



# 2010

ANNUAL REVIEW

## Deltares

Enabling Delta Life





# **ANNUAL REVIEW 2010**



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# ENABLING DELTA LIFE

From Poland to Pakistan, the floods that made the headlines in 2010 left no room for doubt: living near a river or on the coast makes you vulnerable. The intensive use of space and natural resources is at odds with what is often a fragile natural environment.

Population growth, the drive for prosperity and climate change have further increased the pressure on space. Efforts towards sustainability are bringing solutions within reach. How to strike a balance between our lifestyle and the environment is one of the main challenges facing humanity in the 21st century. A challenge that provides a breeding ground for development and innovation, an opportunity to change direction, to gather and share new knowledge.

Living beside a river or on the coast raises many questions. How to supply large numbers of people with food and clean water? How to reconcile urbanisation and natural resilience? What is the best way to use space: should we build above or below ground? In this age of climate change, what exactly is a 'safe delta'? Deltares addresses such issues under the heading of 'Enabling Delta Life'.



# POLICY AND PLANNING

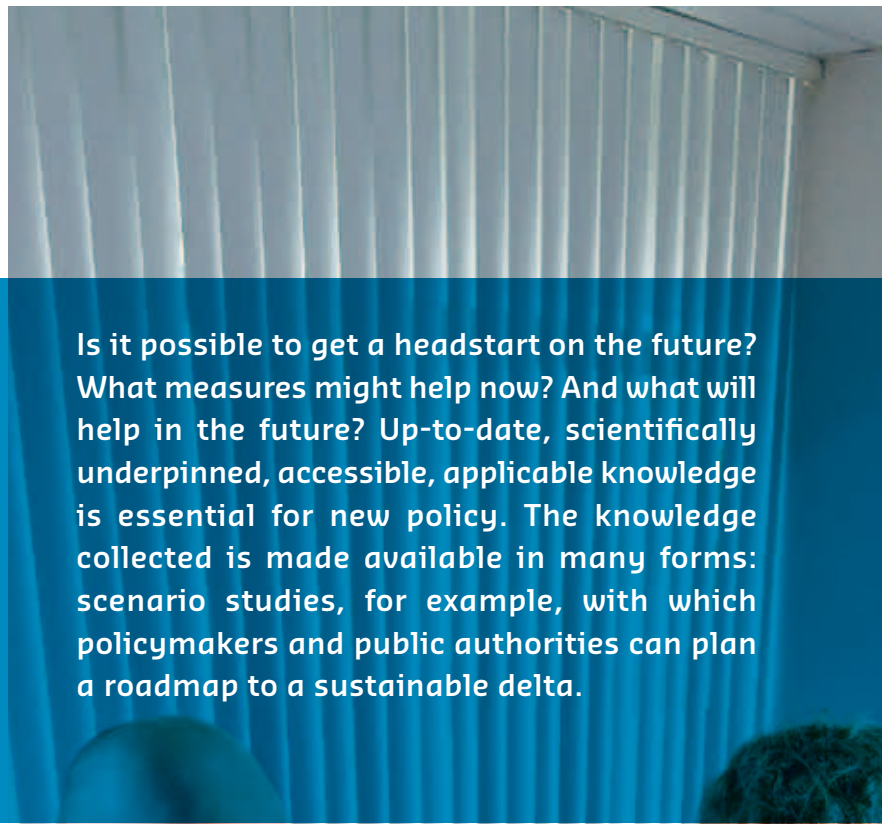




# How do we manage the **delta**?



- Healthy North Sea
- Ten deltas and four rivers
- Taming the torrents of spring in Azerbaijan
  - Flood risk profile
- Serious games are no child's play

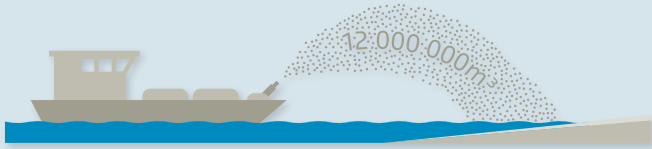


Is it possible to get a headstart on the future? What measures might help now? And what will help in the future? Up-to-date, scientifically underpinned, accessible, applicable knowledge is essential for new policy. The knowledge collected is made available in many forms: scenario studies, for example, with which policymakers and public authorities can plan a roadmap to a sustainable delta.

