Programme Spatial Adaptation with a digital knowledge portal to support knowledge exchange and provide limited funding to stimulate pilot projects or experiments;³⁷
- National Water and Climate Knowledge and Innovation Programme to stimulate collaboration between government authorities, knowledge institutes and industry partners in pilot projects, thematic issues and long-term developments;³⁸
- Annual one-day National Delta conference to discuss the progress of the Delta Programme and to connect people from civil society organisations, industry, science and government authorities working on the Delta Programme and thereby to strengthen ties and share stimulate knowledge sharing;³⁹
- In addition, a formal consultation procedure was followed for (the successor of) the National Water Plan from September 2014 to 2015;⁴⁰
- Delta Programme Agreement signed by representatives of the provinces, water boards, municipalities and the Minister of Infrastructure and the Environment to anchor the Delta Decisions and preference strategies in their own plans (2014).⁴¹

4.2 Connections with other policies

The objectives of the **Delta Programme** are linked to all administrative divisions within the Dutch state (national government, provinces, municipalities and water boards) and the Delta Decisions have been embedded in the National Water Plan as policy decisions by the Dutch government in 2014. In addition, representatives of the provinces, water boards, municipalities and the Minister of Infrastructure and the Environment signed the Delta Programme Agreement to anchor the Delta Decisions and preference strategies in their own plans (2014).

From a R&I perspective, the Delta Programme is linked to:

- The knowledge and innovation agenda of the Ministry of Infrastructure and Environment, Department of Public Works, knowledge institutes STOWA, KNMI, Deltares, Alterra and TNO and the Dutch universities;⁴²
- The Knowledge and Innovation Agenda of the Top Sector Water.⁴³

On international level the initiatives are linked to:

- UN Sustainable Development Goals (SDG): SDG 13 - Take urgent action to combat climate change and its impacts, SDG 6 - Ensure access to water and sanitation for all and SDG 15 - Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss;

³⁷ Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken (2014). Deltaprogramma 2015. Werk aan de delta. De beslissingen om Nederland veilig en leefbaar te houden. Den Haag: Ministerie van Infrastructuur en Milieu, Ministerie van Economische Zaken

³⁸ <https://waterenklimaat.nl/>

³⁹ <https://www.deltacommissaris.nl/nationaaldeltacongres>

⁴⁰ <https://www.deltacommissaris.nl/deltaprogramma/vraag-en-antwoord/er-wordt-samengewerkt-met-allen-overheden-maar-hoe-kunnen-burgers-meedenken-meepraten-over-het-deltaprogramma>

⁴¹ <https://www.deltacommissaris.nl/deltaprogramma/wat-is-het-deltaprogramma>

⁴² <https://www.deltacommissaris.nl/deltaprogramma/kennisprogramma-van-het-deltaprogramma/kennisontwikkeling>

⁴³ <http://www.topsectorwater.nl/>

- Flood Directive EU Directive 2007/60/eG on the assessment and management of flood risk;⁴⁴
- Delta Alliance: The National Water and Climate Knowledge and Innovation Programme serves as the Dutch Wing of the international Delta Alliance. The Delta Alliance is an international knowledge-driven network organisation with the mission of improving the resilience of the world's deltas. With increasing pressure from population growth, industrialisation and a changing climate, it is more important than ever that these valuable and vulnerable locations increase their resilience to changing conditions. The Delta Alliance, with 18 network members from 15 countries, brings people together that live and work in deltas. The Delta Alliance provides a platform where knowledge can be shared and countries can benefit from each other's experience and expertise and as such contribute to an increased resilience of their delta region.⁴⁵

4.3 Key turning points of the initiative and policy adaptation measures

As described above the original Delta Plan had to be revised after societal protests against the closure of the Eastern Scheldt, resulting in a six times more expensive open storm surge barrier containing a number of sluices that would only be closed during heavy storms and high-water levels and building two additional auxiliary dams.

