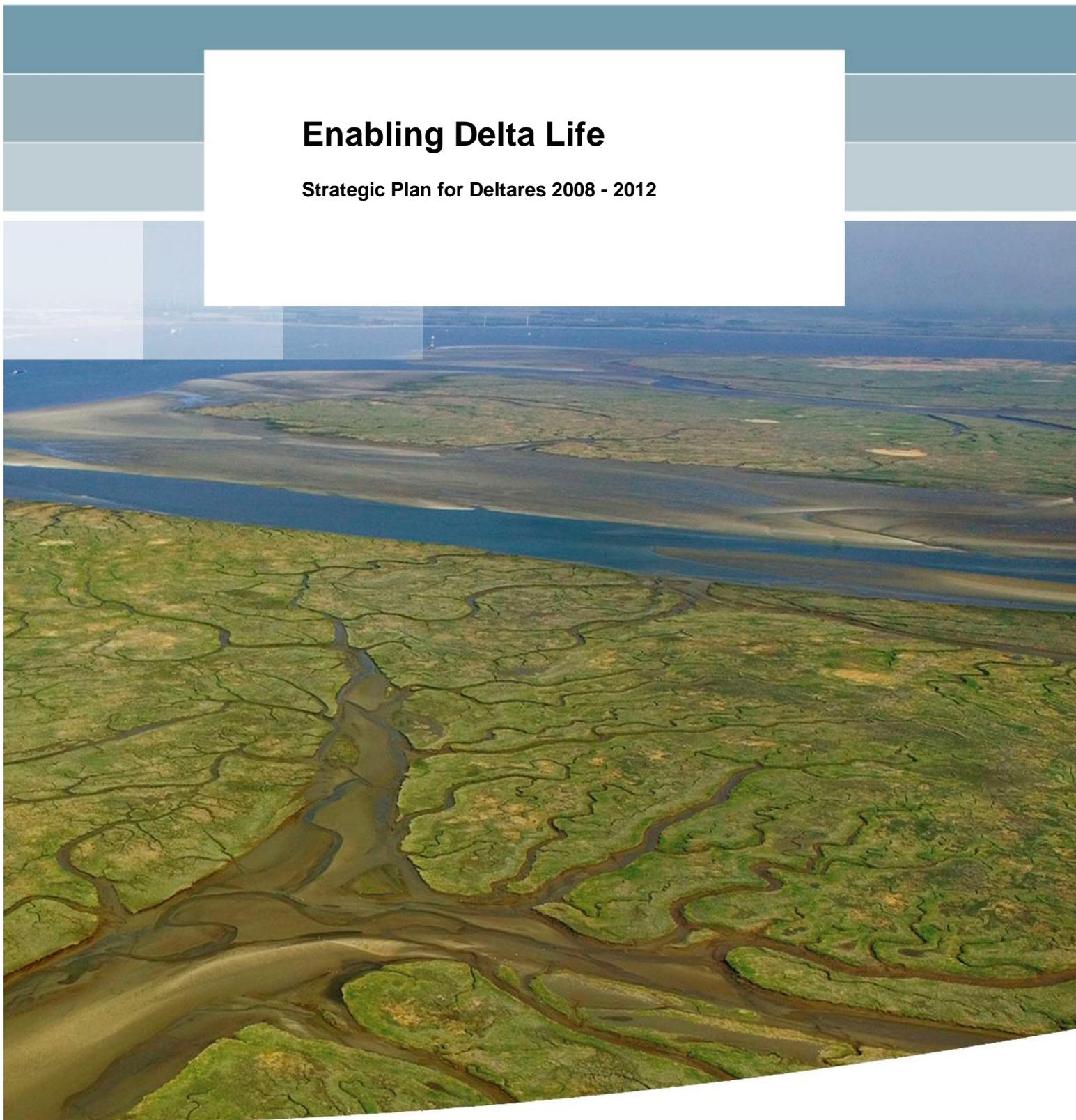


Enabling Delta Life

Strategic Plan for Deltares 2008 - 2012



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1000062-000

Title

Enabling Delta Life

Project

1000062-000

Reference

1000062-000-ZKS-0008

Pages

22

Keywords

Place keywords here

Summary

Place summary here

References

Place references here

Version	Date	Author	Initials	Review	Initials	Approval	Initials
	dec. 2009						

State

final

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1 Foreword

The new institute Deltares is unique in the world; it combines knowledge on subsurface, soil and water systems. Knowledge we use in our deltas and abroad. Translating science into solutions for delta-related issues is the core of activities of Deltares. Deltares goal is to be an internationally leading institute on delta-related issues, with excellent facilities, employing high-level professionals, attracting high-level talent and being recognised as a valuable (value adding) partner by public authorities, knowledge institutions, private companies, and the public, in the Netherlands and abroad.

Worldwide, delta areas have developed into important centres of high activity. Industry, trade, and population, all are attracted by high fertility, easy accessibility (over land and water) and easy supply of fresh water. But managing delta areas is challenging: soils are soft and not easy to build on, increasing activity puts pressure on the environment, and availability of resources and energy is limited. Changes predicted by climate change scenarios, further complicate balancing safety, living and working, and environmental quality. Temperature and water levels are predicted to rise, and extremes in weather conditions (more and more extreme periods of drought and heavy precipitation) are expected. There is a growing awareness that the different elements of delta areas – soil, subsurface, and surface and ground water – are all connected and different interests – of industry and citizens - have to be served and balanced. Managing delta areas asks for a multidisciplinary, systems approach.

The Netherlands has a long tradition of excellence in managing delta areas¹; natural and engineered systems. New challenges, ask for new solutions, to be enabled by scientific development, and application of knowledge and new engineering techniques. In 2005, the Dutch government decided to bring together in one single institute for applied research and development - Deltares - different existing centres of excellence (Geodelft, WL | Delft Hydraulics, parts of TNO building and subsurface, and specialist services of Rijkswaterstaat, the executive branch of the ministry of Traffic and Public Works). This concentration and combination of expertise will enable the multidisciplinary, systems approach needed.

At the end of the planning period, the benefits of combining the expertise of the original institutes must be fully harvested. Addressing delta-related issues in an integral and multidisciplinary manner, from the start, will support fast integration of the original expertise areas.

Management and employees have worked together with stakeholders on drawing up plans for research and development to meet the challenges ahead. We are proud to present the strategic plan of the new institute in this document. As you will see, our employees are set on meeting the demands of the 21st century, by developing excellent knowledge and bringing it to practical application.

