Foreword

Deltares is a leading independent institute for applied research, operating worldwide in the field of water, subsurface and infrastructure. Since it was established in 2008, more than 800 Deltares specialists have developed innovative insights to make living in deltas safe, economically and socially achievable and environmentally sustainable.

Our research is always a response to the needs of society. We focus on five themes: Flood risk, Ecosystems and environmental quality, Water and subsoil resources, Delta infrastructure and Sustainable delta planning. These priorities guide our strategic research objectives.

Here, in The World of Deltares, we set out the strategic research objectives for each theme for 2016 and the concrete steps we will be taking in 2013 to achieve those goals.

By contrast with previous years, this edition provides an overview of the entire Deltares portfolio: strategic, long-term research, applied research for the medium term and also more short-term contract research for private parties. Knowledge advancement is not something we do alone. We are convinced that it is only by forging alliances that we can tackle the challenges we face. That is why we collaborate closely with universities, other institutes and the private sector both at home and abroad.

And we do not keep our breakthroughs to ourselves; we share them with others. Development of new knowledge depends on sharing the knowledge we have. Government authorities, community organisations and the commercial sector benefit from our research and specialist consultancy. Deltares is an independent, not-for-profit organisation. Our activities always aim to maximise knowledge development and knowledge transfer.

I am proud of the fact that Deltares, despite declining subsidies from the national government, has succeeded in establishing and extending a consistent research line. So I sincerely hope you will enjoy reading this overview of the Deltares portfolio: The World of Deltares.

Best regards,

Maarten Smits,
Managing Director
Introduction

This book of maps, The World of Deltares, presents an overview of the planned activities of Deltares from 2013 to 2016. The aim of this book is to inform interested parties about the complete set of activities performed by Deltares: development of knowledge, transfer of knowledge and specialist consultancy.

The book starts off with a map of the organisation. This map gives insight in Deltares’ strategic position, how Deltares organises this position and in the people of Deltares who execute this. The following map presents all themes and programmes, as well as the total revenue in 2012.

As with previous editions, this book is composed along the five themes and 27 programmes into which Deltares has divided its activities. The Argumentation Factory has visualised these on Theme maps and Programme maps. Theme maps outline activities within each theme, focussing on the main issues. These concern, among others, the long-term ambitions, the international field of activity and the key benefits for the public and private sector.

Each theme is divided in four to eight programmes, which show the more specific focus of Deltares’ activities. They are visualised on Programme maps. The information such as key partners, trends and research questions is shown on the left side of each Programme map.

The right side is composed of three related components: What is the current status of the programme and what are the ambitions for 2016 and for 2013? To illustrate the activities within the themes, Deltares has selected example projects within each theme, which are displayed on Project in practice.

This is The World of Deltares.

The Argumentation Factory was privileged to support Deltares in mapping out its world. For this purpose a process was developed in which, together with Deltares, research questions were formulated clearly and information was collected efficiently. Subsequently The Argumentation Factory has edited information, structured it, verified its consistency, converted it into maps and has assembled these maps into this book. The theme leaders and programme leaders were closely involved during the entire process.

The Argumentation Factory is proud to present the end result, and also grateful for the longstanding and constructive cooperation with Deltares.

Katrin Weber
Daniël Coenen
Sara Blink
What is Deltares?

Deltares is a leading independent institute for applied research, operating worldwide in the field of water, subsurface and infrastructure.

What is the mission of Deltares?

Deltares develops, applies and transfers knowledge of top-level expertise in order to enable delta life.

What is Deltares’ role within the public and private sector and scientific world?

Deltares is an independent advisor for governments on a local, regional and national level. Deltares accelerates innovation worldwide and strengthens the position of the Dutch private sector. Deltares develops applied solutions derived from scientific research. Deltares combines its own knowledge with knowledge from other research institutes.

What people work at Deltares? How is Deltares' staff trained?

Deltares’ staff consists mostly of men. The staff is of all ages and is mostly from the Netherlands. Deltares’ staff consists of a specific mix of disciplines and is mostly from the Netherlands. The #24 staff members are highly educated. And most of the PhD students work in Delft.

How does Deltares organise its work?

Themes

Deltares’ activities are divided into five themes, each reflecting challenges connected to living in deltas. Together the themes contribute to the realisation of Deltares’ mission.

Programmes

Deltares has organised its themes into several multi-year programmes. Together the programmes contribute to the realisation of the themes’ ambitions.

Programme lines

Deltares has organised its activities within each programme into multi-year programme lines. Together the programme lines contribute to the realisation of the programme goals. Programme lines consist of a number of projects.

Which knowledge-based activities does Deltares distinguish?

Development of knowledge

Development of applicable knowledge based on fundamental research. Deltares develops and integrates knowledge, with global leading research institutes and local research organisations. Deltares develops interdisciplinary knowledge and tools, tailored to the needs of Deltares’ clients.

Transfer of knowledge

Transfer of knowledge is based on open cooperation with governments, the private sector and research institutes. Deltares initiates transfer of knowledge by actively gathering and providing information. Deltares mainly transfers knowledge through software, models, publications and training programmes.

Specialist consultancy

Specialist consultancy consists of advice on complex issues demanding specialist knowledge for integrated solutions. Deltares cooperates with partners worldwide in its specialist consultancy.

Position

Operation

Staff

Gender of the people at Deltares

Age of the people at Deltares

Nationality of the people at Deltares

Educational background of the people at Deltares

Number of Deltares PhD students per university
How is revenue divided among the themes for 2012?

<table>
<thead>
<tr>
<th>Theme</th>
<th>Revenue (€1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme Flood risk</td>
<td>€ 49,500</td>
</tr>
<tr>
<td>Theme Ecosystems and environmental quality</td>
<td>€ 15,500</td>
</tr>
<tr>
<td>Theme Water and subsoil resources</td>
<td>€ 16,500</td>
</tr>
<tr>
<td>Theme Delta infrastructure</td>
<td>€ 21,000</td>
</tr>
<tr>
<td>Theme Sustainable delta planning</td>
<td>€ 7,500</td>
</tr>
<tr>
<td>Programme Software innovation</td>
<td>€ 8,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€ 112,000</strong></td>
</tr>
</tbody>
</table>

How is revenue divided among the funding sources for 2012?

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>Revenue (€1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Economic Affairs</td>
<td>€ 12,200</td>
</tr>
<tr>
<td>Ministry of Infrastructure and the Environment</td>
<td>€ 33,700</td>
</tr>
<tr>
<td>Subsidised research programmes</td>
<td>€ 5,500</td>
</tr>
<tr>
<td>Private sector</td>
<td>€ 28,100</td>
</tr>
<tr>
<td>Public sector</td>
<td>€ 32,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€ 112,000</strong></td>
</tr>
</tbody>
</table>

How is revenue spread across the world for 2012?

<table>
<thead>
<tr>
<th>Region</th>
<th>Revenue (€1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>the Netherlands</td>
<td>€ 80,190</td>
</tr>
<tr>
<td>Europe (excl. the Netherlands)</td>
<td>€ 12,200</td>
</tr>
<tr>
<td>South East Asia</td>
<td>€ 8,900</td>
</tr>
<tr>
<td>Middle East</td>
<td>€ 2,600</td>
</tr>
<tr>
<td>America</td>
<td>€ 3,800</td>
</tr>
<tr>
<td>Australia</td>
<td>€ 1,400</td>
</tr>
<tr>
<td>Africa</td>
<td>€ 2,000</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>€ 910</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>€ 112,000</strong></td>
</tr>
</tbody>
</table>

What are the revenue ambitions for 2016?

- The revenue from the European Union, foreign governments and the private sector in the Netherlands and abroad will increase significantly.
- International revenue will amount to one third of the total Deltares revenue.
- The total revenue will remain the same, or may increase slightly.
In which parts of the world is Deltares currently active and which will have been added by 2016?

- Australia, Azerbaijan, Bangladesh, Belgium, Brazil, Cambodia, China, Colombia, Egypt, France, Germany, Indonesia, the Netherlands, New Zealand, Philippines, Russia, Singapore, Spain, Switzerland, Thailand, Trinidad and Tobago, United Kingdom, United States, Uruguay, British Virgin Islands and Vietnam.

Deltares increases its activities in the current countries and regions.

What are the revenue ambitions for 2016?

- Deltares will slightly increase its revenue.
- Deltares will increase its international revenue and will maintain its current level of national revenue.

What issues from the public and private sector and scientific world will be addressed?

- How can (impacts of) hydraulic loads and water defence strengths be predicted and assessed?
- How can measures to prevent, manage and mitigate floods remain effective, affordable and technically feasible?
- How can the Netherlands be optimally prepared for flooding, during extreme events and in the long term?

Which facilities and (experimental) field locations are used?

- Deltares uses wave facilities, such as the Delta Flume, the Scheldt Flume and Atlantic Basin.
- Deltares uses experimental facilities, such as the GeoHall, for small- and medium-scale physical modelling.
- Deltares uses experimental full scale test facilities in the field, such as IJkdijk and the Markermeerdijk test sites.

What are the benefits for the public sector?

- Public authorities manage flood risks more effectively and efficiently with innovative methods and tools.
- Public authorities reduce flood risks due to better understanding of warning and modelling.
- Public authorities maintain and design flood protection defences more effectively and efficiently with tools and methods.

What are the benefits for the private sector?

- Dutch engineers and dredging companies improve their position and turnover using knowledge and tools.
- Deltares' reputation generates business opportunities abroad for Dutch engineers and dredging companies.

What are the goals until 2016?

- Deltares will develop procedures and warning tools to manage and mitigate effects of floods.
- Deltares will provide innovative, cost effective solutions to improve flood risk management in deltas and urban areas.
- Deltares will improve its understanding of the occurrence and impacts of floods.
- Deltares will improve its understanding of how to deal with (impacts of) flood hazards and extreme events.

What is the focus of this theme?

The theme is about flood risk in deltas (coasts, rivers and estuaries) all around the world.

The theme develops knowledge, tools and approaches for flood risk management in deltas (coasts, rivers and estuaries).

What are relevant trends?

- The flood risks in deltas are increasing because of climate change, land subsidence and urbanisation.
- Climate change is increasing flood risks, due to rising sea levels and changing wind, wave and precipitation patterns.
- Land subsidence is increasing because of soft soils, changes in water use and geological effects.
- The growing population and increasing economic activity aggravate the consequences of flooding.
- The number of stakeholders involved in flood risk management is increasing.
- New insights are leading to a growing importance of natural processes in flood risk management.

Which programmes are included in this theme?

- Flood risk strategies
- Real-time information for flood event management
- Coastal, estuarine and river morphodynamics
- Event-driven hydro- and morphodynamics
- Dikes, levees and dams

How is revenue for 2012 distributed among the funding sources and across the world?

<table>
<thead>
<tr>
<th>Funding sources</th>
<th>World (x €1.000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NL</td>
<td>€ 34.950</td>
</tr>
<tr>
<td>SR Prog</td>
<td>€ 3.950</td>
</tr>
<tr>
<td>Min IE</td>
<td>€ 1.850</td>
</tr>
<tr>
<td>Min EA</td>
<td>€ 1.500</td>
</tr>
<tr>
<td>Min WE</td>
<td>€ 150</td>
</tr>
<tr>
<td>Min PE</td>
<td>€ 2.000</td>
</tr>
<tr>
<td>Min AS</td>
<td>€ 500</td>
</tr>
<tr>
<td>Min AU</td>
<td>€ 50</td>
</tr>
<tr>
<td>Total</td>
<td>€ 43.500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>World (x €1.000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NL</td>
</tr>
<tr>
<td>SR Prog</td>
</tr>
<tr>
<td>Min IE</td>
</tr>
<tr>
<td>Min EA</td>
</tr>
<tr>
<td>Min WE</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

What is Deltares' position, now and in 2016?

- Deltares is currently, and will be in 2016, a national leader with extensive expertise and experience of flood risks.
- Currently Deltares is an international leader on some topics, and will be leading on all topics in 2016.
Deltares implements methods and tools for effective and efficient strategies to manage flood risks in (urban) deltas. The flood risk strategies cover: flood prevention, spatial planning and disaster management (multi-layer approach).

Acciona, Alterra, Arcadis, CPB Netherlands Bureau for Economic Policy Analysis, Delft University of Technology, DeltaSync, Dura Vermeer, Dutch Delta Programme, Environmental agency, Erasmus University of Rotterdam, Fugro, HKV Lijn in Water, HR Wallingford, IFSTTAR, Institut national de recherche en sciences et technologies pour l'environnement et l’agriculture (IRSTEA), ISAMCE, Ministry of Infrastructure and the Environment, municipalities, NIVF, Oxford Brookes, partners of research programme Kennis voor Klimaat, PBL Netherlands Environmental Assessment Agency, regional water authorities, Rensseler Polytechnic Institute, Rijkswaterstaat, Royal Netherlands Meteorological Institute, Royal HaskoningDHV, Sintef, STOWA, TNO, University of Twente, USACE-ERDC, Utrecht University, VU University Amsterdam, Wageningen University and Research Centre and Witteveen+Bos.

Population and economic activity in deltas is growing which increases the effects of flooding. The effects of climate change are increasing the demand for knowledge of extreme events like flash floods. A growing number of extreme events, like floods, is increasing global demand for rapid flood risk assessments. Incidents like Fukushima are increasing the demand for expertise on vulnerability of structures and society. People are demanding regionally and locally suitable implementation of flood risk reduction measures.

Funding sources World

<table>
<thead>
<tr>
<th>Funding sources</th>
<th>€ (x €1.000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>600</td>
</tr>
<tr>
<td>Africa</td>
<td>5.200</td>
</tr>
<tr>
<td>E Europe</td>
<td>100</td>
</tr>
<tr>
<td>Rest Europe</td>
<td>750</td>
</tr>
<tr>
<td>Americas</td>
<td>3.650</td>
</tr>
<tr>
<td>total</td>
<td>€10.300</td>
</tr>
</tbody>
</table>

Policy makers use a multi-layer approach for flood risk assessment. Policy makers work with extended flood risk management tools, including tools on flood consequences. Consultancy firms and researchers apply newly developed fundamental knowledge for flood risk approaches. Public water authorities improved their flood risk management by implementing risk approach strategies.

Deltares works in the Netherlands, Europe, the United States, Asia and South and Central America. Deltares is leading in the development of models and tools for flood risk assessment. Deltares develops knowledge together with key partners on vulnerability, exposure and consequences of floods.