Major changes / turning points of the initiative	Description of the flexibility mechanism / policy adaptation measures
<p>The original plan for the Delta Plan of 1957 included a regular dam to close the Eastern Scheldt. The first activities for this had been started in 1967 and in 1973 already a five-kilometre section of the (in total 9 kilometre) dam had been closed. Due to increasing societal protests against the plan to close the Eastern Scheldt (first protests started by a group of fishermen in 1967) the original plan had to fully revised.</p>	<p>In 1973 a new (progressive) government came to power. The government appeared to be sensitive for the arguments of the protestors and installed the Eastern Scheldt Committee to advise on possible alternatives for a closed dam. The Committee presented its advice for an open surge barrier in 1974. Because the new proposal would be much more expensive than the original one and included building two auxiliary dams (the Philips Dam and the Oester Dam) to restrict the surface of the Eastern Scheldt and strengthened the tidal movements a lot of discussion arose in the Dutch Lower Chamber of Parliament. After many debates it was agreed to that the construction works needed to be fully revised, even some parts of the dam had to be taken away. The construction of the open storm surge barrier started in 1976. On 4 October 1986, the Eastern Scheldt storm surge barrier was officially opened. The total cost of the barrier was six times higher than initially budgeted.</p>

5 Realised or expected outputs, outcomes and impacts

⁴⁴ http://ec.europa.eu/environment/water/flood_risk/implem.htm

⁴⁵ <http://www.delta-alliance.org/>

5.1 Outputs and new instruments

In the short term, the Delta Plan contributed to increased safety, because the Ministry of Public Works started quickly with the implementation of the first advice of the Delta Committee. Already in 1958, five years after the disaster, the first project (Storm barrier Hollandse IJssel) had been completed.

Also, the establishment of the separate Delta Service department within the Ministry of Public Works in May 1956. This new department consisted of experts from various disciplines was created coordinate and execute the implementation of the Delta Plan.

In the short term, the Delta Programme resulted in a new Delta Law providing the legal framework for the independent Delta Commissioner to formulate, actualise and execute the Delta Programme, and the setup of the Delta Fund to secure continuity in finance for the cost of maintenance and development of new infrastructure. The Delta Law makes the execution of the Delta Programme less dependent from the short-term cycle of politics and provides institutional continuity.

Also, the formulated Delta Decisions have been embedded in the National Water Plan as policy decisions by the Dutch government in 2014. In addition, the Delta Programme Agreement was signed in 2014 by the provinces, water boards, municipalities and the Minister of Infrastructure and the Environment to anchor the Delta Decisions and preference strategies in their own plans.

Furthermore, the establishment of the National Water and Climate Knowledge and Innovation Programme to stimulate joint-programming and connecting clients with contractors.

Moreover, to be able to execute all measures sooner and with less budget research and innovation plays an important role in the Delta Programme. For this reason, new instruments are introduced, such as competitions to collect new ideas and solutions for challenges, solution-focused public tenders to give contractors more room to suggest own ideas and giving more weight in the evaluation of tenders to innovation rather than price. In addition, knowledge exchange and pilot projects and experiments are stimulated under the Stimulation Programme Spatial Adaptation.

5.2 Outcomes

In the medium term, the reconstruction and the realisation of the construction works initiated under the Delta Plan brought many jobs to the province of Zeeland. The province experienced a period of prosperity in the years after the flood, which led to decades of improvement in a few years.

For The Netherlands as a whole, the gross domestic product grew by 8.4% in the year of the disaster, an unprecedented high percentage. The national government increased consumption by ten percent and investments in 1953 were 60% higher than the year before. All this gave a powerful positive impulse to the Dutch economy.⁴⁶

⁴⁶ <http://www.deltawerken.com/Deltaworks/23.html>

In the medium term, the Delta Programme connected the policy domains of flood risk and spatial adaption and thereby strengthened the coherence between the two domains.

The Delta Decision on flood risk management provided new and higher safety standards for flood risk management. The new standards are developed from a risk perspective: the standards are not only related to the probability of a flood, but also to the consequences of a flood. As a result, the scale of the consequences determines the height of the standard.⁴⁷

5.3 *Impacts*

Besides shortening the total length of the dykes by 700 kilometres and increasing safety, the Delta Plan had impact on many other aspects.