¹ In the definition used here, delta areas include coastal, estuarine and riverine areas. This document also follows the Dutch definition of 'delta technology', i.e. the development and application of scientific knowledge in relation to delta areas in the broad sense defined here.

Challenges are exciting subjects to work on, together with our partners and stakeholders. We look forward to working with you. Deltares wants to support you in your operations and ambitions and wants to 'really make a difference':

Enabling Delta Life

Harry Baayen
Managing Director Deltares

2 Introduction

This document describes the strategic plan for the period 2008-2012 of Deltares, the Dutch institute for applied research and development on issues related to living and working in delta areas. The strategic plan focuses on the overall goals and strategic directions of the organisation. Operational plans will complement it, by further detailing actions and milestones related to the strategic goals.

In chapter 2, the identity (mission statement and role) of Deltares is described. In chapter 3 an analysis of the surroundings of Deltares is made: identifying major challenges for delta areas. Also the strategic priorities are defined in this chapter: the issues Deltares will focus on in the planning period. The external performance of Deltares – addressing the strategic priorities of chapter 3 – must be underpinned by internal development of knowledge, tools, facilities, etc. The corresponding strategic actions and goals are described in chapter 4.

3 Deltares Identity

3.1 Mission Statement: Enabling Delta Life

The mission of Deltares is to develop, acquire, apply and disseminate integral, multidisciplinary knowledge and knowledge products related to living and working in delta (coastal, estuarine, and riverine) areas, on an internationally leading level. With this, Deltares supports public authorities, private parties and society in their operations and ambitions, related to sustainable development of delta areas: Enabling Delta Life.

3.2 Profile

Deltares is the Dutch institute for applied research and development on issues related to living and working in delta areas. Its primary task is bringing together science and application: translating scientific knowledge into innovative solutions needed in sustainable (clean and safe) development of delta areas. Deltares is worldwide unique, as expertise and activities cover (and bundle) a broad scope: water, soil, subsurface, and environment. It will play an active role in innovation networks with the ultimate goal of creating societal value, by supporting and speeding up innovation.

In supporting public authorities, private parties and society, Deltares distinguishes five roles:

- **Research and development centre:** Research programming of Deltares is demand-driven and covers the entire spectrum of fundamental research to valorisation. Deltares responds to demands for new knowledge, innovative products and advanced services. Together with stakeholders and partners, research goals are defined and translated into road maps and actions.
- **Knowledge broker:** Deltares cooperates with knowledge providers, both in the Netherlands and abroad, to acquire knowledge, integrate it, and make it available to stakeholders.
- **Knowledge and information centre:** Deltares makes high-quality, science-based, products and expertise available to a broad public. By continuous interaction with stakeholders, it proactively identifies knowledge gaps, disseminates knowledge and supports valorisation. It develops ready-for-use software products, decision support tools, and provides courses and trainings. Deltares will also offer services to stakeholders to manage combine and enrich data collections, to create easily accessible information systems.
- **Specialist advisor:** Deltares incorporates state-of-the-art knowledge and innovations in independent, authoritative, expert advice, create new engineering solutions, and supplies advisory capacity in case of national emergencies.
- **Assessor and analyst:** Deltares provides authoritative, independent and factually-based assessments of the physical state of delta areas; it identifies physical and social trends and developments, supports policy development and evaluates effectiveness of policies.

Deltares will develop the roles into a balanced mix, enabling a response optimally attuned to different requirements of different stakeholders at different times. The roles in combination provide essential added-value to our stakeholders, and are the pillars in defining strategic targets and operational plans. The roles mutually reinforce each other, and together they cover all stages of the innovation cycle: from developing and acquiring new scientific knowledge to valorisation and validation of new knowledge and models in real world projects.

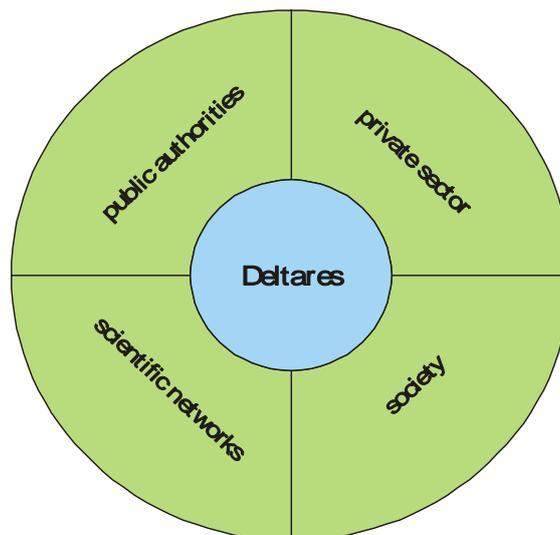
Issues related to sustainable development of delta areas are increasingly complex. A systems approach is needed: physical and social (or societal) aspects must be balanced, interventions in soil systems may directly affect the quality of natural (ground and surface waters), and so on. Deltares brings together, and integrates all relevant expertise areas, covering physical and social sciences, in a multidisciplinary approach, enabling integral solutions and creating value to society.

All of Deltares activities are judged against the following criteria:

- they must create societal value,
- they must contribute to strengthening the Dutch knowledge position on delta-related issues,
- they must advance the international reputation of Deltares as a top institute, and
- they must contribute to financial soundness of Deltares

3.3 Partnering with Stakeholders

Deltares puts high value on forming long-term partnerships with all relevant stakeholders to maximise knowledge exchange and valorisation options. The stakeholder groups are schematically depicted in the figure below. Characteristics of the relations with the stakeholder groups and the ways of partnering are described in this paragraph.



3.3.1 Types of Stakeholders

Public Authorities

The primary goals of the Dutch government are: safety (e.g. protection against flooding), improved mobility, and a healthy and attractive living environment. Dutch national government is a major financier of Deltares and an important partner in defining research and development planning. Together with ministries, knowledge demands, connected with government priorities, are defined and translated in research agendas, covering both long-term developments and short-term solutions.

In the Netherlands, lower governmental levels (and private companies) become more and more involved in the definition and execution of public works.² Deltares works for and with public authorities on all levels, from ministries to water boards, provinces and cities. Activities focus on support of policy development, development and maintenance of operational systems, and expert advice in case of national crises.