Deltares develops knowledge on a full flood risk approach instead of on a dike failure approach. Deltares applies rapid flood risk assessment tools worldwide. Deltares’ tools are further developed and used by open communities, especially in Europe, Asia and the US. Deltares transfers knowledge to communities by publishing papers and reports and providing tools and software. Deltares optimally uses global data sets and is able to easily apply its knowledge in any region worldwide. Deltares increases revenue from European and international public funds. Deltares changes its focus to urban environments, full risk assessments, cost-effective solutions for design and innovative building solutions.

Deltares is leading in the development of models and tools for flood risk assessment. Deltares develops knowledge together with key partners on vulnerability, exposure and consequences of floods. Deltares optimally uses global data sets and is able to easily apply its knowledge in any region worldwide. Deltares changes its focus to urban environments, full risk assessments, cost-effective solutions for design and innovative building solutions.
People are increasingly expecting transparency in decision making due to increasing availability and accessibility of data. How can probabilistic forecasts of loads, levee strength and risk of flooding best be used in operational procedures, and what is the predictability of loads, strengths and risks for flood event management? What is the value of loads, strengths and risk forecasts? What are the main research partners and in which field of expertise do they contribute? Who are the programme leaders? How does Deltares work with? What is the main goal of this programme? How is revenue for 2012 distributed among the funding sources and across the world?
What are the effects of large-scale coastal sand buffers on waves, currents, ecology, economy, safety and recreation?

Climate change, rising sea levels and subsidence are increasingly affecting the mutually connected systems of rivers, estuaries, deltas and coasts. How can long-term changes in morphology and sediment composition be explored with process-based models?

Deltares develops and applies knowledge of morphological changes in rivers, estuaries and coasts and tools for the prediction of them.

Who does Deltares work with?

Alterra, Arcadis, Boskalis, Bundesanstalt für Gewässerkunde, Bundesanstalt für Wasserbau, CanooPhilips, Delta University of Technology, partners of the consortium EcoShape, HEK Lién in Water, IMARES, INTEMAR, Royal Netherlands Meteorological Institute, Ministry of Infrastructure and the Environment, National Centre for Earth-surface Dynamics, Netherlands Centre for Luminescence Dating, Rijkswaterstaat, Royal HaskoningDHV, Singapore-Delft Water Alliance, Statoil, TNO, University of Twente, UNESCO-IHE, University of Minnesota, University of Texas at Austin, United States Geological Survey, United States Navy Office of Naval Research, Utrecht University, Wetlands International and Witteveen+Bos.

Who are the main research partners and in which field of expertise do they contribute?

Delta University of Technology: coastal, estuarine and river morphodynamics and applied geology.
UNESCO-IHE: development of models and morphodynamic modelling.
Utrecht University: coastal, estuarine and river morphodynamics.

Who are the programme leaders?

Ad van der Spek (ad.vanderpek@deltares.nl)

What is the mixture of activities in the present programme portfolio?

The emphasis within this programme is on the development and transfer of knowledge. Knowledge is being developed in (applied) research projects, often in cooperation with universities.

What are the most important results so far, who uses them and how do they apply them?

Oil and gas producers use publications on process-based variation in internal architecture of sedimentary hydrocarbon reservoirs, to improve their production strategies.
Rijkswaterstaat applies knowledge of natural transport of sand and mud to increase coastal safety and to run their coastal maintenance programme effectively and efficiently.
Knowledge institutes and consultants apply improved and expanded numerical models to predict coastal evolution and to assess the impacts of measures.

In which parts of the world is Deltares active?

Deltares works in the Netherlands, Europe, North America, Singapore, Thailand and Indonesia.

What are relevant trends?

Climate change, rising sea levels and subsidence are increasingly affecting the mutually connected systems of rivers, estuaries, deltas and coasts. The increasing impacts on interconnected natural systems is increasing the demand for integral solutions.
Policy horizons are extending due to the long-term impact of climate change, rising sea levels and subsidence.
Mangrove systems are increasingly deteriorating worldwide because of human activities.

Which issues from the public and private sector and scientific world will be addressed?

What are the effects of large-scale coastal sand buffers on waves, currents, ecology, economy, safety and recreation?
How can sand buffers as coastal maintenance measures help to mitigate the impacts of climate change?
What are the most important results so far, who uses them and how do they apply them?

Who are the main research partners and in which field of expertise do they contribute?

Delta University of Technology: coastal, estuarine and river morphodynamics and applied geology.
UNESCO-IHE: development of models and morphodynamic modelling.
Utrecht University: coastal, estuarine and river morphodynamics.

What are the ambitions for 2016?

Deltares leads the development of science-based concepts and tools for prediction of coastal evolution, on time scales ranging from centuries to millennia.
Deltares’ strategies for improving and restoring degraded mangrove systems are applied in several countries.
Deltares is one of the leading institutes on morphodynamics and evolution of river branches in large deltas worldwide.
Deltares expands its work for national agencies on climate buffers to international projects.
Deltares increases its turnover from international activities.
Deltares applies its knowledge by participating in high-quality international projects.

What are the programme lines and what are they about?

Climate buffers: Researching the functioning of sand buffers, their effects on the coastal system and their ability to protect the coast against impacts of climate change.
Long-term coastal evolution: Understanding and predicting coastal evolution on time scales ranging from decades to centuries.
Muddy coasts: Developing morphodynamic expertise to improve and restore muddy mangrove coasts.
Integrated river systems: Researching the functioning of the river-estuary-coast chain; the river from source to sink.

How are revenue for 2012 distributed among the funding sources and across the world?

Revenue

Funding sources

<table>
<thead>
<tr>
<th>Country</th>
<th>Total (€1.000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>€ 6.850</td>
</tr>
<tr>
<td>America</td>
<td>€ 4.400</td>
</tr>
<tr>
<td>SE Asia</td>
<td>€ 1.600</td>
</tr>
<tr>
<td>Europe</td>
<td>€ 300</td>
</tr>
<tr>
<td>NL</td>
<td>€ 100</td>
</tr>
<tr>
<td>Africa</td>
<td>€ 50</td>
</tr>
<tr>
<td>Rest</td>
<td>€ 50</td>
</tr>
<tr>
<td>Total</td>
<td>€ 6.850</td>
</tr>
</tbody>
</table>

Development of knowledge

Transfer of knowledge

Specialist consultancy

Flood risk

Deltares applies its knowledge by participating in high-quality international projects.

Deltares advises on issues like coastal erosion, river discharges and environmental quality and safety.

Deltares is one of the leading institutes on morphodynamics and evolution of river branches in large deltas worldwide.

Deltares is an international leader in developing models and performing research, together with partner institutes.

Deltares is one of the leading institutes on morphodynamics and evolution of river branches in large deltas worldwide.

Deltares advises on issues like coastal erosion, river discharges and environmental quality and safety.

Deltares applies its knowledge by participating in high-quality international projects.

Deltares is an international leader in developing models and performing research, together with partner institutes.

Deltares advises on issues like coastal erosion, river discharges and environmental quality and safety.
Climate change is leading to rising sea levels, changes in wind and wave climates and more extremes in precipitation. How do changes in river morphology, during a high-water event, affect water levels, discharges, distributions and the riverbed and river course? The increasing number of stakeholders in flooding areas is leading to an increased demand for an integral response.

Deltares develops and applies hydro- and morphodynamical knowledge, models and tools to evaluate the response of coasts, rivers and estuaries to natural events such as storms and tsunamis.

What is the main goal of this programme? Flood risks in deltas are increasing since hazards and consequences are both increasing. Which factors are important for the development of early warning systems for dune erosion, coastal inundation and storms? Risk in the Netherlands is increasing since hazards and consequences are both increasing.


Who are the main research partners and in which field of expertise do they contribute? Deltares is a leading partner in the development of numerical models and knowledge.

Ap van Dongeren (ap.vandongeren@deltares.nl) and Kees Sloff (kees.sloff@deltares.nl)

What is the mixture of activities in the present programme portfolio? A pilot of the demonstration version of an early warning system of rip currents for lifeguards to increase swimmer safety.

Knowledge is transferred via journal publications, PhD dissertations, presentations, courses and open source software.

What are the most important results so far, who uses them and how do they apply them? Models of wave transformation over coral reefs used by coastal managers and scientists. A quick assessment tool (WAQBank) for bank erosion forecast based on 2D hydrodynamic simulations applied by consultants for planning and design.

What are the most important research results so far, who uses them and how do they apply them? Funding agencies are increasingly requiring open source models to promote transparency and transfer.

A subgrid bank erosion approach for 2D morphological simulations in Delft3D applied in an American research project. A pilot of the demonstration version of an early warning system of rip currents for lifeguards to increase swimmer safety.

Deltares is a leading partner in the development of numerical models and knowledge.

In which parts of the world is Deltares active? Deltares works in Europe, the United States, Australia, South East Asia, Eastern Asia, Central Asia and Latin America.

Which issues from the public and private sector and scientific world will be addressed? A subgrid bank erosion approach for 2D morphological simulations in Delft3D applied in an American research project.

What are the ambitions for 2016? Deltares is leading (with acknowledged partners) on coastal morphology in tropical and temperate coasts.

A quick assessment tool (WAQBank) for bank erosion forecast based on 2D hydrodynamic simulations applied by consultants for planning and design.

Which role does Deltares play in the international field of expertise? Deltares works in Europe, the United States, Australia, South East Asia, Eastern Asia, Central Asia and Latin America.

Deltares is a leading partner in the development of numerical models and knowledge.

In which parts of the world is Deltares active? Deltares is a leading partner in the development of numerical models and knowledge.

Which results does Deltares want to achieve in 2013? Deltares develops and applies hydro- and morphodynamical knowledge, models and tools to evaluate the response of coasts, rivers and estuaries to natural events such as storms and tsunamis.
How can innovative flood defence concepts, such as eco-engineering and multifunctional flood defences be implemented?

How can the probability of failures be better predicted by more knowledge on the strength of dikes, levees and dams?

The assessment of the Dutch primary flood defences is shifting from water level exceedance to probability of failure of dikes, levees and dams. HKV Lijn in Water, HR Wallingford, Imperial College of London, International Society for Soil Mechanics and Geotechnical Engineering, Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture, Ministry of Economic Affairs, Ministry of Infrastructure and the Environment, Ministry of the Flemish Community, municipalities, provinces, regional water authorities, Rijkswaterstaat, Royal HaskoningDHV, Technology Foundation STW, TNO, STOWA, SWECO, United States Geological Service, United States Army Corps of Engineers, University of Twente, Utrecht University, Van Oord, Wageningen University and Research Centre and Witteveen+Bos.

Deltares improves policy, design and management of dikes, levees and dams regionally and internationally.

AGT, Alterra, Arcadis, Basilisk, Delft University of Technology, Engineer Research and Development Center, ENW, Fugro, HKV Lijn in Water, HK Wellingford, Imperial College of London, International Society for Soil Mechanics and Geotechnical Engineering, Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture, Ministry of Economic Affairs, Ministry of Infrastructure and the Environment, Ministry of the Flemish Community, municipalities, provinces, regional water authorities, Rijkswaterstaat, Royal HaskoningDHV, Technology Foundation STW, TNO, STOWA, SWECO, United States Geological Service, United States Army Corps of Engineers, University of Twente, Utrecht University, Van Oord, Wageningen University and Research Centre and Witteveen+Bos.

Which investments in flood defences are optimal in terms of safety and life cycle costs?

Who are the main research partners and in which field of expertise do they contribute?

Deltares improves policy, design and management of dikes, levees and dams regionally and internationally.

AGT, Alterra, Arcadis, Basilisk, Delft University of Technology, Engineer Research and Development Center, ENW, Fugro, HKV Lijn in Water, HK Wellingford, Imperial College of London, International Society for Soil Mechanics and Geotechnical Engineering, Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture, Ministry of Economic Affairs, Ministry of Infrastructure and the Environment, Ministry of the Flemish Community, municipalities, provinces, regional water authorities, Rijkswaterstaat, Royal HaskoningDHV, Technology Foundation STW, TNO, STOWA, SWECO, United States Geological Service, United States Army Corps of Engineers, University of Twente, Utrecht University, Van Oord, Wageningen University and Research Centre and Witteveen+Bos.

Deltares improves policy, design and management of dikes, levees and dams regionally and internationally.

AGT, Alterra, Arcadis, Basilisk, Delft University of Technology, Engineer Research and Development Center, ENW, Fugro, HKV Lijn in Water, HK Wellingford, Imperial College of London, International Society for Soil Mechanics and Geotechnical Engineering, Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture, Ministry of Economic Affairs, Ministry of Infrastructure and the Environment, Ministry of the Flemish Community, municipalities, provinces, regional water authorities, Rijkswaterstaat, Royal HaskoningDHV, Technology Foundation STW, TNO, STOWA, SWECO, United States Geological Service, United States Army Corps of Engineers, University of Twente, Utrecht University, Van Oord, Wageningen University and Research Centre and Witteveen+Bos.
Piping is the internal erosion process that may occur during periods of high water in the sandy layer beneath a dike. Sand grains are transported by water seeping under the dike, creating tubular openings (pipes) under the dike, which may finally lead to a complete collapse of the dike.

Deltares was commissioned by the Water Authority Rivierenland to carry out a study concerning the effectiveness of geotextiles to prevent piping. In September 2012, Deltares carried out a very successful full-scale piping test, at the IJkdijk test location in Groningen. The geotextile was embedded vertically in the upper part of the aquifer underneath the dike, retaining the sand but allowing the free flow of water. Piping was soon seen below the clay dike at the downstream side of the textile, but the geotextile was successful in stopping the further development of the piping channel. The test was compared to a former test without geotextile, where a complete collapse of the dike was realised. The next step in the development, foreseen in 2013, is a larger scale test at a longer section of dike in the Rivierenland area.
Ecosystems and environmental quality

What is the focus of this theme?
The theme explores ways to integrally restore, improve and protect the quality of aquatic and subsurface environments.

Who is the theme leader?
Harm Duel (harm.duel@deltares.nl) and Tom Schilperoort (tom.schilperoort@deltares.nl)

Which programmes are included in this theme?
From catchment to coast
Ecosystem services
Eco-innovation
Eco-engineering
Next generation information tools

What are relevant trends?
- Dutch research and innovation policy is increasingly focused on specific sectors and business cases ("top sector approach").
- For EU member states European environmental policy frameworks are becoming more important.
- European Innovation Partnerships (EIPs) are developing into important instruments for development and promotion of eco-innovation and eco-engineering solutions.
- Green economies are becoming increasingly important politically, in both developed and developing countries.
- Charity funds and non-governmental organisations are increasing their investments in low income countries.