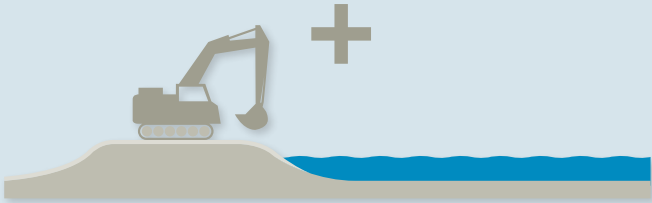




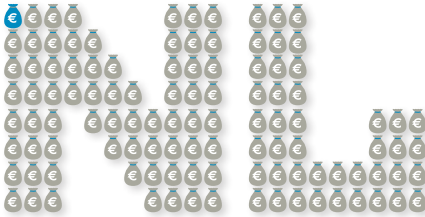
### DUTCH SPENDING ON FLOOD PROTECTION



Sand replenishment: € 45,000,000



Barrier management: € 550,000,000



Gross National Product (GNP): € 650,000,000,000

### NEED TO TACKLE DELTA ISSUES

	Nile	Incomati	Ganges-Brahmaputra-Meghna	Yangtze	Cilwung	Mekong	Rhine-Meuse	Danube	California Bay	Mississippi
	2	3	3	1	3	2	2	1	3	2
	1	2	3	1	3	2	2	1	3	2
	2	3	3	1	3	2	2	1	3	1
	2	3	3	1	3	2	2	1	3	1

The world's population will continue to grow for some time and is expected to reach nine billion by the end of this century. More than half of us will be crowded into urban areas along rivers and coasts. The pressure on already fragile deltas will increase. But just how much can they actually take? How do you maintain a balance between development and protection? Policymakers and water managers are constantly asking themselves these questions.

In 2008 the Dutch Delta Committee studied the implications of climate change for The Netherlands and explored how we might respond. Its report gave rise to a national Delta Programme. What do we need to do to protect ourselves and ensure an adequate supply of freshwater? Deltares is helping policymakers to understand the pros and cons of proposed measures and make sensible decisions. By developing knowledge and presenting it in a usable form. By using our current knowledge to look ahead at what may happen in the future. By combining our understanding of the physics of the delta with what we know about population trends, economics, communications, policymaking and innovation.

Deltares develops and seeks interesting alternatives and groundbreaking concepts. These include an innovative approach to hydraulic engineering and coastal defences in which engineer and nature work alongside each other as allies. Other examples are closed urban water cycles, multifunctional dikes and strategies for efficient and sustainable use of space, both under and above ground, for instance in combination with flexible, temporary infrastructure.

All this knowledge is used to produce strategic studies, policy analyses, integrated visions, scenarios and software. It becomes manifest in the application of sophisticated information systems and promising new technologies. Thus knowledge becomes a breeding ground for policy and planning.

The Marine Strategy Framework Directive – European legislation for a healthy marine environment – has been in force since 2008. It is up to governments to implement it. The Dutch government is introducing it gradually up to 2020.



The Marine Strategy Framework Directive is intended first and foremost to strike a balance between the natural value and human exploitation of the sea. Sustainable use and conservation of marine ecosystems should ensure that all European seas achieve 'good environmental status' by 2020. First, however, we have to establish their current status, what good environmental status actually entails, how to achieve it and how to measure and monitor it. Deltares and IMARES have explored these issues on behalf of the Dutch Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs, Agriculture and Innovation. IMARES specialises in the biological processes, while Deltares focuses more on the human exploitation aspect, as well as on translating the directive into national policy frameworks.