Many countries, in particular highly developed economies, face the same challenges for delta areas as the Netherlands. Deltares will establish contacts (and work for) authorities outside the Netherlands where knowledge developed in the Netherlands has clear value, there are options to advance international recognition of Deltares as a top institute, and opportunities to strengthen the Deltares knowledge base through working with strong and knowledgeable partners. The European Union (EU) has a special position in this. The influence of EU regulation on policy requirements in the member states is growing rapidly. The EU, therefore, increasingly will be a natural market for Deltares. Scientific knowledge can add value to the whole trajectory from policy development to the implementation of measures.

Private sector:

In relation with the private sector, the ambitions of the Dutch government are to translate the excellent Dutch knowledge position on delta-related issues in economic growth (through export growth), and to create a strong and innovative home market in which private companies can prosper and grow. Deltares will cooperate with Dutch private companies, and with its knowledge support them in increasing export. Deltares will develop special measures to support of SMEs.³

Deltares will also establish contacts with, and work with, private companies outside the Netherlands. The motivation is to advance international recognition of Deltares as a top institute, strengthen the reputation of the Netherlands as a 'delta expert centre', creating new opportunities for Dutch private companies, and strengthen the knowledge base by working with strong and knowledgeable partners.

Scientific networks:

Scientific development is international by nature. Deltares will strengthen and complement its knowledge position by forming alliances with relevant institutes and universities, in the Netherlands and abroad, that give access to the latest scientific developments. Forming strong and enduring bonds will be supported by working together in concrete research projects, personnel exchange and dual placement. The cooperation with international scientific partners also provides the opportunity of benchmarking the Deltares knowledge position.

Public:

The social chapter of the Deltares mission is to provide integral knowledge and information on delta issues to a broad public. Both NGO's and individual citizens can access knowledge and information available within Deltares.

² One of the trends in government is decentralisation of authority. Thus, lower governmental levels play a larger role in spatial planning and regional development. Another trend is the change of government contracting of private companies from the realisation of predefined specifications (defined by specialist services of the government) to combinations of design, building, maintenance and even financing.

³ For instance through expansion of the innovation voucher system and easy access to advanced facilities. The present Dutch innovation vouchers are an innovation-stimulation instrument of the ministry of Economic Affairs. SMEs can get vouchers of 2500-5000 euro per year that can be spent at research facilities. Deltares could similarly offer reduced-rate periods. This could also apply to the use of advanced facilities of Deltares.

International Ground Water Assessment Centre (IGRAC)

The world's groundwater resources are key to sustainable development. Taking full benefit of the available groundwater resources and, at the same time, effectively controlling the ubiquitous groundwater-related problems is very demanding tasks. Sharing groundwater information and experience on a world-wide scale is of great value here. IGRAC – an UNESCO centre accommodated by Deltares – supports and promotes this by giving access to available information, free of charge.

The social chapter of the mission also has other dimensions. Deltares will also participate actively in supporting developing countries to improve living standards for their citizens, health and quality of the living environment.

3.3.2 Partnership with Stakeholders

Partnerships are formed throughout the whole innovation cycle. The goal is to define research and development activities that are attuned to the needs of stakeholders and to speed up innovation and valorisation by constantly working together (exchanging knowledge and experience) in the execution phase of activities.

In the programming phase, together with the stakeholders, knowledge demands and opportunities arising from newly developed knowledge are identified and translated into research and development goals and road maps. Programming meetings with stakeholders (so called knowledge arenas, see appendix 1) have a central role in this.

Dutch national government has a special role in the programming phase. It has its own knowledge demands, it organises knowledge arenas, and it out sources specific services, such as data management and the availability of resources for crisis situations (experimental facilities and specialist advice).

In the execution phase, cooperation is sought to enhance the speed of knowledge development, and innovation and valorisation.

Deltares goal is to excel in combining, and integrating knowledge from different scientific disciplines. The own excellence in disciplines will be complemented by excellence of partners (knowledge institutes in the Netherlands and abroad) through long-term cooperation and strategic alliances. Dual placement, Deltares employees with a university posting, will be used to strengthen cooperation.

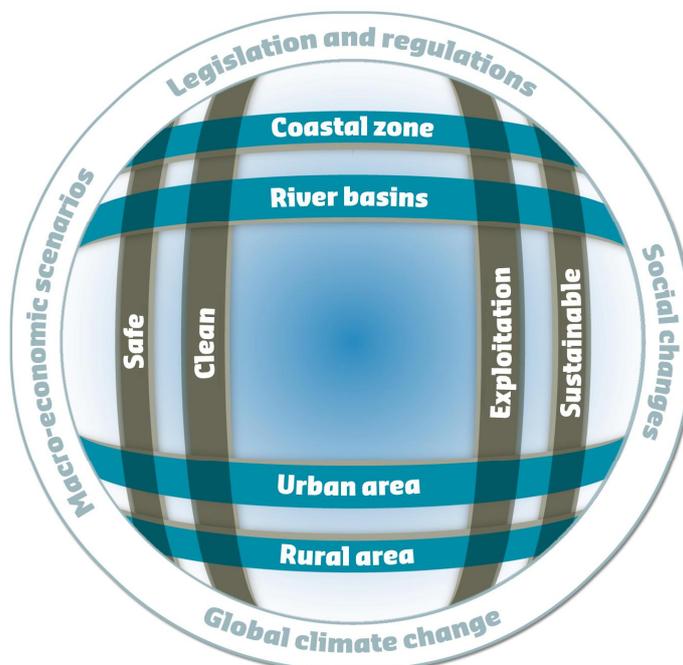
Knowledge transfer is not a one-way street, nor is knowledge development the exclusive domain of scientific institutes and universities; private companies also develop high-level knowledge and know how. To promote knowledge exchange and to strengthen cooperative networks, Deltares will also devise dual placement arrangements (i.e. temporary postings) with private companies.

4 Challenges and Strategic priorities

4.1 Introduction

In this chapter, the surrounding of Deltares is analysed: the main challenges for delta areas and delta-related innovation are identified. Also, the strategic priorities of Deltares are discussed, i.e. the prime focus of research and development activities in the planning period.

In chapter 4, the main internal developments are discussed that underpin the external performance of Deltares: meeting the challenges identified here.



The figure above schematically shows the elements of the analysis of the surroundings, and the scope of Deltares: coastal zone, river basins, urban areas and rural areas. The different aspects shown in the figure are the basis for the discussion of trends and priorities in the next paragraphs.

Delta areas have great appeal to people. The soil is fertile, freshwater is readily available and the towns and cities are easily accessible from both water and land. Over the centuries, delta areas in different parts of the world have developed into key economic and trade centres.