What are issues from the public and private sector and scientific world will be addressed?
- How can the impact of multiple pressures on the ecological status of the aquatic environment, from catchment to coast, be determined on a scientifically valid basis?
- How can the impact of multiple stresses on the capacity of ecological systems be quantified to improve ecosystem services?
- How can technological innovations reduce or mitigate the environmental impact of economic activities?
- How can eco-engineering solutions enhance the aquatic environment quality while increasing its socio-economic value?
- How can decisions on restoring and protecting ecosystems be supported by integrated assessment tools?

What are the goals until 2016?
- Deltares will develop and synthesise knowledge on relations between the abiotic (non-living) and biotic (living) elements in water and soil systems.
- Deltares will develop methods and tools to quantify the ecosystem services that water and soil systems provide.
- Deltares will develop, test and demonstrate technologies that will reduce pollution and minimise the ecological disruption of human activities (ecotechnology).
- Deltares will develop and stimulate the application of eco-engineering solutions in Europe, Asia and Northern America.
- Deltares will develop and globally apply new generation tools for modelling and measuring ecological quality.

What is Deltares’ position, now and in 2016?
- The European science community regards Deltares as a key player in integrating science and making it applicable.
- In 2016, Deltares’ position will be recognised by key stakeholders such as governments, private sector and non-governmental organisations worldwide.
- Deltares will maintain its position as a frontrunner in modelling water quality and aquatic ecosystems.
- In 2016, Deltares will be a preferred partner for the Dutch private sector in developing innovative methodologies and sustainable solutions.

What are the benefits for the public sector?
- (Regional) water authorities have practical tools to realise the concept of ecosystem services in practice.
- Policy makers, regional water authorities and end-users improve their decision making about the aquatic and subsurface environment.
- Policy makers, regional water authorities and end-users have better and cost effective measures to improve, rehabilitate and protect the chemical and ecological status of the aquatic and subsurface environment.
- The European Union and (local) governments improve the implementation of their environmental policies.

What are the benefits for the private sector?
- The Dutch private sector strengthens its position in the international field of green economy.
- Stakeholders in the development of infrastructure have a toolbox to create eco-engineering solutions.
- Small and medium-sized enterprises are given business opportunities for innovative ecotechnologies.

Which facilitics and (experimen)tal field locations are used?
- Deltares uses its experimental facilities and modelling software in geochemical laboratories in Delft and Utrecht.
- Deltares uses research facilities of collaborating institutes, such as the Van Kleef Centre in Singapore.
- Deltares strengthens its position in the international field of green economy.
- Deltares uses experimental full scale field facilities such as the lake Markermeer.
- Deltares will develop, test and demonstrate technologies that will reduce pollution and minimise the ecological disruption of human activities (ecotechnology).
- Deltares will develop and stimulate the application of eco-engineering solutions in Europe, Asia and Northern America.
- Deltares will develop and globally apply new generation tools for modelling and measuring ecological quality.

How is revenue for 2012 distributed among the funding sources and across the world?

<table>
<thead>
<tr>
<th>Funding sources</th>
<th>(x €1,000)</th>
<th>World (x €1,000)</th>
</tr>
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<tbody>
<tr>
<td>NL</td>
<td>€ 2,400</td>
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<tr>
<td>EU</td>
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<tr>
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<tr>
<td>total</td>
<td>€ 15,500</td>
<td>total</td>
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</tbody>
</table>

What are the revenue ambitions for 2016?
- Deltares will increase its overall revenue, mostly via the programmes ecosystem services and Eco-Innovation.
- Deltares will increase the share of international funding, particularly now that Dutch public funds are decreasing.
- Deltares will increase the share of funding by international charity funds and non-governmental organisations.

In which parts of the world is Deltares currently active and which will have been added by 2016?
Europe, Hong Kong, South Korea, Northern America and Singapore.
Australia and East Africa.
International

2016
How do compounds like nanoparticles, mineral oil, micro plastics, heavy metals and nutrients move through catchments?

*Alterra, Arcadis, Cesf, Centre for Environmental Studies Leiden, Czech Environmental Information Agency, Finnish Environment Institute, GKSS Forschungszentrum Geesthacht GmbH, Groninj/Aquasure, IMARES, Joint Research Centre European Commission, KWR Watercycle Research Institute, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Ministry of Infrastructure and the Environment, Moffat & Nichol, Rijkswaterstaat, National University of Singapore, Royal Netherlands Institute for Sea Research, National Institute for Public Health and the Environment, Radboud University, Nijmegen, Royal HaskoningDHV, Scottish Association for Marine Science, STOWA, University of Amsterdam, University of Nijmegen, Utrecht University, United States Geological Survey, VU University Amsterdam and Wageningen University and Research Centre.*

What is the impact of multiple stresses on the chemical and ecological status of aquatic systems and the subsurface environment?

Climate change is affecting ecology and biodiversity, leading for instance to a growing number of invasive species. People are demanding sustainable use of natural resources and less environmental impact of economic activity. The programme includes the effects of global changes in spatial use, demographies and climate.

*Alterra, Arcadis, Cesf, Centre for Environmental Studies Leiden, Czech Environmental Information Agency, Finnish Environment Institute, GKSS Forschungszentrum Geesthacht GmbH, Groninj/Aquasure, IMARES, Joint Research Centre European Commission, KWR Watercycle Research Institute, Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Ministry of Infrastructure and the Environment, Moffat & Nichol, Rijkswaterstaat, National University of Singapore, Royal Netherlands Institute for Sea Research, National Institute for Public Health and the Environment, Radboud University, Nijmegen, Royal HaskoningDHV, Scottish Association for Marine Science, STOWA, University of Amsterdam, University of Nijmegen, Utrecht University, United States Geological Survey, VU University Amsterdam and Wageningen University and Research Centre.*

What is the main goal of this programme?

Deltares improves its understanding of (bio)geochemical and ecological processes of the entire river basin and connecting coastal waters. The programme includes the effects of global changes in spatial use, demographies and climate.

Who does Deltares work with?

University of Utrecht: geohydrology.

Wageningen University and Research Centre: water quality and aquatic ecology.

National University of Singapore: tropical ecosystems.

Who are the main research partners and in which field of expertise do they contribute?

Who are the programme leaders?

Leonard Oste (leonard.oste@deltares.nl)

What are relevant trends?

Land use is intensifying which leads to deforestation and changes in agricultural crops. Climate change is affecting ecology and biodiversity, leading for instance to a growing number of invasive species. Urbanisation of deltas is putting pressure on the chemical and ecological state of the environment. People are demanding sustainable use of natural resources and less environmental impact of economic activity. Environmental policy from the European Union as formulated in the Blueprint Water is moving towards more integration of water quality and other policy fields.

Which issues from the public and private sector and scientific world will be addressed?

How can understanding of ecosystems be improved to enable integrated assessment and management?

How is revenue for 2012 distributed among the funding sources and across the world?

Funding sources (€ 1,000)

- World
  - € 7,350
  - € 500
  - € 200
  - € 0
  - € 0
  - € 0
  - € 0
  - € 0
  - € 0
  - € 0
  - total € 8,300

What are the programme lines and what are they about?

- Across spatial and temporal scales: Integrating multi-party knowledge of processes ranging from small plots to coastal waters, and from days to decades.
- Connecting compartments: Geochemical and ecological processes at interfaces such as river- and groundwater-surface water.
- Systems under stress: Integrating and synthesising knowledge on the impact of multiple stresses on geochemical processes and ecological functioning of the aquatic and subsurface environment.
- Recovery processes: Ecological response to improved water quality and consequences for the carrying capacity of the aquatic environment.

What is the mixture of activities in the present programme portfolio?

- Development of knowledge is carried out within national and European research projects.
- Transfer of knowledge takes place via software, tools and publications in scientific and branch journals.
- Specialist consultancy in the Netherlands focuses on the implementation of European Union policy.
- Specialist consultancy in foreign countries often concerns water quality modelling.

What are the most important results so far, who uses them and how do they apply them?

- Strategic options for an ecologically robust aquatic system (the lake Usselstroom) are identified for Rijkswaterstaat.
- Water managers can account for bioavailability and background concentrations in quality standards for heavy metals.
- Water managers now use an optimisation model to compose the most cost-effective set of river load reductions.
- Deltares has been invited to join an expert team to evaluate the intercalibration of an assessment method.

In which parts of the world is Deltares active?

Deltares works in the Netherlands, Europe, South East Asia, the Gulf region, Canada and the United States. Specialist consultancy in foreign countries often concerns water quality modelling.

Who does Deltares play in the international field of expertise?

Deltares delivers knowledge on (modelling of) ground and surface water quality, measurement of bioavailable concentrations and microbial degradation of compounds in the environment.

- Deltares delivers its specific expertise through international consortia for research projects.
- Deltares integrates multi-party knowledge on ecological and water quality issues, and makes it applicable.

Which role does Deltares play in the international field of expertise?

- Deltares delivers key knowledge on ecosystem analyses based on catchment modelling.
- Deltares is recognised worldwide as a specialist in quantifying interface processes, such as sea-land with interdisciplinary knowledge.
- Deltares integrates specific expertise into a holistic understanding of the aquatic and subsurface environment.
- Deltares improves knowledge of ecological processes, such as grazing and macrophyte growth.
- Deltares predicts the behaviour of cyanobacteria (blue algae) and pathogens in aquatic systems.
- Deltares implements its newly developed knowledge in next generation information tools.
- Deltares has published ten PhD theses, forty scientific papers and ten branch journal publications.
- Deltares is a key partner in the development of national and European quality standards for ecology, surface water, groundwater and sediments.
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What are the ambitions for 2016?

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What are the focuses of development for 2013?

Bio-availability models for copper, zinc, and nickel to be used by (Dutch) water managers.

- Start of research projects on integrated water quality in estuaries.
- New upscaling approaches in catchment modelling to be tested in real-life cases.
- Improved understanding of the effects of abiotic processes on the presence and growth of (submerged) aquatic plants and potentially harmful cyanobacteria.
- Approximately fifteen scientific papers on lake ecology, chemicals and marine ecosystems.
- Worldwide consultancy projects on ecosystem analysis which simulate catchments and coastal waters.
- Project initiatives in European countries, as well as in South East Asia, North America and Australia.
The socio-economic importance of ecosystems and their ecosystem services are increasingly being acknowledged and understood. How can knowledge about ecosystem services support the design of measures that achieve multiple societal goals? Developing countries are applying the ecosystem services concept within the context of health and poverty alleviation.

What are practical indicators for quantifying service delivery in the context of payment for ecosystem services? Deltares improves the applicability of knowledge about changes in the ecosystem and ecosystem services.

Deltares integrates knowledge about the natural system and the socio-economic system. Deltares delivers expertise and specialised tools for understanding ecosystem functioning. Deltares is being recognised for its unique position in developing knowledge and methods applicable in practice. Deltares is being funded by international institutions and is continuing its funding by the Dutch government. Deltares maintains its activities in Europe and expands in Asia and Africa. Deltares is frequently a partner in multidisciplinary consultancy projects, national and international.

Deltares has a state-of-the-art methodology for assessing and advising on natural resource management. Deltares has a track record in quantifying impacts of ecosystem change on ecosystem services. Deltares is being recognised for its unique position in developing knowledge and methods applicable in practice. Deltares is being funded by international institutions and is continuing its funding by the Dutch government. Deltares maintains its activities in Europe and expands in Asia and Africa. Deltares is frequently a partner in multidisciplinary consultancy projects, national and international.

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What are the main research partners and in which field of expertise do they contribute? Alterra, Centre for Ecology and Hydrology, Institute for Environmental Studies, Georg-August-Universität Göttingen, Radboud University Nijmegen, Royal HaskoningDHV and Technische Universität Dresden.

Who are the programme leaders? Suzanne van der Meulen (suzanne.vandermeulen@deltares.nl)

Revenue

Ecosystem services in marine and coastal systems: Improving understanding of, and developing methods for quantification of (changes in) ecosystem services in marine and coastal systems.

Ecosystem services in land systems: Improving understanding of, and developing methods for quantification of (changes in) ecosystem services in land systems.

Transfer of knowledge occurs via networks, knowledge platforms, conferences, courses and publications. Specialist consultancy services are provided in projects for Dutch and foreign authorities to support implementation of policy and integrated measures.

In which parts of the world is Deltares active? Deltares works mainly in the Netherlands and Europe, and has started initiatives in Africa, North America and Asia.

Which role does Deltares play in the international field of expertise? Deltares is being recognised for its unique position in developing knowledge and methods applicable in practice.

What are the programme lines and what are they about? 'Ecosystem services' includes in European Union decision making.

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What are the most important results so far, who uses them and how do they apply them? A report on European experiences with ecosystem services is used by the Australian National Water Commission as a handbook for recognising the broader benefits of aquatic systems in water planning. The results of case studies are used by Dresden Technical University for a survey on ecosystem service assessments with stakeholders. Dutch consultants explore spatial development opportunities using ecosystem service assessments. A report on European experiences with ecosystem services is used by the Australian National Water Commission as a handbook for recognising the broader benefits of aquatic systems in water planning. The results of case studies are used by Dresden Technical University for a survey on ecosystem service assessments with stakeholders. Dutch consultants explore spatial development opportunities using ecosystem service assessments.

What is the mixture of activities in the present programme portfolio? The focus is on development and transfer of knowledge. Development of knowledge occurs in several European research projects. Transfer of knowledge occurs via networks, knowledge platforms, conferences, courses and publications. Specialist consultancy services are provided in projects for Dutch and foreign authorities to support implementation of policy and integrated measures.

Which role does Deltares play in the international field of expertise? Deltares is being recognised for its unique position in developing knowledge and methods applicable in practice. Deltares delivers expertise and specialised tools for understanding ecosystem functioning. Deltares integrates knowledge about the natural system and the socio-economic system.

What are the relevant trends? The growing competition for land and water use for ecosystem services, is increasing the demand for assessments of possible synergies and trade-offs. The socio-economic importance of ecosystems and their ecosystem services are increasingly being acknowledged and included in European Union decision making. Developing countries are applying the ecosystem services concept within the context of health and poverty alleviation.