### ■ INFORMATION

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## Ten deltas and four rivers

**Housing, jobs, food ... the majority of the global population can be found where living conditions are most favourable. But the more people crowd together, the greater the pressure on the environment.**

How vulnerable are the world's deltas to flooding, overpopulation, climate change and malnutrition? Along with research institute Alterra, Deltares conducted a comparative study of ten delta regions. Thanks to input from local experts, the *Comparative Assessment of the Vulnerability and Resilience of 10 Deltas* provides an up-to-date overview of the world's most urgent delta issues. It considers the resilience of individual deltas and the need for knowledge. The study came about thanks to the Knowledge for Climate research programme and the international networking organisation Delta Alliance.

### ■ INFORMATION

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**WIM VAN DRIEL,**  
**DELTA ALLIANCE PROGRAMME MANAGER:**

“How fragile are deltas? All over the world, the problems are similar, but there are also many differences. To compare delta regions, we developed a framework incorporating demographic, economic, climatological, physical and other data. Then we ‘scored’ the ten deltas on land use, water consumption, infrastructure, resources and governance. Comparing the results reveals how we can help each other.”

### **AquaTerra**

The main product of the EU AquaTerra project is a scientific basis for responsible management of European river catchments – from subsurface to surface waters. Four European catchments – the Meuse, Elbe, Ebro and Danube – were screened, to establish the effects of pollutants on the system both locally and in a wider area, for example, or the impact of changes in climate or land use. Over the past five years, Deltares has helped develop knowledge and tools under the programme, to provide valuable new insights into the effects of how we deal with pollutants in river systems.

### ■ INFORMATION

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## Taming the torrents of spring in Azerbaijan

## Flood risk profile



**In May 2010, Azerbaijan was hit by flooding. The Araz and Kura rivers overtopped their banks, causing serious damage. Thousands of people had to be evacuated. The Azerbaijani government, with initial support from the ambassadors from Azerbaijan and The Netherlands, invited a team of Dutch experts to come and assess the situation. Michiel van der Ruyt from Deltares explains:**

“The floods were mainly due to large quantities of melt water flowing down from the Caucasus and Turkey. The rivers were unable to contain the peak discharges and dikes were breached and overflowing occurred in several places. At the invitation of the Ministry of Emergency Situations, a team from Deltares and Royal Haskoning joined the National Working Group and are working in close and strong cooperation with experts from Azerbaijan. After conducting hydrological and geotechnical research accompanied by dike inspections, the Group recommended a range of short-term measures. These included reservoir operation rules, the construction of a diversion channel to control the Araz, the creation of a water level monitoring network, leading on to the improvement of flood prediction capabilities through the introduction of monitoring and data management. Eventually, the hydrology of the entire catchment area will be studied, including the influence of cross-border snow and rainfall. To improve the dike system, we have proposed a set of measures ranging from dike realignment and strengthening to (in the long term) riverbed dredging. Looking to the longer term, we are also studying the institutional organisation of water management. But right now we’re just hoping that the spring torrents of 2011 will be less tempestuous than last year’s.”

### ■ INFORMATION

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**Climate change and changes in land use and population numbers partly determine the location and level of flood risk. Integrating modelling systems and information gives us a more precise global flood risk profile.**

Since 2010, the Netherlands Environmental Assessment Agency (PBL), Utrecht University and Deltares have been working together to develop global scenarios for flood risks, at the request of the Netherlands’ Directorate-General for International Cooperation. As part of the effort, Deltares is working on the integration of two simulation frameworks through the DELFT-FEWS model shell. One is PBL’s Integrated Model to Assess the Global Environment (IMAGE), which simulates the effects of human activity on the environment worldwide. The other is the large-scale hydrological model developed by Utrecht University (PCR-GLOBWB). The integration of the two frameworks will make it possible to assess and predict changes in exposure to floods as well as changes in the impact of floods worldwide.