But there are also challenges connected to living and working in delta areas. There is the ever present danger of flooding, the softness and heterogeneity of the soil complicates building, resources (water, energy, and minerals) are limited, and the concentration of economic activity puts pressure on the environment. In short, managing delta areas, maintaining a good balance between economic value and quality of the living environment is demanding.

Delta regions strive for continued economic growth. This creates further pressures: space is scarce, infrastructure becomes clogged and the quality of the living environment is further threatened. Demands are shifting, and new solutions to regional development are needed.

Several important elements come to the fore: adaptation to climate change, scarce space for exploitation, safety, quality of the living environment (cleanliness and sustainability), and social acceptance of innovations. Although these elements are interconnected, in the next paragraphs these elements will be discussed one by one, to identify both specific and common needs.

4.2 Climate Change

The challenges

The scenarios for climate change predict rising temperatures, rising water levels, and more and more extreme periods of drought and heavy precipitation. This has multiple consequences:

- protection against flooding must be adapted,
- discharge capacity of sewage and waterways has to be enlarged to deal with larger water discharge in periods of heavy precipitation,
- water storage capacity has to be adapted, to fulfil the needs in periods of drought
- rising temperature and extremes in water levels threaten the health and quality of ecosystems, measures must be developed to protect the ecosystems and increase their resilience,
- extremes in water discharge not only have direct consequences for natural habitats, but changes in discharge may lead to sudden release of historic pollutants captured in sediments, threatening the quality of fresh water, source of, amongst others, drinking water,
- spatial planning has to find a new balance between developing new areas for industry activity and housing, and safety,
- and so on.

Deltares focuses on adaptation to climate change. 'Climate adaptation' is a prime example of a challenge that needs an integral, systems approach. Not only are there many components of delta systems that have to be adapted, but the interaction between these components has to be accounted for, and conflicting interests have to be balanced. In the Netherlands, recently the so called second Delta Committee (or commissie Veerman, named after its chairman) stressed the need for an integral approach and new ways of thinking in its report: *Samen werken met water, een land dat Leeft bouwt aan zijn toekomst*.⁴

The 2nd Delta Committee

Dutch national government installed a committee of experts in various aspects of delta areas to describe strategic issues and general directions of development in dealing with climate change. Starting from certain water level rises, the committee has drawn up 12 recommendations. The committee stresses the need for new ways of thinking, and an integral approach. Safety against flooding and securing fresh water supply are not the only issues, also sustainability must be addressed and the coherence and interaction of living and working, agriculture, nature and landscape, infrastructure, and energy supply.

⁴ *Working together with water, a country that lives builds on its future, September 2008.*

Strategic priorities

Adaptation to climate change is a common thread in all activities of Deltares. In many of the following paragraphs, challenges and strategic priorities show a clear connection with adaptation. Here, we focus on the general, overall issues.

Concentration of activity in low lying areas is high, along the coast, polders, and river floodplains. Future spatial planning has to be based on a cost-benefit analysis that includes the economic and social benefits of development, but also - even more than before - the risks involved, such as the damage to industry and society in case of calamities. Existing tools for risk assessment have to be extended, and new tools be developed, to support this new approach.

Flood protection is a matter of first and utmost importance. With new challenges, new engineering solutions for defensive structures must be developed and response to impending calamities has to be adapted. New early warning systems and decision-support systems are needed to meet the challenges ahead.

The quality of the living environment and ecosystems has become a more important and integral aspect of spatial development (see also § 3.4). Presently, new legislation is aimed at improving the quality of ecosystems under the actual climatic conditions. But climate change will shift natural balances. Temperatures and water levels are predicted to rise and extremes in water levels and precipitation will be larger and more frequent. The rising sea water level also means higher risk of salt intrusion in natural waters and soil behind coastal defences. The possible impact of climate change must be analysed thoroughly, and effective measures be devised to preserve the quality of ecosystems under the changing conditions.

Natural water bodies not only are valuable ecosystems, they also are an important source for irrigation and drinking water, and water used in industrial production. With extremes in weather conditions, the suppletion of this valuable resource will vary strongly. In periods of drought, low river levels may also lead to intrusion of salt water from the sea. New measures will have to be developed to maintain both the quantity and quality of natural water at a level that ensures sufficient and safe supply.

4.3 Scarce Space

The challenges

Onshore and offshore, Delta areas are characterised by intense use, with multiple – often conflicting – functions. Population and industry activity in delta areas will continue to grow. This puts ever more pressure on available space. Enabling further growth of activity in delta areas requires new solutions.

Strategic priorities

The multiple functions of delta areas – in a limited and densely populated space - require new developments in spatial planning. Insight into the interactions of the various components and the effects of interventions must be enlarged and integral decision making must be strengthened, for instance by the development of integral decision support tools.

Not only on land space is scarce, but the use of the sea also is increasingly intense. Space is required for transport, fishery, oil- and gas production and energy production (e.g. wind energy), and recreation. Interventions, such as offshore construction (e.g. harbour extensions or windmill parks) but also pollutants from rivers flowing into the sea put pressure on the natural system. Typical for the sea and coastal area are the large dimensions and the long timescales of morphological changes. Again, insight into the interactions of the different components (activities and ecosystem) must be enlarged and integral tools must be developed.

Building on soft soil has always been challenging. Not only does construction ask for special means to provide load-bearing capability (such as foundations), but settling of the soil also means that maintenance costs are high. On further growth of activity, areas even less suitable for construction (with even softer soils) will have to be developed. This requires a thorough understanding of the geological composition of the subsurface, its geotechnical properties, and natural waters, new construction engineering solutions, but also of the cultural, economic, political and environmental aspects. Policy development and decision making need improved physical models of soil, subsurface and water body behaviour and new tools (such as scenario studies) that support decision making with an integral approach. As heterogeneity of the soil is high, such models and tools must also give insight in the uncertainties in behaviour of the system components, thus supporting solid design rules (science-based safety factors).

Multiple use of space, combining building on the surface with underground building can create new options for more efficient use of scarce space. Much experience with underground (road and rail) tunnels has been gained in the last decade, and micro-tunnelling is developing into a good option for efficient and easy-to-maintain underground laying of light infrastructure (pipes and cables). But there are still many questions to be answered. Understanding of the behaviour of the subsurface, the construction, and the interaction of both, has to be improved to expand the options for underground building. At the same time, measures must be developed to prevent (or minimise) damage to existing infrastructure and buildings. Monitoring during construction (see below) is one of the options to improve control of construction. Further development of monitoring, and expansion of databases for validation of predictive models are needed.