What are the programme targets? How do changes in marine and coastal systems, river basins, wetlands and sub-surface influence ecosystem services? How can the use of ecosystem services for different societal needs be balanced? How can knowledge about ecosystem services support the design of measures that achieve multiple societal goals? How can the (potential) societal contribution of ecosystem services be quantified? What are the trade-offs between ecosystem services?

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Intensifying land use is increasing the importance of monitoring environmental quality and understanding the effects of measures. Intensifying land use in deltas is leading to a growing demand for innovative technological solutions to facilitate the efficient use of (increasingly rare) earth resources. People are increasingly acknowledging the need to reduce the impact of economic activities on soil and water, more efficient land use.

Development of knowledge, transfer of knowledge and specialist consultancy are all equally present. Deltares is a leader in the development of knowledge and application of passive sampling technologies. Knowledge is mainly being developed with both other research institutes and multinational enterprises. Development of knowledge, transfer of knowledge and specialist consultancy are all equally present. Deltares is a leader in the development of knowledge and application of passive sampling technologies.

Which issues from the public and private sector and scientific world will be addressed?

- Ecosystems and environmental quality
- Research related to the monitoring of environmental quality
- Development of knowledge, transfer of knowledge and specialist consultancy are all equally present. Deltares is a leader in the development of knowledge and application of passive sampling technologies.

What is the main goal of this programme?

Deltares creates practical, technological solutions to reduce negative impact of economic activities on the environment. Deltares creates practical, technological solutions to optimally benefit from natural systems and their resources.

What is the mixture of activities in the present programme portfolio?

- Reduction of negative impacts and increase of resource efficiency: Developing technologies to reduce the impact of environmental contaminants, such as nanoparticles, and to increase the efficient use of resources.
- Innovative monitoring of environmental quality: Developing monitoring technologies and approaches related to the shift towards a biobased economy.
- Specialist consultancy reduces negative impacts on the environment and increases resource efficiency.

What are the relevant trends?

- Efficient use of (increasingly rare) earth resources is becoming more and more pressing.
- Intensifying land use is increasing the importance of monitoring environmental quality and understanding the effects of measures.
- Intensifying land use in deltas is leading to a growing demand for innovative technological solutions to facilitate more efficient land use.

What are the most important results so far, who uses them and how do they apply them?

- Puridrain, an innovative method to reduce the amount of phosphate in surface water, has matured and has been implemented by several regional water authorities.
- Deltares delivers key knowledge and has consultancy experience on reducing negative impacts of contaminants in soil, groundwater and surface water.
- Deltares is partner in implementing and field testing of sensors for the soil, groundwater and surface water systems.

What are the programme lines and what are they about?

- Development of knowledge, transfer of knowledge and specialist consultancy are all equally present.
- Development and transfer of knowledge are related to the monitoring of environmental quality.
- Transfer of knowledge occurs via the joint development of innovative monitoring technologies.
- Specialist consultancy reduces negative impacts on the environment and increases resource efficiency.

What role does Deltares play in the international field of expertise?

- Deltares is active in the European Union and other high income countries worldwide.
- Deltares is a leader in the development of knowledge and application of passive sampling technologies.
- Deltares delivers key knowledge and has consultancy experience on reducing negative impacts of contaminants in soil, groundwater and surface water.

What are the ambitions for 2016?

- Deltares has improved technologies to assess and mitigate risks related to emerging contaminants in the soil, groundwater and surface water systems.
- Deltares develops lab-on-a-chip and passive sampling technologies with small and medium-sized enterprises for fast transfer of knowledge and market uptake.
- The consultancy activities will be extended to data interpretation of passive sampling technologies, as well as risk assessment and remedial activities for nanoparticles.
- The funding by enterprises and other research institutes will increase through partnerships and cooperation.
- Financing from Dutch governmental sources and European research projects will remain.

What results does Deltares want to achieve in 2016?

- Deltares interprets passive sampling data for regional water authorities and other clients.
- An operational lab-on-a-chip sensor for the field measurements of algal toxins in surface waters.
- Start of a European project related to the risks of nanoparticles in the soil, groundwater and surface water systems.
- Start of development of passive sampling technologies for contaminants related to the biobased economy.
- Transfer of knowledge related to the deployment of passive sampling of surface water to water authorities.
- Share design and construction knowledge to deploy Puridrain with selected partners.
- Initiated cooperation with enterprises to test sensors in the soil, groundwater and surface water systems.
- Focus is especially on Singapore, Canada and the United States.
- Partnerships for activities related to bio-based industrial processes and development of lab-on-a-chip sensors.

How is revenue for 2012 distributed among the funding sources and across the world?

<table>
<thead>
<tr>
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<tbody>
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<td>(€ 1.000)</td>
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<td>Total 800</td>
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In which parts of the world is Deltares active?

- SE Asia
- Africa
- Mid E
- Austr
- Rest
- Eur
- NL
Ecosystems and environmental quality

What is the main goal of this programme?

EcoShape: Building with Nature approach.

Who does Deltares work with?

National University of Singapore: tropical coastal ecosystems.

Other partners of the EcoShape consortium, PUB, Singapore’s National Water Agency, Queen Mary University of London, regional water authorities, Rijkswaterstaat, Royal HaskoningDHV, Royal Netherlands Institute for Sea Research, STOWA, Swedish University of Agricultural Sciences, The Government Service for Land and Water Management, Universidad Politécnica de Madrid, Universität für Bodenkultur Wien, University of Duisburg-Essen, University of Cambridge, University College of London, University of Florence, University of Hull, University of Patras, University of Reading, Utrecht University, Wageningen University and Research Centre, Warsaw University of Life Sciences, Wetlands International and Witteveen+Bos.

Basic information

What is the mixture of activities in the present programme portfolio?

The focus is on development and transfer of knowledge; application in specialist consultancy projects is limited.

What are the ambitions for 2016?

Research focuses on risks, mitigating uncertainties and intervention-effect relationships of multifunctional eco-engineering solutions.

What results does Deltares want to achieve in 2013?

EcoShape eco-engineering guidelines and a wiki are published, including Building with Nature results.

What are relevant trends?

The EU Green Infrastructure vision is stimulating that engineering solutions use natural processes instead of fighting them.

The navigation organisation PAMC has embraced the eco-engineering approach (Building with Nature).

People are increasingly demanding sustainable, nature based flood defences because of climate change.

How can flood protection and ecosystem restoration be combined using green infrastructure?

Ecosystem restoration can replace mangrove forests, resulting in the loss of mangrove ecosystem services, such as serving as ecosystem nurseries and providing flood protection.

How can agricultural and aquacultural practices be adapted to reduce impact on rivers, lakes and wetlands?

Which issues from the public and private sector and scientific world will be addressed?

EcoShape is regularly invited to advise on the implementation of eco-engineering solutions.

Which role does Deltares play in the international field of expertise?

Deltares' role is to combine expertise in hydrology, morphology, ecology, modelling and engineering.

Which results does Deltares want to achieve in 2013?

Deltares is regularly invited for key-note lectures on eco-engineering solutions.

Development of knowledge

What are the programme lines and what are they about?

Multifunctional solutions: Improving the use of dynamic processes for sustainable and cost-effective multifunctional solutions for both ecosystem health and ecosystem goods and services.

Risks and uncertainties: Quantifying risks and uncertainties in the development and self-maintenance of eco-engineering solutions.

Intervention-effect relationships: Improving the understanding of intervention-effect relationships regarding hydrological and morphological restoration and environmental quality.

What are the most important results so far, who uses them and how do they apply them?

Various green adaptation solutions in urban areas in India and the city of Rotterdam.

Coastline rehabilitation using mangrove recovery in Indonesia.

An eco-based design of the dike Oeverdijk and the dam Gesterdam for Rijkswaterstaat.

Assessments of the natural flood defence in the polder Noordwijk.

Key knowledge contributions to the EcoShape eco-engineering guidelines and wiki.

Proofs of eco-engineering concepts within the Dutch and Singapore cases of the EcoShape programme.

Assessment methods for hydromorphology and ecology of rivers for the EU project on restoring rivers for effective catchment management (REFORM).

In which parts of the world is Deltares active?

Deltares works mainly in the Netherlands, as well as in Europe, Singapore, Indonesia, India and the United States.

Ambition

Innovation consortia, Deltares connects knowledge from the private sector, research institutes and universities.

Deltares' role is to combine expertise in hydrology, morphology, ecology, modelling and engineering.

Context

How can the ecological status of heavily modified water bodies be improved cost-effectively and sustainably?

How can agricultural and aquacultural practices be adapted to reduce impact on rivers, lakes and wetlands?

What are relevant trends?

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Aquaculture is replacing mangrove forests, resulting in the loss of mangrove ecosystem services, such as serving as ecosystem nurseries and providing flood protection.

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Which results does Deltares want to achieve in 2013?

All intermediate results of REFORM are made publicly available through the wiki and a workshop in Brussels.

EcoShape eco-engineering guidelines and a wiki are published, including Building with Nature results.

Projects of the second Building with Nature programme are awarded.

The EU FP7 proposal FAST quantifies the feasibility and risks of nature based flood defences.

Various conference presentations on oyster reef restoration and other nature based flood defence techniques.

Specialist consultancy projects on natural flood defence solutions in various regions worldwide.

Increased consultancy activities in the Netherlands, South East Asia and the United States.

Market potential for eco-engineering in North America is explored and a strategy is developed.

Funding share of EU subsidies, foreign companies, public bodies and non-governmental organisations increases.

Revenue

What are the programme lines and what are they about?

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Funding sources World

<table>
<thead>
<tr>
<th>World</th>
<th>Revenue</th>
<th>Ambition</th>
<th>Status</th>
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Deltares provides state-of-the-art models, tools and information systems to support management of ecological and chemical quality of water, soils and sediments.

**Who does Deltares work with?**

**Alterra, Arcadis, Brockmann Consult, CEFAS, Delft University of Technology, Deltares Inc., DHI, Institute for Environmental Survey, Utrecht University, Wadden Academy, Wageningen University and Research Centre, Water Insight and Waternet.**

**Singapore Delft Water Alliance, STOWA, TNO, University of Amsterdam, University of Hamburg, United States Geological Survey, Het Waterschapshuis, IMARES, National Environment Agency Singapore, National University of Singapore, MUMM, municipalities, Netherlands Space Organisation, PUB Singapore’s National Water Agency, regional water authorities, Rijkswaterstaat, Port of Rotterdam, Royal HaskoningDHV, Royal Netherlands Institute for Sea Research, Singapore Delft Water Alliance, STOWA, TNO, University of Amsterdam, University of Hamburg, United States Geotechnical Survey, Utrecht University, Wageningen University and Research Centre, Water Insight and Waternet.**

**Deltares**

**Models and tools are increasingly modular and generic, allowing components to be coupled and exchanged.**

**Funding comes from Dutch and foreign, public and private sources with an increase of the foreign share.**

**Deltares extends its position as an international leader to the United States and Australia.**

**Deltares’ software and tools continue to be the backbone of most specialist consultancy within this theme.**

**Realise a coupling between Delwaq-OpenDA-FEWS software for operational information systems.**

**Start activities for coupled groundwater and surface water models and an algae early warning system.**

**Preliminary realisation of a catchment model.**

**Key developments are published and presented at conferences, meetings and exchanged via open source communities and webinars.**

**Deltares’ role has been extended from developing alone to contributing to developments by others.**

**End-to-end ecosystem models are developed in cooperation with partners to assess broader policy issues.**

**Further developing tools to support early warning systems and international policies.**

**Further developing tools, guidelines and models for supporting implementation of national and international policies.**

**Policy support tools: Further developing tools, guidelines and models for supporting implementation of national and international policies.**

**Operational instruments and monitoring strategy: Further developing tools to support early warning systems and operational management systems, including data model integration, data management and monitoring strategies.**

**Focus is on development of new models and tools and their application in specialist consultancy projects.**

**Development of knowledge occurs in the context of research projects, strategic research investments and through focused activities within specialist consultancy work.**

**Transfer of knowledge occurs via open source communities, training courses and workshops and application of the models in research and consultancy projects.**

**Models and tools related to ecosystem quality are used worldwide in research and consultancy projects.**

**Tools for real-time information systems and operational management systems have been developed.**

**Groundwater quality transport models are integrated with data to assess the risk of the spreading of contaminants.**

**Tools have been developed for regional water authorities to calculate the effects of measures on ecosystem health, to support implementation of the Water Framework Directive.**

**Deltares is active in the Netherlands, Europe, the Middle East, Hong Kong and Singapore.**

**Deltares plays a leading role internationally as a developer of ecology and water quality models.**

**Deltares develops and manages models and the supporting tools and instruments.**

**Deltares integrates its models and tools with those of other parties and shares them with others through formal training as well as open source communities.**

**In which parts of the world is Deltares active?**

**Deltares is active in the Netherlands, Europe, the Middle East, Hong Kong and Singapore.**

**Which role does Deltares play in the international field of expertise?**

**New knowledge is anchored in generic software and tools.**

**Delegation’s role has been extended from developing alone to contributing to developments by others.**

**Models and tools are more modular, enabling easy coupling to models of other institutes and organisations.**

**End-to-end ecosystem models are developed in cooperation with partners to assess broader policy issues.**

**The Deltares modular, integrated modelling system for ecology and water quality is widely accepted.**

**Key developments are published and presented at conferences, meetings and exchanged via open source communities and webinars.**

**Deltares’ software and tools continue to be the backbone of most specialist consultancy within this theme.**

**Deltares extends its position as an international leader to the United States and Australia.**

**Funding comes from Dutch and foreign, public and private sources with an increase of the foreign share.**

**Which results does Deltares want to achieve in 2013?**

**Ongoing realisation of a catchment model.**

**Start activities for coupled groundwater and surface water models and an algae early warning system.**

**Realise a coupling between Delwaq-OpenDA-FEWS software for operational information systems.**

**Start of cooperation with strategic partners on an end-to-end ecosystem modelling.**

**D3D-WAQ is open source and an open source community is established.**

**A number of publications, presentations, trainings and workshops is realised.**

**An increase in activity in the United States on knowledge development and application of software and tools.**

**One or more EU project(s) with a significant software and tools component is awarded.**

**Open source communities contribute in kind to software development.**

**What are the programme lines and what are they about?**

**Integrated modelling: Further developing generic instruments for integrated modelling of ecology and water quality in groundwater, surface water, soils and sediments.**

**Policy support tools: Further developing tools, guidelines and models for supporting implementation of national and international policies.**

**Operational instruments and monitoring strategy: Further developing tools to support early warning systems and operational management systems, including data model integration, data management and monitoring strategies.**

**What is the mixture of activities in the present programme portfolio?**

**Focus is on development of new models and tools and their application in specialist consultancy projects.**

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**What are the most important results so far, who uses them and how do they apply them?**

**Models and tools related to ecosystem quality are used worldwide in research and consultancy projects.**

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**Groundwater quality transport models are integrated with data to assess the risk of the spreading of contaminants.**

**Tools have been developed for regional water authorities to calculate the effects of measures on ecosystem health, to support implementation of the Water Framework Directive.**

**Who contributes to the research?**

**Which issues from the public and private sector and scientific world will be addressed?**

**Who are the main research partners and in which field of expertise do they contribute?**

**Which results does Deltares want to achieve in 2013?**

**How are the programme lines and what are they about?**

**What is the main goal of this programme?**

**What are the ambitions for 2016?**

**What is the mixture of activities in the present programme portfolio?**

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Many shallow lakes suffer from poor water clarity due to an excess of suspended particles in the water column. This leads to a poor ecosystem health as the lack of light inhibits the development of submerged aquatic vegetation that forms a key element of a healthy aquatic ecosystem in shallow lakes.