- Firstly, the agricultural freshwater supply was improved. Because the border between freshwater and saltwater was moved further west, less freshwater was required to balance the freshwater-saltwater division. The excess water could be transported to the north of the Netherlands, in the direction of the IJsselmeer (IJssel lake), where extra freshwater was welcomed to improve the water conditions.
- Secondly, the complete water balance of the Delta area was improved. Thanks to the construction of the major and auxiliary dams, it became possible to manipulate the streams in this area more easily. Different types of sluice made it possible to allow fresh water in, or polluted water out.
- Thirdly, the construction of the Delta Works encouraged traffic between the many islands and peninsulas. Large parts of the province of Zeeland had literally been isolated for centuries.
- Fourthly, the inland waterways shipping was supported by the Delta Works. In 1976, Belgium and The Netherlands signed a contract that would regulate the shipping between the ports of Antwerp and Rotterdam.
- Fifthly, the Delta Plan has influenced new development in the areas of nature and recreation. Although a number of nature reserves were irreparably damaged, as compensation, new nature reserves have emerged at different sites that are nowadays used for recreation.
- Sixthly, the Delta Plan increased the Dutch knowledge position in this area and strengthened export position of the industry. The Delta Plan created an enormous challenge for civil engineers and construction companies to develop new techniques and thereby the opportunity to build an impressive showcase of modern water management infrastructure. It greatly contributed to the world-wide recognised number one position of Dutch water management expertise.⁴⁸

It is too early to analyse the impact of the Delta Programme, although it is already clear that the Delta Programme extends the number one position of the Dutch industry by adding new expertise on water-related climate adaption strategies and techniques.

⁴⁷ <https://www.deltacommissaris.nl/deltaprogramma/deltabeslissingen/deltabeslissing-waterveiligheid>

⁴⁸ <http://www.deltawerken.com/Deltaworks/23.html>

5.4 Summary of the key indicators

Key indicators	
Timeline:	<p>Delta Plan: 1953-1978 (the actual realisation of the Delta Plan took until the opening of the Eastern Scheldt storm surge barrier in 1986).</p> <p>Delta Programme: 2010-2100</p>
Objective and targets:	<p>Delta Plan:</p> <ul style="list-style-type: none"> • Protect the Netherlands against flooding by the sea <p>Delta Programme:</p> <ul style="list-style-type: none"> • Make The Netherlands resilient to climate change and sea-level rise • Ensure a sufficient supply of fresh water
Total budget:	<p>Delta Plan:</p> <p>EUR 680 – 900 million (3.3 billion guilders). The actual total cost of the Delta Plan is estimated at around EUR 5 billion (inflation-adjusted), three times as much as the original estimated budget.</p> <p>Delta Programme:</p> <p>For the implementation of the Delta Programme’s total budget was initially estimated on average EUR 1 to 1.5 billion annually until 2100, resulting in total cost of the implementation up to EUR 90 to 135 billion. The formulated Delta Decisions with new standards for flood risk (i.e. probability x consequence) resulted in adjusted measures at lower cost. The estimated costs of the measures to meet the new standards total EUR 26 billion until 2050.</p>
Annual budget:	<p>Delta Plan: no information available on the annual budget</p> <p>Delta Programme: appr. EUR 1 to 1.2 billion until 2050</p>
Share of budget, public funding:	<p>Delta Plan: 100%</p> <p>Delta Programme: 100%</p>
Share of budget, private investment:	<p>Delta Plan: limited, for specific parts of the Delta Plan private parties were contracted.</p> <p>Delta Programme: limited, for specific parts of the Delta Programme private parties are contracted. In addition, private partners participate in the National Water and Climate Knowledge and Innovation Programme.</p>
Leverage effect (additional public/private investments the initiative has triggered):	<p>Delta Plan: no data available. The Delta Plan contributed to the increased Dutch knowledge position in this area and strengthened export position of the industry.</p> <p>Delta Programme: No detailed data available. The funding for the Delta Programme is mainly financed by the National Budget. Water boards, provinces and municipalities also contribute financially, as</p>