Improved control of underground construction

Underground construction is complex, especially in urban areas with existing buildings and infrastructure. Models for the subsurface and its geotechnical properties and design tools can only predict the effects of underground construction to a certain extent. Developing monitoring systems of the effects of construction during construction itself is an alternative. For instance measuring changes in land height, strains on buildings or changes in water levels, can be used to keep effects within limits and initiate remediative actions (such as local soil reinforcement by grouting) where needed. This approach has proven to enable construction in areas with considerable risks.

Both underground construction and construction on softer soil generate a need for improved means of soil stabilisation and improvement of load bearing capability. Especially in-situ improvements like grouting need further development. New methods like the biochemical SmartSoils[®] treatment may provide additional options.

4.4 Safety

The challenges

Safety has multiple dimensions: safety against flooding, ecological safety (e.g. protection against the effect of oil or chemical spills), safety of constructions, and loss of soil integrity by earth quakes, and so on. With climate change and ever more intense use of delta areas, risks grow. Key to safety is preparedness for calamities and adequate, fast response.

Strategic priorities

There is a growing demand for transparent tools for risk management. Monitoring networks and data processing will have to be developed to build reliable systems that register impending calamities and predict their effects. Tools to support authorities in developing emergency plans need further development as well. Deltares goal is to become leading in early-warning systems, effect prediction models, and decision support systems.

Basic to all delta areas is defence against flooding. Thorough understanding of the load on- and resilience of defensive structures (dikes, dams, etc.) is essential in maintaining appropriate levels of protection. With changing demands, for instance caused by climate change, new types of structures have to be developed, and evaluation procedures have to be adapted. Priorities are enhancing the current periodical evaluation of defences as well as develop real time monitoring of defensive structure integrity. Clearly, such real time information also serves in improving early warning and flood control systems.

In the last decades, in the Netherlands a new philosophy on safety has been evolving. The alternative to enlarging defensive structures is to allow excess water to (controlled) flood limited areas in extreme conditions. Overflowing of defensive structures then is allowed, but the structures must remain intact under these conditions. This puts a whole new perspective on designing and engineering defensive structures. It requires new design rules and models for structure integrity.

Chemical pollution can spread by transport in natural water bodies (ground and surface water), affecting public health, and the quality of aquatic and soil ecosystems. Presence of pollutants is not the only issue, whether they are in solution or bound to surfaces (e.g. sediments, and soil) is equally important. Sudden changes in river discharges and heavy precipitation may lead to sudden release of (historic) pollutants so far bound: penetration 'bursts' of pollutants in soil, inland natural waters, and the sea. In periods of drought, and low discharge, flushing out of pollutants is hindered, but concentrations in discharge may be high. Improved insight in the interrelations of soil and water, and into storage (e.g. binding to sediments, and soil) and transport pathways is needed to devise effective protective measures.

4.5 Quality of the living environment

The challenges

Maintaining and improving quality of the living environment has become an ever more important criteria in judging plans for spatial development. Not only do citizens put higher demands on quality, but there is also a growing influence of national and EU regulation.

Strategic priorities

In the past, environmental quality was often sacrificed to economic development. Over the years, there has been a shift to at least maintaining environmental quality when developing new areas. Presently, a new paradigm shift is happening: new development must (preferably) improve natural quality. This requires a totally new philosophy of construction and development. The research program 'Building with Nature' will develop this new approach.

Building with Nature

This project focuses on the development of new knowledge for sustainable development of delta areas. The spatial development design process takes the ecosystem as the starting point and makes use of natural processes. Economic and infrastructural development is tailored to reinforce the natural ability of the ecosystem to maintain and improve its quality. Examples are the development of the West- and Oosterschelde estuaries and the research of options to use natural sand transport to protect the Dutch coast.

Sustainable development of the living environment requires measures and decision making in complex situations, involving many conflicting interests. Policy and improvement measures tend to focus on certain aspects, for instance the concentrations of certain (hazardous) chemicals in the soil and water or algae bloom. But the different elements of the environment are connected, and interventions on one aspect may negatively affect others. Sustainable development of the living environment has to be on an integral, systems level. It requires a thorough understanding of the physical, chemical and biological interaction in water bodies and soil, and the response to natural or human-induced changes. New predictive models and decision support tools that describe the environment on an integral, systems level, have to be developed.

The realisation that improving quality of the environment requires a transnational approach is growing. Already for a longer period, for instance, the countries through which the Rhine flows have cooperated on improving the water quality of this river. The influence of the EU on national environmental regulations has become more predominant in the last years. A number of directives – such as the Water and Marine Framework Directives, and Directives on soil – already exists or are in a preparatory phase. The development of regulations needs support with sound scientific information from beginning to end. Goal setting must be realistic (must fit with the regional conditions) and implementation measures must be cost-effective. Only in this way, a good balance can be found between maximum benefit to the environment and restraining societal costs.

4.6 Mobility

The challenges

Mobility is an essential factor for economic development and growth of delta areas. This not only applies to land transport. Delta areas are favoured locations for logistical hubs (transshipment centres), connecting sea transport to transport by road, rail and inland waters. Transportation, commuting, recreation all put a claim on available capacity. In the Netherlands – as in many other delta areas worldwide – infrastructure is clogging up. Improving mobility is a priority issue of national governments. Extension of capacity and maintenance of infrastructure are necessary, but at the same time creates further bottlenecks in capacity.

Strategic priorities

Investments in infrastructure will be large in the years to come. At the same time, the arrangements for design and construction are changing. In the past, government specialists drew up detailed specifications to be fulfilled by contractors. New contract forms are emerging, such as design-build-maintain. This provides a number of challenges. First, government now has to specify in terms of functionality and performance. This requires thorough understanding of the relation between works planned and achievable performance. Second, contractors now will have to accept responsibility for long-term performance of infrastructural works; a life cycle approach is becoming more predominant. This requires the development of new models that can reliably predict long-term.

Maintenance in delta areas – with soft soils – not only is a large cost factor, but also creates further bottlenecks in capacity as infrastructure must be (partially) closed during maintenance. Bringing costs and hinder from maintenance down requires the development of new construction techniques.