In a PhD study Deltares explored the interplay of water movement, turbidity and vegetation in large shallow lakes. The study encompassed field and flume studies looking at the effects of vegetation on wave attenuation and water quality. The effectiveness of various measures, such as local deepening and wave-reducing barriers, was studied. An important finding is that lakes that seem similar in general appearance actually function in very different manners. Water depth, lake size, spatial variability and seasonality are factors to be taken into account when selecting or evaluating specific measures. In addition to improved knowledge, a simple framework was made for quick assessment of these factors in individual lakes.
In which parts of the world is Deltares currently active and which will have been added by 2016?

Deltares is currently a national leader and a prominent international player. In 2016, Deltares will be a global leader on water assessments in river basins and urbanising deltas. In 2016, Deltares will be a worldwide competitive player on applied research on sustainable energy and characterisation of the subsoil.

What facilities and (experimental) field locations are used?

Deltares uses field experiment locations for energy saving and power production at universities in Utrecht and Delft.

What is Deltares’ position, now and in 2016?

Deltares is currently a national leader and a prominent international player. In 2016, Deltares will be a global leader on water assessments in river basins and urbanising deltas.

What are the revenue ambitions for 2016?

Deltares will maintain its overall revenue. Deltares will increase its international revenue and will have less revenue from national projects.

How is revenue for 2012 distributed among the funding sources and across the world?

Policy makers within water and land use management, and Delta Programme participants, make more adequate medium and long-term decisions. Cities improve their water availability by an increase in rainfall harvesting, more efficient water use, reduction of water loss and reduction of water pollution. The Netherlands reduces its greenhouse gas emissions by using new approaches to generate and save energy that use water and soil.

Russia and South America.

What are the revenue ambitions for 2016?

Deltares will maintain its overall revenue. Deltares will increase its international revenue and will have less revenue from national projects.

What are the benefits for the private sector?

(Re)insurance companies use global data on flood and drought risks for risk and premium calculations. Agricultural enterprises near coasts get to know the future salinity in their (ground)water. Contractors reduce costs through more detailed and more efficiently collected information on the subsoil. Consultants save costs by using open source software.

What issues from the public and private sector and scientific world will be addressed?

How can undesirable effects of temporary water surplus in cities be avoided? How can water use in cities be improved? How can water and soil resources be used to generate and save energy in deltas? How can more detailed information about the subsoil reduce risks of building on land and at sea?

What is the focus of this theme?

The theme deals with water supply and water distribution in river basins and deltas, now and in the future. The theme explores the possibilities for using soil and water more efficiently.

Who is the theme leader?

Jaap Kwadijk (jaap.kwadijk@deltares.nl)

Which programmes are included in this theme?

River basin management
Water supply in urbanising deltas
Sustainable energy from water and subsoil
Characterisation and visualisation of the subsurface

What are relevant trends?

Climate is changing and sea levels are rising. The growing world population is increasing the scarcity of natural resources and space in deltas. Computing power continues to rapidly increase. The accessibility and availability of meteorological and satellite data is growing rapidly. The availability of open source software is increasing.

Which issues from the public and private sector and scientific world will be addressed?

How do climate, demographic and technological changes affect water supply and demand in deltas and river basins? How can the extent of (future) salinisation of groundwater and surface water be determined? How can undesirable effects of temporary water surplus in cities be avoided? How can water use in cities be improved? How can water and soil resources be used to generate and save energy in deltas? How can more detailed information about the subsoil reduce risks of building on land and at sea?

What are the goals until 2016?

Deltares will map current and future global water availability. Deltares will assess the impact of climate change and rising sea levels on the Rhine and Meuse basins. Deltares will develop tools and measures which enable cities to increase their self-sufficiency with regard to water supply. Deltares will test new methods for generating and saving energy when using water. Deltares will develop methods to quickly assess and visualise physical properties of the subsoil. Deltares will close the gap between the models simulating the ocean and those simulating continental hydrology.
Growing economies and populations are increasing impacts of floods in river basins, especially in deltas and along coasts. How can the impact of large scale changes in land use, including urbanisation, on flood risks be predicted? How can the growing demand for water in river basins and deltas be met? What are strategies to reduce vulnerability to drought?

Changes in land use are affecting hydrological processes in response to rainfall. How can the impact of large-scale changes in hydrological conditions be quantified? Changes in land use are affecting hydrological processes in response to rainfall. How can the impact of large-scale changes in hydrological processes be quantified?

The Delta Programme applies methods to assess the vulnerability of river deltas, and to design robust and flexible adaptation strategies. The Delta Programme applies methods to assess the vulnerability of river deltas, and to design robust and flexible adaptation strategies. What are the ambitions for 2016? What are the ambitions for 2016?

Deltares focuses its development of knowledge on tool development, scenario development will be abandoned. Deltares continues applying results of its research in consultancy projects. Deltares has its own tool for hydrological modelling of river basins, including water allocation and water quality. Deltares is a research partner in consultancy consortiums working on large water management projects.

Insurers and the World Bank make (financial) decisions with a global assessment tool for flood risks. Deltares increases activities in Australia, North America and developing regions in Africa and South and Central America. Deltares is a research partner in consultancy consortiums working on large water management projects.

Deltares uses its upgraded Framework of Analysis to structure its approach of large integrated projects. Deltares increases activities in Australia, North America and developing regions in Africa and South and Central America. Deltares is a research partner in consultancy consortiums working on large water management projects.

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How can negative impacts of drought on agriculture and the environment in rural areas near delta cities be reduced?

Climate change is expected to hamper water and food supply due to more frequent and extreme weather events.

What are cost-effective innovative ways to improve the availability of fresh (ground)water in urbanising deltas?

By 2050, 40 per cent of the world population will live in river basins under severe water stress.

Who are the main research partners and in which field of expertise do they contribute?

Deltares develops knowledge and solutions to manage water demand and supply in urbanising deltas worldwide.

What is the main goal of this programme?

Who does Deltares work with?

Acacia, Alterra, Arcadis, Delft University of Technology, Government Service for Land and Water Management, Het Zeeuwse Landschap, HKV Lijn in Water, InnovationNetwork, Kiemkracht, KWR Watercycle Research Institute, Ministry of Economic Affairs, Ministry of Infrastructure and the Environment, municipalities, Natuurmonumenten, National University of Singapore, provinces, regional water authorities, Royal HaskoningDHV, Rijkswaterstaat, Smul’s Bouwbedrijf, Tauw, TNO, Utrecht University, VU University Amsterdam, Waternet, Wageningen University and Research Centre and ZLTD.

What are relevant trends?

The demand for water is increasing due to a growing world population. Climate change is expected to hamper water and food supply due to more frequent and extreme weather events. By 2050 nearly 70 per cent of the world population will live in urban areas. By 2050, 40 per cent of the world population will live in river basins under severe water stress.

Who are the programme leaders?

Remco van Elk (remco.vanek@deltares.nl)

Who are the programme partners?

Deltares works with delta cities in South East Asia (Jakarta) and North and South America (Belo Horizonte).

What is the mixture of activities in the present programme portfolio?

The majority of the activities focus on specialist consultancy. A slight minority of the activities focus on development of knowledge. Transfer of knowledge comprises about 10 per cent of the revenue.

What are the most important results so far, who uses them and how do they apply them?

Deltares is frontrunner on drought early warning systems via improved linkage between land use and hydrology. Public and private organisations have incorporated new knowledge on drought for the usage by early warning systems. Users, such as farmers and consultants, are able to apply Deltares’ solutions for water scarcity and water resources.

In which parts of the world is Deltares active?

Deltares is globally competitive (scientifically and commercially) regarding water supply in urbanising deltas.

Deltas work primarily in the Netherlands and Europe, and for some activities in Singapore and India.

Which results does Deltares want to achieve in 2013?

Increase of specialist consultancy projects abroad based on current knowledge and tools developed earlier.

Results of field testing of innovative measures to optimise fresh water availability in urban and rural areas.

Professionalising drought early warning systems: Improving integration of agricultural production models and water supply models for crisis management.

Field testing of innovative measures to optimise fresh water availability in urban and rural areas.

What are the ambitions for 2016?

Deltares has increased expertise on water scarcity and proposes improved solutions for rural and urban areas.

Users, such as farmers and consultants, are able to apply Deltares’ solutions for water scarcity and water resources.

Deltas work primarily in the Netherlands and Europe, and for some activities in Singapore and India.

In which parts of the world is Deltares active?

Deltares is active in America, Asia, Africa, and Europe.

Which role does Deltares play in the international field of expertise?

Deltares develops tools and measures which help to secure water availability in urbanising deltas.

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Professionalising drought early warning systems: Improving integration of agricultural production models and water supply models for crisis management.

Field testing of innovative measures to optimise fresh water availability in urban and rural areas.
What is the main goal of this programme?

- Deltares contributes to the reduction of CO₂ emissions by investigating innovative ways to exploit thermal and mechanical energy from water.
- Deltares works with partners to develop software tools for the design and control of district heating systems.
- Deltares connects academic research to practical applications via software, troubleshooting, and training.

Who does Deltares work with?


Basic information

- Deltares is a partner for internationally operating companies on renewable energy systems.
- Deltares software tools are state-of-the-art tools with an outstanding reputation.
- Deltares focuses on the Netherlands and stakeholders will apply the knowledge abroad.

Context

- Global warming is leading to a sense of urgency from society and politicians for reducing CO₂ emissions.
- Global warming is increasing the demand for cooling in the summer.

What is the maximum injection temperature in an ATES system without negative consequences for the system and the environment?

- How can urban environments benefit from integrated renewable thermal energy sources?
- What are relevant trends?
- Which issues from the public and private sector and scientific world will be addressed?

Who are the main research partners and in which field of expertise do they contribute?

- Wageningen University and Research Centre: water quality and thermal modelling of the subsurface.
- ECN: exchange of near/far field modelling approaches of (offshore) wind farms and tidal parks.

What is the mixture of activities in the present programme portfolio?

- What is the programme lines and what are they about?
- What is the programme ambition for 2013?

Status

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- Deltares software tools are state-of-the-art tools with an outstanding reputation.

In which parts of the world is Deltares active?

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- Deltares focuses on the Netherlands and stakeholders will apply the knowledge abroad.

Which trends will be addressed in which world?

- Water and subsoil resources
- Global warming is leading to a sense of urgency from society and politicians for reducing CO₂ emissions.
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Which role does Deltares play in the international field of expertise?

- Deltares connects academic research to practical applications via software, troubleshooting, and training.
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What are the ambitions for 2016?

- At least one peer-reviewed journal publication on the use of ATES systems in a polluted underground.
- At least two peer-reviewed journal publications on interference and thermal efficiency of ATES systems.
- WANDA 4 Heat extension for the modelling of complex building HVAC systems.

What are the most important results so far, who uses them and how do they apply them?

- Urban and regional governments use research results to optimise their regulations for ATES permits.
- Urban and regional governments use research results to support their spatial planning of the underground.
- Consultants, energy companies and Deltares use WANDA 4 Heat for design and control of district heating systems.
- Water companies use WANDA 4 Heat to assess the temperature increase in drinking water pipelines.
- Urban and regional governments use research results to support their spatial planning of the underground.
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- Deltares focuses on the Netherlands and stakeholders will apply the knowledge abroad.

Ambition

- Deltares connects academic research to practical applications via software, troubleshooting, and training.
- Deltares focuses on the Netherlands and stakeholders will apply the knowledge abroad.

What does Deltares want to achieve in 2013?

- Water and subsoil resources
- Global warming is leading to a sense of urgency from society and politicians for reducing CO₂ emissions.
- Global warming is increasing the demand for cooling in the summer.

Which results does Deltares want to achieve in 2013?

- At least one peer-reviewed journal publication on the use of ATES systems in a polluted underground.
- At least two peer-reviewed journal publications on interference and thermal efficiency of ATES systems.
- WANDA 4 Heat extension for the modelling of complex building HVAC systems.
- Innovative case study on the integration of a geothermal source in a district heating system on the university campus in Delft.
- Delft3D prototype for the modelling of the performance and environmental impact of a tidal park in the sea.
- Consultants use Deltares for specialist advice on tidal parks.

Revenue

- Water and subsoil resources
- Global warming is leading to a sense of urgency from society and politicians for reducing CO₂ emissions.
- Global warming is increasing the demand for cooling in the summer.

Total: € 4,060

- Funding sources
  - Public: € 4,060
  - Private: € 0
  - Min EA: € 200
  - Min IE: € 0
  - Water and subsoil resources: € 0
  - Global warming: € 0

- World
  - Europe: € 1,000
  - America: € 1,000
  - SE Asia: € 1,000
  - Africa: € 1,000
  - Australia: € 1,000
  - Rest: € 1,000

- Total: € 4,060

Funding sources

- Public: € 4,060
- Private: € 0
- Min EA: € 200
- Min IE: € 0
- Water and subsoil resources: € 0
- Global warming: € 0
What is the main goal of this programme?

Deltares develops knowledge, tools and solutions to visualise and characterise the near subsurface.

Who does Deltares work with?