	<p>well as with other resources (such as coordination activities) to the Delta Programme, its sub-programmes, research studies or other measures. The contribution of the administrative bodies depends on their regional interests and therefore varies per measure/activity.</p>
<p>Key (official/public) indicators applied for monitoring the progress towards the targets:</p>	<p>Delta Plan:</p> <p>No detailed information available on key indicators applied for monitoring of the progress. Half-yearly progress reports included information on technical issues of progress (and completion) of construction works, as well as information on the financial and budget implications.</p> <p>Delta Programme</p> <p>The Delta Commissioner reports annually to the Dutch Government and Parliament on the progress of the Delta Programme at the sub-programme level, including an overview of projects scheduled and budget implications.</p> <p>To be able to systematically monitor and evaluate the progress and effectiveness of the agreed measures as well as to measure how developments are taking place, to know what the consequences are for the chosen strategies and how to act accordingly a system of 'measuring, knowing, acting' (in Dutch Meten, Weten, Handelen; MWH) is currently being developed. This systematic approach will inform all involved stakeholders on 'input', 'output', 'outcome' and 'learning'.</p>
<p>Other key indicators (e.g. outputs/outcomes/impacts):</p>	<p>Delta Plan</p> <p>The following outputs/outcomes/impacts of the Delta Plan were reported:</p> <ul style="list-style-type: none"> • Agricultural freshwater supply; • Water balance of the Delta area (different types of sluices made it possible to allow fresh water in, or polluted water out); • Mobility between the many islands and peninsulas; • Inland waterways shipping infrastructure and regulation; • New development in the areas of nature and recreation; • Dutch knowledge position in this area and export position of the industry. <p>Delta Programme</p> <p>Key indicators will be identified with the development of the system to monitor and evaluate the measures agreed and strategies developed under the Delta Programme.</p>

6 Conclusions and lessons learned

6.1 Identification and assessment of key strengths and weaknesses of the initiative

Strengths	Weaknesses
<p>Delta Plan</p> <ul style="list-style-type: none"> • Sense of urgency • Simple governance structure • A phased approach and start with the simpler projects first to gain experience and make use of the experience with the more complex projects • The framework structure of the Delta Law creating the necessary flexibility for the execution of the projects • Increased the Dutch knowledge position in this area and strengthened export position of the industry <p>Delta Programme</p> <ul style="list-style-type: none"> • Insidious problem of climate change translated into a permanent mission • New Delta Law providing the legal framework • Independent Delta Commissioner responsible for the formulation, actualisation and execution of the Delta Programme (including financial implications) making the execution of the Delta Programme less dependent from the short-term cycle of politics and provides institutional certainty • Delta Fund to secure continuity in finance for the cost of maintenance, development (new) infrastructure • Delta Decisions embedded in the National Water Plan and anchored in plans of the provinces, water boards, municipalities • Multi-annual perspective of the Delta Programme (12 years) • Connection between policy domains flood risk and spatial adaption • Joint programming of the National Water and Climate Knowledge and Innovation Programme connects demand with supply • Increased the Dutch knowledge position in this area and strengthened export position of the industry 	<p>Delta Plan</p> <ul style="list-style-type: none"> • Although the framework contract was the preferred contract form to ensure the quality, flexibility and planning requirements in 1975 this contract form with contractors did not lead to the lowest cost <p>Delta Programme</p> <ul style="list-style-type: none"> • Transition from planning to implementation took quite some time and reduced the interest of the industry to participate

6.2 Lessons learned and key messages for European R&I policy

Research and innovation play an important role to achieve a mission. Research and innovation provide new knowledge, ideas and insights and thereby new solutions to reach the goal(s) of a mission. The examples of the Delta Plan and the Delta Programme show that by fostering knowledge exchange, close collaboration with all stakeholders involved and joint programming are key to develop innovative solutions for urgent societal issues.

The Delta Plan and its successor the Delta Programme show that with a **specific mission oriented law** missions can be given a legal basis to a) secure the finance of the required investments and b) define the role, competences and responsibilities of the coordinator/executor of the mission.

Many of the global societal challenges are challenging problems that require an integral policy mix. The integration of flood risk management and spatial adaption under the Delta Programme shows that the **coherence between different policy domains** can be strengthened by making use of the synergies and trade-offs and thereby increase the impact of measures to achieve the mission.