### ■ INFORMATION

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## Serious games are no child's play

Imagine yourself sitting round a TouchTable with a number of professionals. On the table you see a building site, where subsidence has been worse than expected. Each of you, from contractor to local councillor, has their own role to play. How do you solve the problem, and ensure good communication?

Just like real life. That is the beauty of sophisticated computer-supported games. They are used for training and communication, to make abstract situations understandable and to transfer knowledge. At Deltares, a special team is developing games addressing a range of issues. Like the National Flood Committee game released in 2010. The players are water managers in a flood situation, who have to resolve issues by negotiating with the mayor and other partners in the flood protection system. Serious games are the perfect way to learn crisis management.

### ■ INFORMATION

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### Sustainable Delta

Marjolijn Haasnoot, water management and environmental modelling consultant, is involved in a project exploring different versions of the future to support strategic water management. "A game has been developed for this project, Sustainable Delta, to help both players and researchers understand how to set out a sustainable water management policy. It's a combination of a board game and a computer model. Two teams of 'water managers' are confronted with realistic problems, like reduced navigability as a result of climate change. Each team proposes policies, which they have to negotiate

to arrive at socially sustainable policies. The computer model calculates and visualises the short-term implications, providing input for policy adjustments. After three or four rounds the game takes you a little further into the future, and there's enough material for an interesting evaluation. From several gaming sessions with SustainableDelta we learnt that people tend to respond to short-term problems, despite their intention to anticipate long-term processes."

### ■ INFORMATION

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MARJOLIJN HAASNOOT

"We learnt that people tend to respond to short-term problems."

# FLOOD RISK MANAGEMENT



# How do we manage **excess water?**



- Flood risk mapping
- Green Adaptation: the benefits of nature
- Prepared for the worst
- Delta issues in Southeast Asia

Protection against flooding cannot be taken for granted. It is a matter of keeping your finger on the pulse. Knowing what to expect. Studying how others deal with excess water. Learning from and building with nature. It is a matter of being there when it matters. Of seeing the big picture, but never losing sight of the detail.





**NUMBER OF NATURAL DISASTERS  
WORLDWIDE (1991-2005)**



750



450



1,300

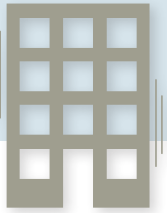


2,000

**NUMBER OF VICTIMS (1991-2005)**



65,000



420,000



220,000

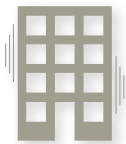


135,000

**COST IN USD BILLIONS (1991-2005)**



110



270



400



370



Drought (incl. heatwave and fires)



Storms



Earthquake and tsunami



Flooding and landslides

**RATIO OF FLOODING TO ECONOMIC LOSS**



in 1960



in 2000



## FLOOD RISK MANAGEMENT

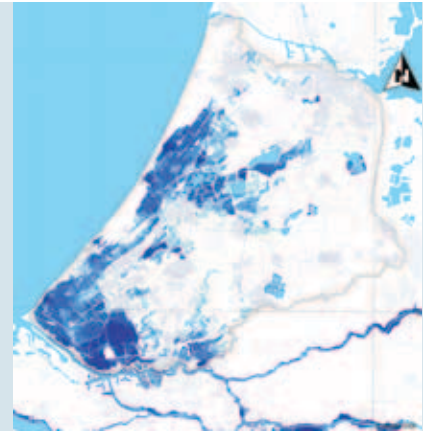
Azerbaijan, Albania, Brazil, France, Pakistan, Poland, Vietnam ... as in previous years, in 2010 the big stories were about flooding. From wet feet to full-blown disasters, all over the world floods brought the facts home: people who live near water have to work hard to protect themselves. Harder than ever, in fact, given the large number of people affected, the high costs of damage and the implications of a changing climate.

Holding back water is one thing, controlling it is quite another. In The Netherlands we have experience in both. But we stay alert. Safety can never be taken for granted. Flood prevention continues to receive our full attention and the country is working hard to strengthen its dikes. More space is being created to accommodate temporary peaks in river levels and rainfall. Measures devised at the end of the last century.