Boskalis, BasoI, Cultural Heritage Agency, Delft University of Technology, DPWE, Ghent University, Ministry of Infrastructure and the Environment, National University of Singapore, partners of consortium EcoShape, Port of Rotterdam, regional water authorities, Rijkswaterstaat and TNO.

Who are the main research partners and in which field of expertise do they contribute?

Delft University of Technology: fundamental research on near surface geophysics.

Boskalis: applied offshore geophysics.

TNO: imaging and data management of the subsurface.

Who are the programme leaders?

Bob Hoogendoorn (bob.hoogendoorn@deltares.nl)

Basic information

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<td></td>
<td></td>
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<tr>
<td>Public</td>
<td>€ 190</td>
</tr>
<tr>
<td>Private</td>
<td>€ 0</td>
</tr>
<tr>
<td>Water and subsoil resources</td>
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Revenue

What are the programme lines and what are they about?

Characterising submarine soil properties: Experiments using acoustic signals ('Scholte' waves) to characterise the stiffness of the seabed.

1D interferometry on levees: Experimental validation of geophysical processing theory using field data of the Hondsbossche sea wall.

Status

What is the mixture of activities in the present programme portfolio?

The majority of activities consist of specialist consultancy (about 60 per cent of the revenue).

Other activities consist of development of knowledge (about 40 per cent of the revenue).

What are the most important results so far, who uses them and how do they apply them?

Rijkswaterstaat calculates the risks for pipelines regarding levee failure, using output of subsurface data analyses.

Deltares executed extensive applied research to assist Boskalis in finding resources along the coast of Kenya.

Deltares assisted BASF to determine the location, size and nature of a polluted surface so appropriate and inexpensive remediation could be carried out.

In which parts of the world is Deltares active?

Deltares is active worldwide within this field, for example in 2012 in India, France, Nigeria and Iraq.

Which role does Deltares play in the international field of expertise?

Deltares has high level expertise on collecting, processing and interpreting geophysical data.

Deltares’ focus is on delivering a solution for clients and not to just delivering data.

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What are the ambitions for 2016?

Users of tools are aware of the added value of methods and data that characterise and visualise the subsurface.

Dutch companies use visualisation and characterisation techniques for quantifying resources in the subsurface and determining the quality of levees.

Deltares works in delta cities in South East Asia, Australia and New Zealand.

Deltares’ activities are funded by a mix of public applied research funding and consultancy projects.

The number of programme lines is expanded from two to four, related to the demands of major stakeholders.

Water and subsoil resources

What is the programme ‘Characterisation and visualisation of the subsurface’?

Which issues from the public and private sector and scientific world will be addressed?

How can academic geophysical methods be implemented in the real world?

How can uncertainties in the estimates of resources be reduced in the Netherlands and abroad?

How can subsurface imaging techniques be made better applicable?

How can levee breaches be estimated on the base of tremendous amounts of data?

What are relevant trends?

The growing and developing world population is increasing demand for resources.

The supply of resources is decreasing because of the reduced resource availability and accessibility.

The relevance of the subsurface below artificial levees has become clear, resulting in increasing demand for knowledge.

The risks of levee breaches have increased leading to greater demand for knowledge on the subsurface of artificial levees.

Lower societal acceptance of levee breaches is leading to greater demand for knowledge on the subsurface of artificial levees.

Who are the programme leaders?

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One of the social issues of our time is the availability of enough water of the right quality for agriculture, the public and industry, sharing the water when there are shortages, and preventing damage and nuisance when there is too much water. Policy decision making concerning these complex issues has to be well informed, for example in relation to infrastructure. Infrastructure like river barrages for water management are large investments with long lasting consequences.

Deltares was commissioned by the Dutch government to develop the Delta Model, a suite of software instruments supporting these policy decisions. In the past, dozens of different models were used by different parties, leading to different results and generating unnecessary discussions. Over one hundred specialists of Deltares have worked together to create the redesigned Delta Model which was finalised in 2012. A large amount of technical expertise was combined with the most recent knowledge on fresh water supply issues and flood risk. Due to the fact that the calculation results are widely accepted as ‘independent’, discussions and decision making have been greatly simplified. The result is a model that is regarded internationally as ‘unique and innovative’. The model has been applied already to assess several Delta Programme policy options.

erik.ruijgh@deltares.nl
In which parts of the world is Deltares currently active and which will have been added by 2016?

Deltares increases its activities in all regions outside of Europe.

What is the focus of this theme?
The theme focuses on efficient, safe and sustainable design, construction and maintenance of infrastructure in deltas.

Who is the theme leader?
Peter van den Berg (peter.vandenberg@deltares.nl)

Which programmes are included in this theme?
- Ports and waterways
- Offshore engineering
- Coastal and river structures
- Underground construction in urban areas
- Roads and railroads in delta areas
- Subsidence
- Industrial systems and infrastructure
- Coastal developments

What are the benefits for the public sector?
- Public authorities construct harbours, waterways, roads and railroads in an environmentally friendly manner.
- Construction of coastal, harbour, hydraulic, offshore and underground structures by public authorities is efficient, with minimised risks.
- Local governments gain insight in the potential risks and the possible solutions of land subsidence.
- Public authorities decrease the impact of infrastructure on environment and society by incorporating natural processes into the design.
- Public authorities innovate their infrastructure solutions, by improvement of software, facilities and humans’ capabilities in hydraulic and geotechnical design.

What are the benefits for the private sector?
- The (inter)national oil and gas industry, contractors and consultants gain access to knowledge, software and facilities in order to improve their international competitiveness.
- Dutch companies and knowledge institutes improve their international position by cooperation in focus areas, such as water and energy (within the governmental ‘top sector approach’).

Which issues from the public and private sector and scientific world will be addressed?
- How can the costs and risks of construction and maintenance of infrastructure be minimised?
- How can existing infrastructure be adapted to deal with climate change, sea level rise and land subsidence?
- How can infrastructure be incorporated in the environment in a socially acceptable way?
- How can the facilities, software and humans’ capabilities regarding hydraulic and geotechnical design be improved?

Ambition

What are the goals until 2016?
- Deltares will reduce costs and risks related to construction in coastal areas, soft soil conditions and offshore.
- Deltares will optimise the design of infrastructure in deltas, focusing on hydraulic and geotechnical aspects.
- Deltares will incorporate knowledge of natural processes in the design of infrastructure.
- Deltares will develop strategies for adapting infrastructure to climate change, sea level rise and subsidence.
- Deltares will develop innovative, sustainable solutions to minimise environmental impact of construction in deltas.

What is Deltares' position, now and in 2016?
- Deltares is a national leader and internationally prominent in hydraulic and (soft) soil engineering.
- In 2016, Deltares will be one of the internationally leading institutes in hydraulic and (soft) soil engineering.

Results

What are the benefits for the public sector?
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Which facilities and (experimental) field locations are used?
- Deltares uses all wave flumes, all basins, geotechnical laboratories and the geocentrifuge.
- Deltares uses pilot projects for measurements and monitoring, like the new North/South subway in Amsterdam.

How is revenue for 2012 distributed among the funding sources and across the world?

<table>
<thead>
<tr>
<th>Funding sources</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
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<tr>
<td>Public</td>
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<tr>
<td>Min IE</td>
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<td>NL</td>
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<tr>
<td>Min EA</td>
<td>€ 1,200</td>
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<td>SR Prog</td>
<td>€ 650</td>
</tr>
<tr>
<td>Business</td>
<td>€ 250</td>
</tr>
<tr>
<td>Rest</td>
<td>€ 1,500</td>
</tr>
<tr>
<td>Total</td>
<td>€ 1,500</td>
</tr>
</tbody>
</table>

| Total | € 21,000 |

What are the revenue ambitions for 2016?
- Deltares will increase its overall revenue by 10 per cent, to be primarily realised outside of Europe.
- Deltares will double the current amount of programme financing, especially via Joint Industry Projects (JIP).

Increasing mining of natural resources is stimulating development of rivers as new waterways.

New ports are increasingly constructed as reclamations out at sea, combined with a dredged entrance.

In the Netherlands navigation locks and hydraulic structures are reaching the limits of their capacity and lifetime.


Deltares develops knowledge and tools for safe, cost-efficient design and construction of offshore energy infrastructure.

Who does Deltares work with?

Who are the main research partners and in which field of expertise do they contribute?
- Delft University of Technology: offshore technology
- MARIN: wave modelling
- Technical University of Denmark: offshore technology

Who are the programme leaders?
- Tim Rajmakers (t.m.rajmakers@deltares.nl)

What is the programme ‘Offshore engineering’?
- Deltares increases its hybrid modelling capabilities, by combining the strengths of physical and numerical models and field measurements.
- Deltares develops a Metocean Dashboard and Condition-Based Monitoring System for offshore wind parks.
- Deltares is leading in combining hydraulic and geotechnical knowledge by modelling wave-current-structure-soil interaction.
- Deltares develops validated numerical models for local morphology on simplified cases for offshore structures.
- Deltares gradually increases its already strong position in Europe, and the North Sea in particular, and extends its activities in Australia, Middle East, Singapore and Houston.
- Deltares transfers its knowledge via assignments and presentations at conferences and an in-house seminar.

What is the main goal of this programme?
- Deltares is a specialist consultant, from tender phase to construction, maintenance, operation and decommissioning.
- Deltares initiates and participates in JIPs, in which a knowledge gap is bridged in combination with industry partners.
- Deltares can benefit from the worldwide activity of the well-established Dutch offshore industry.

What are the ambitions for 2016?
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- Deltares prioritises involvement in the development of the important offshore projects.

What are the programme lines and what are they about?
- Stability of offshore foundations: Developing knowledge and tools for designing stable and safe offshore foundations in a hostile environment.
- Operational workability predictions: Developing software for workability predictions by combining different Metocean data sources and models.
- Combined geotechnical and hydraulic approach: Optimising offshore design by combining geotechnics and hydraulics.

What are the most important results so far, for whom do they apply and how do they apply them?
- Offshore oil and gas companies make operational scour forecasts for their drilling operations.
- A method to determine irregular wave loads on offshore structures is used by the offshore industry.
- Numerical model, validated against lab model measurements, to calculate breaking wave impact against offshore wind, oil and gas.
- Offshore oil and gas companies work with guidelines, a model test database and software for scour prediction for offshore drilling rigs.
- Open Filter Design against erosion around cylindrical piles is used by the offshore industry.
- A numerical model to predict sand wave growth, decay and migration for the designers of offshore line infrastructure and foundations.
- A method to predict the risk on cyclic liquefaction caused by irregular wave loads.

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What is the mixture of activities in the present programme portfolio?
- Development of knowledge is primarily based on demand driven research and specialist consultancy.
- Research is demand driven, which renders development of knowledge and specialist consultancy activities.
- Deltares transfers its knowledge via assignments and presentations at conferences and an in-house seminar.
- In Joint Industry Projects (JIP) Deltares combines development and transfer of knowledge, and consultancy.

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How can the safety of offshore operations be guaranteed in harsh environments, like the arctic and deep seas?
- How can the workability of offshore operations, and the predictability of it, be increased?
- Who are the main research partners and in which field of expertise do they contribute?
- Which issues from the public and private sector and scientific world will be addressed?
- How are the ambitions for 2016?

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Densification of urban areas is leading to more interaction between new and existing underground structures. People's acceptance of the vast impact and long duration of underground construction methods is decreasing.

Deltares reduces the environmental impact and risks related to underground construction in urban areas. Governments are reducing their investments in innovation and construction.

What is the programme 'Underground construction in urban areas'?

Deltares is a knowledge hub, with workshops, training courses, seminars and up-to-date software. Deltares participates as a reviewer and adviser in committees for the development of guidelines.

Which issues from the public and private sector and scientific world will be addressed?

- Optimising design and construction methods for foundations, construction pits and tunnels: Enhancing sustainability, minimising construction risks and enhancing safety, for the lifetime of the structure.
- Quality of in situ-built foundation elements: Reducing failures by production improvements, geophysical detection techniques and in situ-built techniques.
- Reduction of negative impact to society and the environment: Reducing hindrance and damage for the surroundings and improving the predictability of it.

Who does Deltares work with?

- Arcadis, A.Hakpark, Ballast Nedam, Boskalis, Bride, CRUX Engineering, CUNET, Delft University of Technology, Dura, DWS Vermeer, Fugro, Gasunie, Geo Research Institute Osaka, Grontmij, Heijmans Beton- en Waterbouw, Herrenknecht, Huesker, KIVI NIRIA, Leiden University, Mobilis, Moveres, municipalities, Plass, ProRail, provinces, Railway Technical Research Institute, Royal HaskoningDHV, Ruhr Universität, Strukton, TNO, University of Cambridge, University of Twente, Van Hattum & Blankespoort, Van Oord, Vereniging Van Waterbouwers, VWS Geotechniek, Witteveen+Bos and World Bank.

Funding sources World

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<th>Budget (€1,000)</th>
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<tr>
<td>Mid E</td>
<td>100</td>
</tr>
<tr>
<td>America</td>
<td>800</td>
</tr>
<tr>
<td>Rest</td>
<td>500</td>
</tr>
<tr>
<td>Total</td>
<td>2,150</td>
</tr>
</tbody>
</table>

Transfer of knowledge

- Contractors mitigate imperfections in diaphragm walls by applying two geophysical detection methods.
- The foundation industry uses guidelines to execute faster and cheaper rapid load testings on piles.
- An increasing number of clients use an implementation methodology for geotechnical risk management.
- Universities use the improved FEM code (MPM) for research, and the code is available for practical application.

How is revenue for 2012 distributed among the funding sources and across the world?

- Development of knowledge
- Transfer of knowledge
- Specialist consultancy

Who are the programme leaders?

- Hans Brinkman (hans.brinkman@deltares.nl)

What are relevant trends?

- People are demanding better predictions of risks and impacts of underground constructions.
- Governments are reducing the number of assignments for consultants and constructors.
- The current economic situation is reducing the number of assignments for consultants and constructors.

What are the aims for 2016?

- Deltares maintains its independent position and reputation.
- Deltares is a international knowledge hub, with workshops, training courses, seminars and up-to-date software.
- Deltares keeps the allowable bearing capacity of piles high, limiting costs increases to under 30 per cent.
- Deltares increases the reliability and applicability of in situ foundation elements.
- International firms profit from Deltares' strengthened reputation and increased knowledge.
- Deltares continues to focus on Europe; large cities elsewhere make more frequent use of Deltares.
- The research focus changes from building of new structures to reuse and lifetime extensions of existing structures.
- Deltares Shuts its focus towards sustainability, urban water management and climate change.
- The foundation industry uses guidelines to execute faster and cheaper rapid load testings on piles.
- An increasing number of clients use an implementation methodology for geotechnical risk management.