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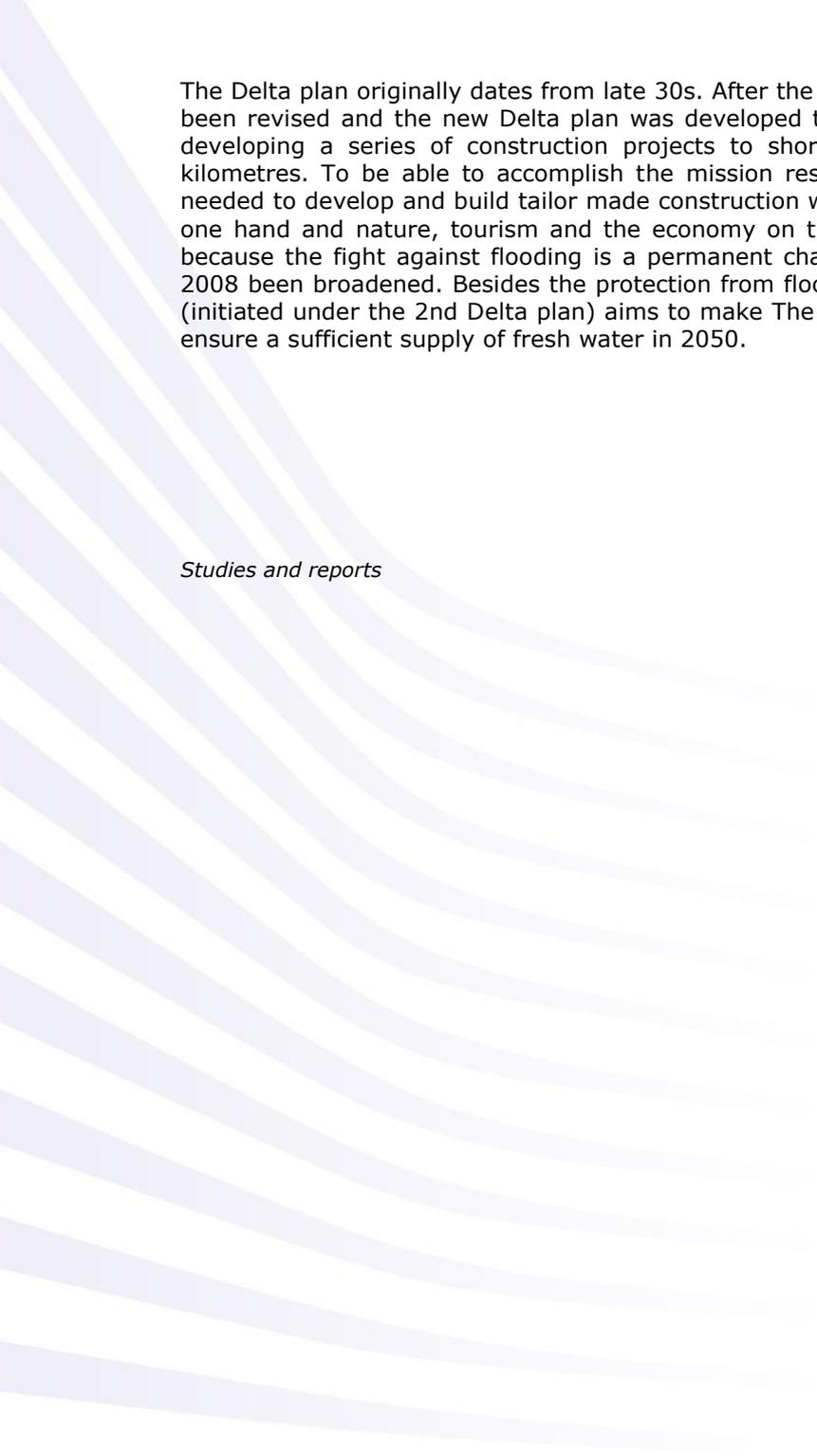
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The Delta plan originally dates from late 30s. After the North Sea flood of 1953, the initial plan has been revised and the new Delta plan was developed to protect the Netherlands from flooding by developing a series of construction projects to shorten the Dutch coastline with in total 700 kilometres. To be able to accomplish the mission research and technological development were needed to develop and build tailor made construction works and to take into account safety on the one hand and nature, tourism and the economy on the other hand. The project is still ongoing, because the fight against flooding is a permanent challenge. Furthermore, the mission has since 2008 been broadened. Besides the protection from flooding by the sea, the current Delta Program (initiated under the 2nd Delta plan) aims to make The Netherlands resilient to climate change and ensure a sufficient supply of fresh water in 2050.

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