Hydraulic engineering constructions at the border of land and sea – harbours – increase in scale. Not only transport intensity rises, but there is a growing need for facilities for large ships, i.e. deep harbours. In practice, such facilities can not be created in existing harbour areas. Thus, harbours are moving out further into the sea. This means that new aspects of harbour development have to be taken into consideration like stronger currents and waves. Society demands that development is sustainable. This raises interesting new questions at the interface of hydraulic engineering and ecology. Not only the effects of engineering on the environment must be considered, but nature (eco-engineering) can also provide solutions for hydraulic challenges, like stabilisation of tidal planes with oyster beds. The new conditions at development sites, sustainability, and the potential of eco-engineering, require extension of knowledge and models, particularly on the interaction of engineering and environment.

Simulation of coastal engineering projects

An example of how science supports infrastructural development is the *Maasvlakte II*. This land reclamation project west of Rotterdam extends the harbour facilities and creates accessibility for large ships. Several aspects are critical: morphological effects (changes in sand transport and deposits along the coast), accessibility of the harbour entrance (currents at the entrance), and resilience of the shore protection structures. Several innovative solutions were put forward in the design-and-build contract tender, with different shapes of land reclamation, different locations of the harbour entrance, and different shore protection structures. Using its physical model testing facilities, Deltares evaluated one of the proposals for various weather conditions (wave and current situations). Deltares is well equipped to evaluate similar large-scale interventions in the future, revealing strength and weaknesses of designs and opening the way to new solutions.

4.7 Innovation and social acceptance

The challenges

Technology – innovative or state-of-the art proven technology - may provide good answers to the challenges ahead, but that does not automatically mean that they will be welcomed by all stakeholders. As planning processes become more complex – more factors have to be combined and balanced – it becomes more difficult for stakeholders to understand the implications of new developments for their and the overall interests. At the same time, considering the number and

magnitude of the challenges ahead (see the above paragraphs) it is important that decision making can be speedy.

Strategic priorities

Fore and foremost, it is important that stakeholders can receive unbiased and authoritative information on developments; in a 'language' they can understand. The roles of knowledge and information centre, and assessor and analyst of Deltares relate to this directly. New tools have to be developed that support decision making processes, providing information in the 'language' of the stakeholders.

Planning kit

The *Blokkendoos Ruimte voor de Rivier* (planning kit 'Room for the River') is a well known and successful tool in supporting joint decision making of stakeholders. Underlying the tool is advanced scientific, cause-effect models. These remain hidden to the users of the tool. They can add 'building blocks' to the existing situation of a river area in an intuitive manner, directly relating to their normal perception. They can for instance add a dam, or change water levels. The tool visualises the results of such interventions, again, in an intuitive way, e.g. showing the effects on natural quality or safety. In this way, stakeholders – ranging from authorities to citizens – can jointly evaluate different scenarios for adaptation in a river area, without being burdened with interpreting the results of the underlying models. Gaming techniques promise to provide similar intuitive simulation options. Deltares aims to further develop this technology (also see chapter 4).

Another way of creating better understanding of- and commitment to innovations, and speeding up innovations is the involvement of stakeholders throughout the entire innovation process. As has been described, in chapter 2, Deltares will do so, with public authorities, knowledge institutions and private companies. Public information, planning kits and policy analysis will support creating understanding and commitment.

Clearly, social acceptance is an area where both technical and social sciences have to be combined and integrated. Deltares will build up the capability for this integration. In the various departments social scientists will be employed to create a certain level of expertise in social aspects of delta-related innovations. The social scientists at Deltares can directly support the integral approach of subjects and can act as linking pins in the cooperation with top institutes on social sciences.

5.1 Customer Perspective

Research and development at Deltares is demand driven. As mentioned earlier, in the programming phase, together with stakeholders, knowledge demands and opportunities arising from newly developed knowledge are identified and translated in research and development goals, and roadmaps.

Deltares will further strengthen the consultation mechanisms with stakeholders, in particular those with private companies, and will promote joint programming with other Dutch knowledge institutes with expertise in delta-related issues. At the end of the planning period, Deltares wants to have achieved a good balance in consultation and (joint) programming.

To fulfil its role, Deltares has to be recognised by stakeholders a knowledge institute with an internationally prominent position, valuable knowledge and products and an integral, multidisciplinary approach of delta-related issues. Actions will be taken to improve visibility of Deltares; a communications plan will be drawn up and executed. Results will be monitored both by surveys (brand recognition) and the number of partners that approach Deltares for cooperation.

Part of creating a clear image of Deltares as a valuable (value adding) partner is to quantify the benefits of its work. Deltares will devise methods to quantify the social and economic value of its work and to make it visible to stakeholders. This requires a strong multi-level communication policy which Deltares will develop, demonstrating that 'Deltares really makes a difference' by solving specific problems and stimulating (and speeding up) new innovations.

Working with partners on solving delta-related issues covers a number of roles as described in § 2.2: a demand-driven research and development centre, a knowledge broker, a knowledge and information centre, and a specialist advisor. The role of advisor and assessor – adding value to the public debate by providing sound scientific information and policy analyses – also requires increased visibility, but with a different type of stakeholders: policy makers and the public. Deltares will regularly publish the *State and Future of the Dutch Delta* to reinforce the image needed. At the end of the planning period, the role as assessor and analyst must be fully matured and recognised as valuable by stakeholders.

Deltares wants to be involved in important, frontline international and foreign projects. This not only is intended to improve visibility, but also to expand the Deltares knowledge position, and to support the efforts of Dutch private companies in export development. Foreign (international) income will be monitored as a measure of success in this area.

5.2 Software and Models

Ready-for-use software and models are important means of transfer of knowledge in tangible form. Software is made available through licensing agreements, and through open source arrangements. In the planning period, Deltares will develop a comprehensive set of software and models, both by streamlining existing- and developing new software and software facilities.

- streamlining existing software: Deltares has been formed by combining a number of institutes and specialist services. Each of these institutes and services has its own software platform and software development (including government software). In the planning period, Deltares will integrate this software and ensure efficient maintenance and development. Quality assurance will be a point of special interest.