What role does Deltares play in the international field of expertise?

- Deltares acts as an independent adviser and arbitrator in court cases and conflicts.
- Deltares participates as a reviewer and adviser in committees for the development of guidelines.
- Deltares is mainly active in the Netherlands, and in Europe, the Middle East and Australia.

What is the mixture of activities in the present programme portfolio?

- Knowledge development is required to keep up with market demands, for example, on new subway tunnels.
- As a specialist consultant, Deltares is involved in projects with the Dutch private sector and the government.
- Transfer of knowledge occurs in assignments and through software, courses and publications.

Where does Deltares work with?

- Delft University of Technology: geo-engineering.
- TNO: geodynamics and groundwater.
- University of Cambridge: geo-engineering.

Who are the main research partners and in which field of expertise do they contribute?

- TNO: geodynamics and groundwater.
- University of Cambridge: geo-engineering.
- Delft University of Technology: geo-engineering.

What are the main goal of this programme?

- Reduction of negative impact to society and the environment: Reducing hindrance and damage for the surroundings and improving the predictability of it.

What are the most important results so far, who uses them and how do they apply them?

- Contractors mitigate imperfections in diaphragm walls by applying two geophysical detection methods.
- The foundation industry uses guidelines to execute faster and cheaper rapid load testings on piles.
- An increasing number of clients use an implementation methodology for geotechnical risk management.
- Universities use the improved FEM code (MPM) for research, and the code is available for practical application.

In which parts of the world is Deltares active?

- Deltares is mainly active in the Netherlands, and in Europe, the Middle East and Australia.

What is the role of Deltares in the international field of expertise?

- Deltares acts as an independent adviser and arbitrator in court cases and conflicts.
- Deltares participates as a reviewer and adviser in committees for the development of guidelines.
- Deltares Shuts its focus towards sustainability, urban water management and climate change.

Which results does Deltares want to achieve in 2013?

- Testing the feasibility of centripetal tests on the safety of pile design.
- Contribution to a handbook on integral tunnel design for the Dutch Centrum voor Ondergronds Bouwen.
- PhD thesis on response of piled buildings to the construction of deep excavations.
- Online toolbox for construction pits.
Deltares is a global player in deformation models for soft soils, modelling of groundwater flow in embankments and piled embankments. Deltares develops tools for more reliable (real-time) predictions of the impact of climate hazards and geotechnical risks on construction and asset management. Deltares validates the application of acquired knowledge in consultancy assignments for contractors and infrastructure operators. Deltares puts more emphasis on asset management and system related issues both in Europe and South East Asia. Deltares develops more activities on eco-engineering and research on microbiology.

What is the mixture of activities in the present programme portfolio?
- Activities entail both development and transfer of knowledge and specialist consultancy assignments.
- Development of knowledge and specialist consultancy occurs through cooperation with operators of infrastructure and industry partners.
- Knowledge is transferred via research reports, Geonet, conferences, peer reviewed journal papers, industry guidelines and software.

Who are the main research partners and in which field of expertise do they contribute?
- Delft University of Technology: geotechnics and policy analyses.
- TNO: built environment.
- Deltares.

Which issues from the public and private sector and scientific world will be addressed?
- Robust and resilient infrastructures: Quantifying the impact of climate change on infrastructure and assessment of adaptation measures.

Who are the programme leaders?
- Joris van Ruijven (joris.vanruijven@deltares.nl)

What is the programme ‘Roads and railroads in delta areas’?
- Reliable models and instruments for design and asset management: Quantifying geotechnical risks using geological knowledge, (geophysical) measurements and reliable subsoil and deformation models.
- Robust and resilient infrastructures: Quantifying the impact of climate change on infrastructure and assessment of adaptation measures.

What are the programme lines and what are they about?
- Reliable infrastructure: Providing reliable models and instruments for design and asset management.
- Robust infrastructure: Increasing resistance of large scale systems against the impact of climate change.
- Eco-engineering: Applying eco-engineering solutions for planning, design, construction and asset management.

Which results does Deltares want to achieve in 2013?
- Report on procedures for reliable subsoil models.
- Tool to determine the effects of groundwater changes on bearing capacity of road embankments.
- Report with proposal for improvement of deformation models based on Weesp measurements.
- Publication in a Dutch and a peer reviewed journal on the long term creep tests for the Dutch highway A2.
- Publication in a Dutch journal on the pilot project on geophysical measurements of the Juliana canal.
- Preliminary study on the possibilities of ‘cleaning’ embankments and levees.
- Development of knowledge, Transfer of knowledge, Specialist consultancy.
How can recirculation studies be carried out more efficiently and accurately, so market and governmental demands are better met?

Who does Deltares work with?
Delft University of Technology: industrial flows through pipelines and underground infrastructure.
KWR Watercycle Research Institute: water distribution networks.
TNO: pipelines and risk analysis.

David van Vossen (bas.vanvossen@deltares.nl) and Henk Kruse (henk.kruse@deltares.nl)

Who are the main research partners and in which field of expertise do they contribute?
Deltares decreases the energy consumption, improves the safety and minimises the impact of vital industrial systems and infrastructure, by optimizing design, planning and maintenance.

What is the main goal of this programme?
Deltares develops tools and methods for safe and cost-effective design, maintenance and operations.

Who are the programme leaders?

The demand for sustainable industrial systems and infrastructure is growing, from design to maintenance.

People are increasingly less accepting risks of construction activities.

Who are the programme leaders?

What are the ambitions for 2016?
Deltares develops tools and methods for safe and cost-effective design, maintenance and operations.
Deltares increases its international revenue by executing more geotechnical and hydraulic assignments for existing clients.
Deltares continues its leading role in the Middle East, Asia, Europe and the Netherlands.
Deltares finances its research mainly via assignments by individual companies or Joint Industry Projects (JIP).

In which parts of the world is Deltares active?
Deltares mainly works in the Netherlands, in most Middle East countries, South Korea and Europe.

Deltares finances its research mainly via assignments by individual companies or Joint Industry Projects (JIP).

Which role does Deltares play in the international field of expertise?
Deltares advises on the world’s most complex projects using numerical and physical modelling.
Deltares develops knowledge of trenchless technology and soil and pipeline interaction.

What are the most important results so far, who uses them and how do they apply them?
Developers, operators and regulators justify their decisions using brine and thermal dispersion studies.
Asset management system UNet is used by researchers to upgrade towards the proof-of-concept stage.
The trench stability evaluation method is used by contractors to secure safety in pipeline installation projects.
The designs of industrial systems are improved in terms of safety and costs, and enable developers to obtain the necessary construction and operation permits.
A new method for design of the Direct pipe and HDD pipeline installation method is available and used by contractors and consultants in international projects.

What is the mixture of activities in the present programme portfolio?
Focus is on specialist consultancy for the private sector, which often includes transfer of knowledge.
Transfer of knowledge also occurs via software and training.
Development of knowledge takes place during projects, and is necessary to keep up with market demands.

How is revenue for 2012 distributed among the funding sources and across the world?

What are the programme lines and what are they about?
Optimising design and construction methods: Enhancing sustainability, minimising construction risks and increasing safety for a lifetime.
Minimising impacts: Minimising societal and environment impact of construction and operation.
Optimising maintenance: Supporting asset management, effective monitoring and operations of industrial systems, and the optimal use of available space in densely populated areas.

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What is the main goal of this programme?
Deltares develops tools and methods for safe and cost-effective design, maintenance and operations.

Who are the programme leaders?
How can the efficiency and use of natural processes in design and construction of coastal infrastructure be improved?

ASA Brasil, AECOM, Boskalis, CH2M Hill, Delft University of Technology, Governments, Groningen Seaports, KEPCO, Ministry of Infrastructure and the Environment, municipalities, partners of consortium EcoShape, Port of Sohar, Royal Haskoning DHV, Technital, UNESCO-IHE, United States Army Corps of Engineers, University of Twente, Van Oord and Witteveen+Bos

Deltares stimulates sustainable development of coasts and estuaries by improving efficiency in ecodynamic design, construction and maintenance of coastal interventions.

Who does Deltares work with?

Funding sources World

How can hydro- and morphological effects of construction and use of coastal infrastructure be predicted?

Rising sea level and changes in wave climate are altering the present dynamics of the coast.

Clients are increasingly demanding insight into the uncertainties - the bandwidth - of model predictions.

People and public authorities are increasingly demanding multifunctional coastal development.

What are the main research partners and in which field of expertise do they contribute?

What is the programme ‘Coastal developments’?

Relevant trends

Basic information

Context

Ambition

Status

Revenue

Funding sources World

The main goal of this programme is to improve insight in uncertainties of the effects of climate change for the Netherlands.

What is the mixture of activities in the present programme portfolio?

The focus, for this new programme, is on specialist consultancy and transfer of knowledge.

Deltares is a leader in designing and evaluating coastal interventions and ecodynamic solutions (Building with Nature).

Which role does Deltares play in the international field of expertise?

Deltares is a leader in designing and evaluating coastal interventions and ecodynamic solutions (Building with Nature).

Which issues from the public and private sector and scientific world will be addressed?

What is the added value of an ecodynamic design of coastal infrastructure?

How can the efficiency and use of natural processes in design and construction of coastal infrastructure be improved?

How can hydro- and morphological effects of construction and use of coastal infrastructure be predicted?

Who are the programme leaders?

Arjen Luijendijk (arjen.luijendijk@deltares.nl) and Bas van Maren (bas.vanmaren@deltares.nl)

Who are the main research partners and in which field of expertise do they contribute?

Delta University of Technology: impacts of coastal infrastructure.

EcoShape: ecodynamic design and solutions.

UNESCO-IHE: coastal morphology.

Who is Deltares active in?

Deltares is active in Africa, the Middle East, the United States and in the Netherlands.

What are relevant trends?

Clients are increasingly demanding insight into the uncertainties - the bandwidth - of model predictions.

Research institutes are improving insight in uncertainties of the effects of climate change for the Netherlands.

People and public authorities are increasingly demanding multifunctional coastal development.

What are the programme lines and what are they about?

Multidisciplinary design tool for coastal interventions: Developing a design tool to enable multidisciplinary evaluations of interventions along coasts.

Embedding structures in a soft environment: Developing knowledge and tools to investigate the effects of ecodynamic and hard structures on (soft) surroundings and vice versa.

Uncertainty in effects: Developing knowledge and methods to structurally incorporate uncertainty bandwidths in modelling approaches and scenarios for effect computing.

What are the ambitions for 2016?

Deltares establishes its leading knowledge position by numerous journal publications with partner institutes.

Deltares intensifies its transfer of knowledge by on-the-job-training and by cooperating with consultants.

Deltares is a specialist consultant for international complex coastal dynamics, where appropriate in cooperation with consultants and dredging companies.

Deltares extends its activities in Africa, the Middle East, North and South America.

Funding comes increasingly from Joint Industry Projects (JIP), for example for developing prototypes.

Which results does Deltares want to achieve in 2013?

Three to five published papers on coastal developments.

The start of one or two PhD-students on coastal developments.

Continuation of on-the-job-training of consultants, software courses and lectures at universities.

Optimising cooperation with consultants and dredging companies, via one or two specialist consultancy projects.

Further improvement of the multidisciplinary design tool.

Starting projects in Mozambique, Kenya and Angola.

Prototype demonstrations of the design tool to attract new collaborative opportunities.

Which role does Deltares play in the international field of expertise?

Deltares is a leader in designing and evaluating coastal interventions and ecodynamic solutions (Building with Nature).

Through specialist consultancy, Deltares exchanges knowledge and tools with national and international consultants.

Deltares contributes to science via PhDs, and cooperation in research programmes.

What are the ambitions for 2016?

Deltares is a leader in designing and evaluating coastal interventions and ecodynamic solutions (Building with Nature).

Which issues from the public and private sector and scientific world will be addressed?

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Breakwaters protect harbours against waves and ocean swell. The layout of the breakwater determines the wave propagation in the harbour. The armour layer of natural stones or concrete blocks protects the breakwater itself against waves and makes sure that the structure can withstand extreme waves. During the construction phase a newly designed breakwater of the Sal Rei harbour on the island Boa Vista (Cape Verde) proved to be insufficient in withstand the waves generated by a passing storm.

Only after the breakwater was redesigned, Deltares was commissioned to test a number of cross sections for this redesigned breakwater in the wave flumes. The result of these essentially two-dimensional tests was that a single, flat layer of cubes performed better than all other alternatives. The contractor showed this innovative solution to be the most economic alternative. Finally the complete breakwater was modelled in the Delta Basin to verify and optimize the total design. The result of this modelling effort was that the single layer cubes were applied over the trunk and also on the roundhead. The tested structure is scheduled to be constructed in 2013.

marcel.vangent@deltares.nl
What is the theme ‘Sustainable delta planning’?

The theme develops and tests concepts, methods and instruments to realise sustainability in deltas.

The theme explores ways to integrate Deltares’ expertise on water and soil with knowledge about decision making.

Who is the theme leader?
Hans Vissers (hans.vissers@deltares.nl) and Henriëtte Otter (henriette.otter@deltares.nl)

Which programmes are included in this theme?
- Delta governance
- Climate, water and spatial planning
  - Concepts, methods and instruments for spatial planning and policy making
  - Sustainable delta cities

What are the benefits for the public sector?
National and local governments benefit from sustainable, cost-efficient solutions with optimal public support. Governments make better choices in water management, spatial planning and infrastructure because of better information.

What are the benefits for the private sector?
Engineering consultants, urban designers and developers strengthen their competitiveness using methods and instruments for spatial planning issues related to water, subsurface and infrastructure.

In which parts of the world is Deltares currently active and which will have been added by 2016?
- Europe, Indonesia and Bangladesh
- Canada and North and Central America

What are relevant trends?
Climate change is affecting flood risks and the distribution of water and therefore land use and spatial planning. Delta areas are becoming further urbanised due to international demographic and socio-economic changes. The increasing complexity of decision making processes regarding water, subsurface and infrastructure issues is increasing the public demand for integrated solutions. Stakeholders are increasing their demand for useable knowledge in decision making processes.