This century, we need to do more. We also need to look at how we use land and manage risks and disasters. In this regard, we can learn from the practical experience of other countries. Deltares is a partner in The Netherlands-US Water Crisis Research Network (NUWCRen), a collaboration between Dutch and American universities set up to learn from practical experiences of flood control and crisis situations.

Flood protection research is not about going over old ground. Deciding what measures are needed to protect us in the 21st century is a brand new challenge. One that will require both ingenuity and the flexibility to adapt. Today's world is not the same as tomorrow's and we need innovative knowledge to be able to plan for a safe future.

## Flood risk mapping



Expected water depths in Central Holland for floods with a probability of 1:10,000 per year

**Deltares is involved in flood risk management all over the world, from long-term strategies for river basins to emergency forecasting of tsunami risks.**

Deltares develops scenarios and produces flood risk maps to help various users – water management agencies, planners and crisis managers – form a picture of the likelihood of flooding and the possible consequences. Its flood hazard and flood risk maps help the Dutch government understand flood risks in the Netherlands. What areas are at risk? How fast does the water flow and how deep will it get? Under the EU Flood Directive, every member state must have this information available from 2013. Deltares contributes knowledge to ensure that the risk of flooding is understood and appropriate measures are taken.

### ■ INFORMATION

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## Green Adaptation: the benefits of nature



Increasingly, nature is seen as an ally in delta management. Helena Hulsman, marine ecology consultant, believes 'Green Adaptation' is the future.

"There are many benefits to using ecosystem services in water management and climate adaptation – for safety, ecology and the economy", she says. "Deltares has been investigating the possibilities for years. Green Adaptation involves almost all our disciplines: from ecology to water management, from spatial planning to freshwater supply."

### Buffer

"Green Adaptation covers a whole world of ideas, methods and technologies", explains Hulsman. "From the restoration of mangrove forests to protect the coast of Suriname, to the testing of artificial oyster reefs to stabilise sandbanks in the Eastern Scheldt estuary. I'm involved in creating a green dike to absorb wave energy in the Noordwaard polder, which will be allowed to flood sometimes, as

part of the project Room for the Rivers. The dike will be next to an inhabited fort, but a stand of willows in front will absorb wave energy, so the dike can be a metre lower. The green dike has been designed to blend into the landscape. Safe, cost-efficient, natural and attractive."

### International

"In 2010 a colleague and I identified Dutch 'best practices' and decided which concepts were applicable internationally", she says. "We are now doing the same for developing countries, in collaboration with Conservation International. Green Adaptation is a form of sustainable development that can combine safety with food and freshwater supply. There are lots of benefits to be gained from clever use of natural functions."

### ■ INFORMATION

[www.ecoshape.nl](http://www.ecoshape.nl)

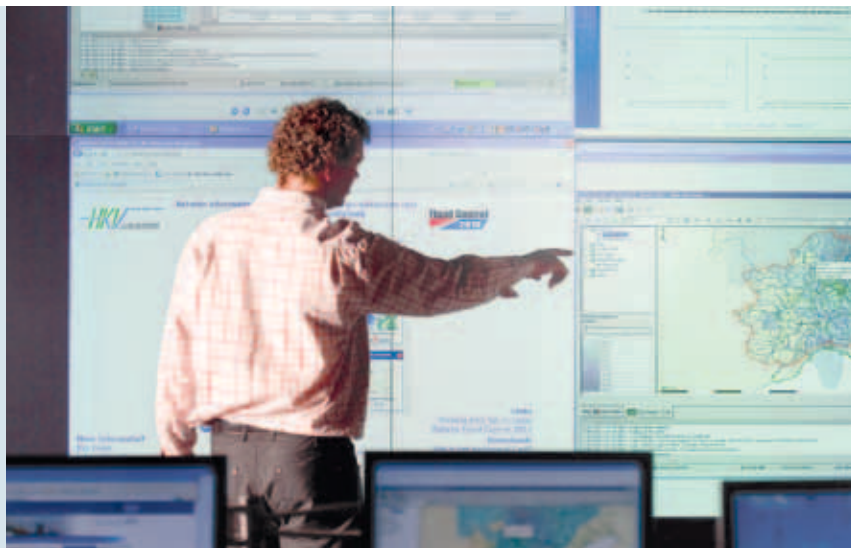
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HELENA HULSMAN

"A stand of willows in front means the dike can be a metre lower."