- data management facilities: currently, in the Netherlands, there are different parties involved in acquiring and archiving modelling data, such as KNMI, DID, Alterra, TNO and Deltares.⁶ Cooperation with outside partners on these issues already exists and will be continued. In the planning period, Deltares wants to achieve a common platform for data acquisition, storage, and recovery on a national level. This will enable easy exchange of data and will support the development of a common modelling practice and integrated models. It will also enable Deltares to develop the data management services that are part of the role as knowledge and information centre.
- new developments are centred around five spearheads:
 - a virtual experimenting facility to support the development and testing of new software tools for complex problems, not covered by existing tools
 - tuning and integration of data assimilation and numerical prediction facilities
 - forecasting systems (e.g. for floods and water quality) and early warning systems, where Deltares wants to develop a internationally leading position
 - supporting decision making and risk management by combining 'hard' and 'soft' data⁷, and data from different scientific disciplines in one integral system.
 - gaming techniques: these techniques have already proven their worth in a number of cases, for example advanced simulations. Gaming offers great potential for the development of decision support systems, as they provide easy-to-use and intuitive user interfaces.

DeltaBrain Foundations

DeltaBrain is a new method to reduce failure costs in construction, maintenance and operations. Using artificial intelligence techniques, it combines different types of knowledge: numerical models, physical model measurements, field measurements, and practical experience. The latter are supplied – on a non-competitive, routine basis – by private companies (pile-driving contractors). Thus, the knowledge base constantly grows and DeltaBrain is a learning experience for scientists and companies. Results are presented in accessible ways like maps, risk profiles or 4D virtual reality simulations.

5.3 Facilities

Experimental, laboratory, and numeric facilities are important tools (base requirements) for knowledge development, innovation and validation of models. Deltares will rationalise, modernise and expand facilities to meet the requirements of the 21st century.

Numeric facilities increasingly offer potential as experimental tools. On extension of experimental facilities, Deltares will critically regard what is the optimum choice: physical testing equipment or numeric facilities. At the end of the planning period, Deltares wants to have a balanced set of both.

Deltares wants to develop and maintain a state-of-the-art and coherent cluster of experimental and laboratory facilities, and trial locations in the field. In the planning period, Deltares will invest in new facilities. Proposals for funding will be submitted to national government for a new, large scale facilities and a shared Environmental Laboratory (shared with the University of Utrecht, the

⁶ KNMI (Koninklijk Nederlands Meteorologisch Instituut) is the national institute for meteorology; DID (Data ICT-Dienst) is the knowledge and service centre of Rijkswaterstaat, the executive branch of the ministry of Traffic and Public Works; Alterra is the institute of Wageningen University and Research Centre that focuses on soil science, ecosystem studies, geo-information, landscape, and water and climate.

⁷ The terms 'hard' and 'soft' here refer to objective measurements and subjective (expert) knowledge, respectively/

Rijksinstituut voor Volksgezondheid en Milieu⁸ and TNO). Deltares will also cooperate with others on realising a complete, comprehensive and efficient set of facilities on a national level. Deltares will cooperate with universities and other knowledge institutes, in mutual use of all available facilities.

5.4 Knowledge Position

Excellence in scientific disciplines is the backbone of Deltares. Deltares has identified those disciplines that are key to its performance. Discipline networks are responsible for maintaining an excellent expertise level. Members of the management team, each monitor quality of specific discipline areas.

Integrated solutions need a systems analysis approach that includes assessment of physical impacts in a social, political and economic context. This approach, under the motto "High tech and High touch", requires not only excellent expertise in key disciplines, but also integration of these discipline areas.

Deltares is the result of a merger between several renowned Dutch institutions. We will build on the strengths of the contributing partners and will exploit the benefits of integration into one single institute. An important step in this is the formation of new departments, with a mix of disciplines and people from different background (formerly employed at different institutes). Thus, a good balance is achieved between a multidisciplinary, systems approach and manageability.

The knowledge innovation cycle from problem identification to solution and application requires a well-established network of stakeholders, universities and knowledge providers to ensure effortless communication between science, technology and society. Deltares will invest in the development of strategic alliances with relevant partners, and the acquisition of knowledge through cooperation and out sourcing of activities.

Integration of exact and social sciences

As has been discussed earlier (§ 3.7), the combination of exact and social sciences is an issue of particular importance. An integral approach of delta-related issues necessitates the integration of both. Deltares will invest in capabilities in social sciences, by employing social scientist in its departments, both for direct support of Deltares activities as to provide a sound basis for the cooperation with top institutes in social sciences, and to incorporate the knowledge of these institutes in the Deltares activities.

5.5 Internal Organisation

The internal organisation must underpin the external ambitions. There are several aspects that will be discussed in this paragraph: accommodation, human resources development, governance, and finance.

It is important to realise that the decision to form one institute from a number of existing institutes and specialist services has only been taken a few years ago. Much has been achieved already,

⁸ The Rijksinstituut voor Volksgezondheid en Milieu (*national institute for public health and environment*) is an public R&D facility, part of the Dutch Ministry of Public Health.

but Deltares is still in a transition phase. In the first years of the planning period, organisational development will, thus, have strong focus on integration and maximising synergies.

New approach supports integration of original institutes

Fundamental to the formation of Deltares is the notion that delta related challenges require a multidisciplinary approach. Combining the centres of excellence that are the constituting parts of Deltares enables that approach. Forming multidisciplinary teams, with people from different background (formerly working in different institutes) supports the integration of the original institutes in the (one) new institute.

5.5.1 Accommodation

No doubt, having people working at one location supports interaction and strengthens the feeling of belonging to one single organisation. Deltares currently occupies four locations in the Netherlands: the Rotterdamseweg and the Stieltjesweg in Delft, and the Daltonlaan and the Princetonlaan in Utrecht. Deltares will concentrate its activities in two locations (the Rotterdamseweg in Delft and the Princetonlaan in Utrecht). On both locations, new facilities will have to be built.

Deltares will invest in facilities for 'workplace independent working', i.e. digital support of work processes enabling cooperation from different locations and for the support of working in teams. Facilities for virtual meetings, cooperative work spaces, etc. will be developed and implemented.

5.5.2 Human resources development

Deltares wants to provide an attractive working environment for high-level professionals, and wants to attract high-level talent. High-level professionals not only want challenging tasks (participation in frontline research) but also value personal development. Empowerment and continuous learning options are pillars of the human resource policy. Professional development is based on a 'triple ladder' concept: growth options through functions related to knowledge, advisory skills and management. In the planning period, a system will be implemented that tunes development paths to individual skills and ambitions.

Deltares wants to be an open and communicative organisation. Employees are challenged to take responsibility. Management steering will not be through tight control, but will be supportive and coaching. Working in teams, and intensive contact with stakeholders are central to Deltares approach. It provides a challenging environment for employees with a variety of opportunities for personal development. Working in multidisciplinary teams also supports integration of the original institutes into the (one) new organisation. The team approach will be fully developed in the planning period.