Which issues from the public and private sector and scientific world will be addressed?
- How can integrated methods and instruments accelerate design, improve quality and decrease costs of spatial planning?
- How can design and research be integrated to improve spatial development?
- How can public organisations use innovative policy arrangements to cope with uncertainty in decision making processes?
- How can Dutch expertise contribute to the realisation of national and European innovation ambitions?
- How can the subsurface be used more efficiently, especially in urban areas?

What are the goals until 2016?
- Deltares will support decision making in spatial planning, through developing and integrating knowledge and sustainable practical solutions.
- Deltares will combine expertise from its themes, to make it applicable in policy making and spatial planning.

What is Deltares’ position, now and in 2016?
Deltares is a national leader and internationally a well-known player on applied interdisciplinary research. In 2016 Deltares maintains its current national position and is more competitive internationally.

Which facilities and (experimental) field locations are used?
Deltares uses mainly pilot areas, for example in Bangladesh and via Knowledge for Climate in Rotterdam.

How is revenue for 2012 distributed among the funding sources and across the world?

<table>
<thead>
<tr>
<th>Funding sources</th>
<th>World (€ 1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>5,600</td>
</tr>
<tr>
<td>Other Public</td>
<td>1,300</td>
</tr>
<tr>
<td>Private</td>
<td>800</td>
</tr>
<tr>
<td>Total</td>
<td>7,500</td>
</tr>
</tbody>
</table>
How can climate adaptation measures be implemented through innovation and flexible governance arrangements?

Deltares develops, disseminates, integrates and applies governance knowledge for safe and sustainable living in deltas, coastal zones and river basins.

Deltares works with:
- Delft University of Technology
- Erasmus University of Rotterdam
- Ministry of Infrastructure and the Environment
- Tygon Serious Gaming B.V.
- UNESCO-IHE
- University of Amsterdam
- University of Twente
- University of Utrecht
- Wageningen University and Research Centre

Funding sources:
- World
- Ministry of Infrastructure and the Environment
- Nederlandse Waterstaat

Wageningen UR: governance arrangements, stakeholder involvement and participatory monitoring.

University of Twente: interactive knowledge development.

Minister of Economic Affairs, partners of the Delta Programme, provinces, regional water authorities.

Gerald Jan Ellen (geraldjan.ellen@deltares.nl) and Henriëtte Otter (henriette.otter@deltares.nl)

How can stakeholders deal with the increasing complexity of living and working in a delta?

Delta areas are urbanising.

Governance of deltas is changing from public, centralised control towards private networks and initiatives.

What are the main research partners and in which field of expertise do they contribute?

- Erasmus University Rotterdam: governance and public administration.
- Wageningen UR: governance arrangements, stakeholder involvement and participatory monitoring.
- University of Twente: interactive knowledge development.

Which issues from the public and private sector and scientific world will be addressed?

- Climate change is increasing the frequency and force of weather events in deltas.
- How can stakeholders deal with conflicts of interests on delta management issues?

How can stakeholders deal with the increasing complexity of living and working in a delta?

- Delta areas are urbanising.
- Governance of deltas is changing from public, centralised control towards private networks and initiatives.

Which role does Deltares play in the International field of expertise?

- Deltares has the capacity to integrate natural and social science disciplines.
- Deltares links science to practice by using its extensive network.

What are the most important results so far, who uses them and how do they apply them?

- Together with end user Waternet the participatory monitoring approach was developed, to increase acceptance among stakeholders of water management issues.
- A national symposium, attended by practitioners, policy makers and researchers, was organised to present the programmes’ ideas and ambitions.

In which parts of the world is Deltares active?

- Deltares works in the Netherlands, Europe, Mozambique, Zambia, Colombia and South East Asia.

What are the ambitions for 2016?

- Delta governance is a well-known concept in the Netherlands and has expanded internationally.
- Deltares develops knowledge on governance of implementing and monitoring short and long term delta policy and measures.
- Deltares publishes at least four articles in scientific journals on the subject of delta governance annually.
- Deltares organises an international symposium on delta governance.
- Deltares is a preferred partner when it comes to specialist consultancy on the subject of delta governance.
- Deltares works for regional and national governments, international research programmes and international financing institutions.

What is the mixture of activities in the present programme portfolio?

- The focus is on development of knowledge, in collaboration with universities and governmental organisations.
- Development of knowledge occurs in scientific research projects and through case studies.
- Transfer of knowledge occurs in case studies and through publication of articles, presentations at conferences and development of apps.
- Specialist consultancy occurs through assignments for the Dutch government.

What results does Deltares want to achieve in 2013?

- Governance strategies on how to deal with wicked problems.
- Publication on participatory monitoring in the context of implementing climate adaptation strategies.
- Implementation of a methodology for climate adaptation strategies, using flexible policy arrangements and participatory monitoring.
- Deltares’ projects are always funded in cooperation with a cofunding partner.
- Regional focus is mainly on the Netherlands and Europe, a more international focus is being developed.

What is the programme ‘Delta governance’?

- Sustainable delta planning
- Governance system diagnostics: Developing methodologies to diagnose governance arrangements.
- Knowledge in decision making: Developing innovative concepts, methods and instruments for production, quality control and use of knowledge in governance arrangements.
- Governance tools: Developing tools and methods on participation of stakeholders, division of costs and benefits and policy instruments.

In which parts of the world is Deltares active?

- Deltares works in the Netherlands, Europe, Mozambique, Zambia, Colombia and South East Asia.

What are the programme lines and what are they about?

- Governance system diagnostics
- Knowledge in decision making
- Governance tools
- Specialist consultancy

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- Netherlands
- World
- Ministry of Infrastructure and the Environment
- Nederlandse Waterstaat

Revenue

Basic information

Context

Status

Ambition

Who are the programme leaders?

Gerald Jan Ellen (geraldjan.ellen@deltares.nl) and Henriëtte Otter (henriette.otter@deltares.nl)

Who does Deltares work with?

- Delft University of Technology
- Erasmus University of Rotterdam
- Ministry of Infrastructure and the Environment
- Tygon Serious Gaming B.V., UNESCO-IHE, University of Amsterdam, University of Twente, University of Utrecht and Wageningen University and Research Centre.

What are relevant trends?

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- Governance of deltas is changing from public, centralised control towards private networks and initiatives.

Ambition

Development of knowledge
Transfer of knowledge
Specialist consultancy

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- Specialist consultancy occurs through assignments for the Dutch government.

What are the programme lines and what are they about?

- Governance system diagnostics
- Knowledge in decision making
- Governance tools
- Specialist consultancy

Deltares organises an international symposium on delta governance.

Deltares links science to practice by using its extensive network.

Deltares has the capacity to integrate natural and social science disciplines.

Delta areas are urbanising.

Governance of deltas is changing from public, centralised control towards private networks and initiatives.

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Among Dutch companies, governments and research institutes, awareness is growing that many deltas resemble Dutch
Scientific understanding on climate change is progressing steadily, but the effects will remain uncertain for a long time.
In science and policy making, there is increasing agreement on robustness and flexible planning as proven concepts to
 cope with future uncertainty.

Deltares develops methods and tools to enable decision making in the face of uncertain climate, water and
spatial developments.

Who does Deltares work with?
Delft University of Technology, International Institute for Applied Systems Analysis, Ministry of Infrastructure and the
Environment, partners of Knowledge for Climate programme, partners of FP7-BASE consortium, provinces,
regional water authorities, STOWA, UNESCO-IHE, Utrecht University, University of Twente, Maastricht University,
VU University Amsterdam and Wageningen University and Research Centre.

Who are the main research partners and in which field of expertise do they contribute?
Delft University of Technology: adaptive assessment frameworks.
Knowledge for Climate programme: climate adaptation strategies.
UNESCO-IHE: climate adaptation strategies.

Who are the programme leaders?
Ad Jeuken (ad.jeuken@deltares.nl)

What is the main goal of this programme?
Deltares develops methods and tools to enable decision making in the face of uncertain climate, water and
spatial developments.

Scientific understanding on climate change is progressing steadily, but the effects will remain uncertain for a long time.
Among Dutch companies, governments and research institutes, awareness is growing that many deltas resemble Dutch
deltas and therefore the same knowledge might apply.
In science and policy making, there is increasing agreement on robustness and flexible planning as proven concepts to
cope with future uncertainty.
The economic crisis is forcing decision makers to set priorities and to seek no-regret investments.

How can future developments and needs be integrated in decisions in water management and spatial planning?
How can we cope with uncertain information in decision making processes in water management and spatial planning?
How do local stakeholders, such as residents and entrepreneurs, adapt to perceived future risks?
How can the effects of climate adaptation strategies be assessed rapidly?

What is the mixture of activities in the present programme portfolio?
The focus is on knowledge, mainly through publications and cooperation with partners.
Transfer of knowledge takes place through cooperation with research partners and publications.
Specialist consultancy on policy adaptation pathways occurs on a national level.
Tools are developed to apply Deltares’ knowledge in specialist consultancy.

What are the ambitions for 2016?
Deltares applies its knowledge and expertise on dealing with uncertainty in a broad range of applications.
Deltares uses scientific cooperation to improve its delta management knowledge and its scientific visibility.
Deltares shifts from knowledge development, via pilot projects, towards tool application in specialist consultancy.
Deltares applies its knowledge and expertise on dealing with uncertainty in a broad range of applications.
Deltares connects different organizations and disciplines.

Deltares is active in the Netherlands, Europe, Bangladesh, Vietnam and Indonesia.

Deltares develops knowledge and makes Dutch knowledge applicable internationally.
Deltares is one of the key institutes connecting scientific insights in water management to practical problems.
Deltares connects different organizations and disciplines.

What are the programme lines and what are they about?
Policy adaptation pathways: Developing knowledge and tools on how adaptation strategies can be designed,
decided upon and executed.
Stakeholder adaptation pathways: Developing knowledge and tools on how risks are perceived by local
stakeholders, what preferred actions are and how policy can influence these.
Policy evaluation: Developing knowledge and tools to assess different policy options for climate adaptation in deltas.

What are the most important results so far, who uses them and how do they apply them?
A rapid flood damage assessment model is used to derive adaptation strategies for the Delta Programme.
Researchers, consultants and policy makers assess climate impact with an adaptation tipping points method.
The Delta Programme applies the adaptive delta management concept for developing strategies to cope with
future uncertainty such as climate change.
The improved concept of system robustness is used within the Knowledge for Climate and Delta Programme
to evaluate different measures to reduce risks.
Knowledge on location-specific flood insurance premiums was deduced using new modelling techniques under
various climate change scenarios and policy options.

In which parts of the world is Deltares active?
Deltares is active in the Netherlands, Europe, Bangladesh, Vietnam and Indonesia.

Which role does Deltares play in the international field of expertise?
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What is the programme ‘Climate, water and spatial planning’?
Deltares knows how to implement solutions for sustainable delta cities, and assists clients in realising this. Deltares will shift its focus from research on urban systems to assessment, selection, configuration and realisation of solutions in complex cities. Deltares excels internationally in the field of sustainable delta cities because of its broad and integral expertise.

What are the ambitions for 2016?

- Introduction of the Brownfield navigator tool in the Dutch market.
- Book on sustainable development and management of the shallow subsurface.
- Scientific publication on how an ecosystem service approach can meet global water challenges in urban areas.
- Report on methods for sustainable harbour constructions based on a case study in Indonesia.
- Report on pros and cons of subsurface constructions in cities from an energy point of view.
- Wiki about Deltares’ progress in the field of rapid assessment tools for urban areas.

What are the programme lines and what are they about?

- Prevention and settlement of damage and nuisance: Gaining knowledge about the emergence, prevention and settlement of subsidence damage to structures.
- Integrated urban assessment models: Developing and applying rapid assessment tools to assess how human activities and the urban environment interact with the physical deltaic system.
- Sustainable design and spatial planning in practice: Implementing innovative concepts in the field of urban design and spatial planning in case studies.

The programme started on January 1st 2013.

Deltares develops concepts and applies suitable solutions for sustainable urbanisation in delta areas.

What is the main goal of this programme?

- Deltares works in the Netherlands, Poland, Romania, Italy, Germany, Canada and Indonesia.
- Deltares generates solutions for delta cities by integrating knowledge of water and subsurface systems, urban design and governance.
- Deltares combines its own knowledge with knowledge from other parties.

Who does Deltares work with?

- TNO: integral assessment of urban environments.
- Utrecht University and University of Amsterdam: sustainable development and management of the shallow subsurface.

What are the programme leaders?

- Marco Hoogvliet (marco.hoogvliet@deltares.nl)

What issues from the public and private sector and scientific world will be addressed?

- How can obsolete, disused industrial areas (brownfields) and urban areas be redeveloped?
- How can subsidence damages in urban areas be prevented and dealt with?
- How can models rapidly assess how human activities influence the deltaic system and the urban fabric?
- How can concepts about sustainable urban design and spatial urban planning be put into practice?
- How is revenue for 2012 distributed among the funding sources and across the world?

<table>
<thead>
<tr>
<th>Funding sources</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x € 1.000)</td>
<td>(x € 1.000)</td>
</tr>
<tr>
<td>NL</td>
<td>Austr</td>
</tr>
<tr>
<td>€ 300</td>
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<td>$ 0</td>
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<td>total € 2.000</td>
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- Continuing urbanisation is increasing natural resource scarcity in deltas.
- Continuing urbanisation in deltas has profound impact on the environment, because more people live on increasingly vulnerable land.
- People are increasingly demanding integrated solutions for urbanisation issues in deltas.
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Which results does Deltares want to achieve in 2013?

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Rotterdam is vulnerable to both tidal and pluvial floods. Most of the city is protected by a network of primary flood defences, but like most other harbour cities, Rotterdam has highly developed urban areas outside the primary water defence system that are to a greater or lesser extent vulnerable to flooding. Which adaptive measures are promising in terms of implementation, financial feasibility, climate resilience and contribution to spatial quality?

Together with a range of partners, Deltares studied the flood risks in the unembanked areas Noordereiland and Feijenoord in Rotterdam. Deltares introduced its Adaptation Pathway method as a way to deal with the uncertainties in climate and urban development. The basis for the pathways is an assessment of the effectiveness of possible measures in the coming century, gained through a tipping point analysis. The method provides insight into the urgency to adapt to climate change and insight into the effectiveness over time of the possible measures. Additionally, the method visualises the link between long term policy approaches and possible measures.

marco.hoogvliet@deltares.nl