5.5.3 Governance

Deltares wants to be a transparent and accountable organisation. On a strategic and tactical level, there is a formal reporting line to the minister of Transport, Public Works, and Water Management supported by the Raad voor Deltaonderzoek and the board of supervisors. Deltares will provide them, but also other stakeholders with clear and comprehensive information about performance.

Overall evaluation will be supported by the development of balanced score cards. The basis for these cards is presently laid. In cooperation with stakeholders Deltares will further develop the system to achieve a well balanced set of monitoring and management control parameters at the end of the planning period.

Operational goals and milestones will be laid down in yearly operational plans that will be discussed with the Raad voor Deltaonderzoek, and board of supervisors. Input for the planning will be sought from other stakeholders, amongst others through the knowledge arenas mentioned earlier. Both the operations and the changes in the longer term strategy and research and development planning will be reported in public annual reports.

Deltares will set up a system for quality assurance of the projects undertaken. Several of the laboratory facilities already are ISO-certified and accredited. The goal is to obtain ISO 9001 certification for the entire Deltares organisation. Starting from this certification, Deltares will develop a program for continuous improvement. Deltares will also organise external audits and reviews to benchmark the quality of its operations and knowledge position.

5.5.4 Finance

Deltares is a not-for-profit organisation. Income is used to support its operations and enable investments in new equipment, research, etc. Over the planning period, Deltares aims for an operational result of 3% of sales, regarded as adequate for investment needs.

Deltares aims for diversification of the portfolio of externally paid projects and advisory work, broadening financing sources. In this way, a more stable work load for different experts and disciplines can be achieved, levelling out fluctuations in demand from specific stakeholders, and enabling maintaining excellence in a broad spectrum of disciplines.

A Knowledge Arenas

Research and development of Deltares is demand-driven. Knowledge arenas are meetings with stakeholders in which knowledge demand is identified and translated into long-term agendas. There are five types of arenas connected with Deltares:

- **institutionalised:** such as the *Raad voor Deltaonderzoek*, an advisory board of Deltares with representatives of public authorities,
- **thematic-strategic:** interdepartmentally organised by Dutch ministries, addressing the research agenda for the medium to long term, clustered in themes involving several ministries per theme
- **thematic-applied:** organised per ministry and involving lower governmental levels, addressing the research agenda for the short to medium term
- **programmatic:** in cooperation with private organisations or public-private partnerships, such as the network Delta Technology of the NWP⁹, the *Centrum Ondergronds Bouwen* (Centre Underground Building), Flood Control and Building with Nature.
- **product centred:** user groups, occasionally combined with knowledge dissemination (symposia, courses and workshops)

The involvement of private and public organisations varies over the arena types, see the table below.

Type of arena	Involvement of	
	Public organisations	Private organisations
Institutionalised	X	X
Thematic-strategic	X	(X)
Thematic-applied	X	
Programmatic	(X)	X
Product centred	(X)	X

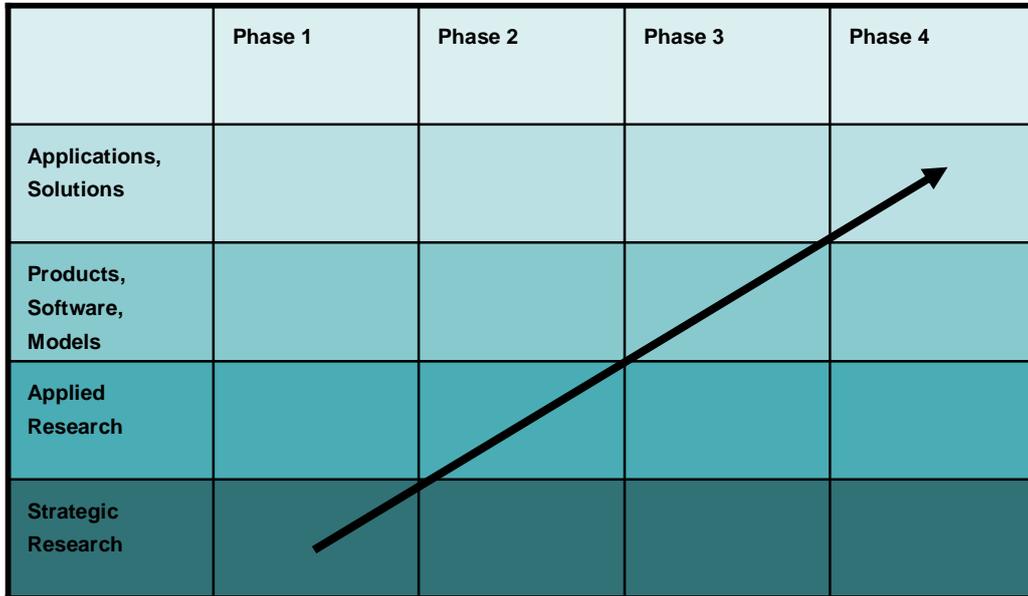
Of course, the world is not static: knowledge demands and knowledge offerings change over time. Building up solid knowledge positions takes time, but a certain degree of flexibility is needed to follow changes. The arenas meet at regular intervals, to update the research and development agenda. The aim is to adjust 25% of the activities per year. Thus time needed to build up knowledge positions and flexibility needed can be balanced.

Road maps

Deltares distinguishes 4 basic types of activities: strategic research, applied research, the development of products (software and models) and advice. Together with stakeholders, the desired development (schematically indicated by the arrow) is mapped: it is established in what phase projects related to a certain issue are, and how they should progress to a desired end situation.

⁹ Netherlands Water Partnership, a public-private partnership of Dutch organisations in the area of water technology. The platform (amongst others) identifies desired strategic developments.

	Phase 1	Phase 2	Phase 3	Phase 4
Applications, Solutions				
Products, Software, Models				
Applied Research				
Strategic Research				

A 4x5 grid with a diagonal arrow pointing from the bottom-left cell to the top-right cell. The grid is divided into four rows and five columns. The columns are labeled 'Phase 1', 'Phase 2', 'Phase 3', and 'Phase 4'. The rows are labeled 'Applications, Solutions', 'Products, Software, Models', 'Applied Research', and 'Strategic Research'. The cells are shaded in a gradient from light blue to dark teal. A black arrow starts in the bottom-left cell and points towards the top-right cell.