## Prepared for the worst



### Preventing flooding and coping with the risk of flooding are two different skills. Comprehensive flood risk management has to comprise both.

A balanced flood risk management policy focuses on keeping the water out, and on what to do if that proves impossible. In that case, you need to know the risks and be prepared for a crisis. Monitoring, forecasting, warnings and other forms

of information provision are just as important as clear arrangements between stakeholders, decisive action by the authorities and communication with local residents. Administrators and the public need to understand and trust

each other when the water is lapping at their feet. And this requires well-founded decisions and timely action.

### Forecasts

Deltares considers all aspects of flood protection. It combines expertise in flood protection with expertise in how to manage flooding once it occurs. An adequate supply of information is vital in flood risk management. Deltares helps clients all over the world forecast drainage capacity and water levels in rivers and along coastlines and lakes to make the threat of flooding clear. The Delft-FEWS system forms the basis of this service. Its user community continues to grow, and new applications are continually being added. In 2010 the US National Weather Service started using their new forecasting system based on Delft-FEWS.

### ■ INFORMATION

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### Going further with Delft-FEWS

Over the years Delft-FEWS has been used in more and more regions, to tackle more and more issues. In the past year Deltares has supported several users, including:

- the Southern African Development Community, providing advice on the feasibility of a flood forecasting system for the Zambezi river;
- the UK Environment Agency, with a forecasting model for wave heights and wave overtopping along the Welsh coast;
- the Australian Bureau of Meteorology, helping it understand the uncertainties of forecasting;
- the Netherlands' Directorate-General for Public Works and Water Management (Rijkswaterstaat), in harmonising its different operational systems for water level forecasting.

## Delta issues in Southeast Asia

**Deltares is active on various fronts in Southeast Asia: from Bangladesh, in a project to upgrade the flood forecasting system, to Jakarta, where a strategy was prepared to protect the 'sinking' megacity from flooding. Rinus Vis, specialist in sustainable use of water and soil, sums up.**

### What's the issue?

"In short, we're facing the consequences of climate change coupled with economic and population growth. The sea level is rising and extreme rainfall is causing rivers to flood. The greater the population and the prosperity, the greater the damage if something goes wrong. In a large coastal city like Jakarta, the ground is also subsiding rapidly due to excessive pumping of groundwater, so the city is sitting in a kind of bath tub. Without facilities to store, drain or block excess water, large parts of the city will flood more and more frequently."

### What did you do last year?

"I'll give you two examples. We worked with the International Centre for Water Hazard and Risk Management (ICHARM), a Japan-based organisation affiliated to UNESCO. Together with this centre of excellence and several local organisations, we are conducting trial projects in three countries. In the Mekong delta in Cambodia we are targeting flood risk management at village level, a forecasting system based on remote sensing is being implemented in the Solo catchment in Indonesia and we are advising Bangladesh on an upgrade of its

flood forecasting system. One key aim of the project is to transfer knowledge to ICHARM. A second example is the Jakarta Coastal Defense project: a study for the Indonesian Ministry of Planning. In close cooperation with local stakeholders, a consortium of Deltares and several Dutch consultancies has prepared a strategy to protect Jakarta from flooding. The strategy deals with flooding from the sea as well as from the rivers, and flooding due to excessive rainfall."

### ■ INFORMATION

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**RINUS VIS**

"The greater the prosperity, the greater the damage when something goes wrong."

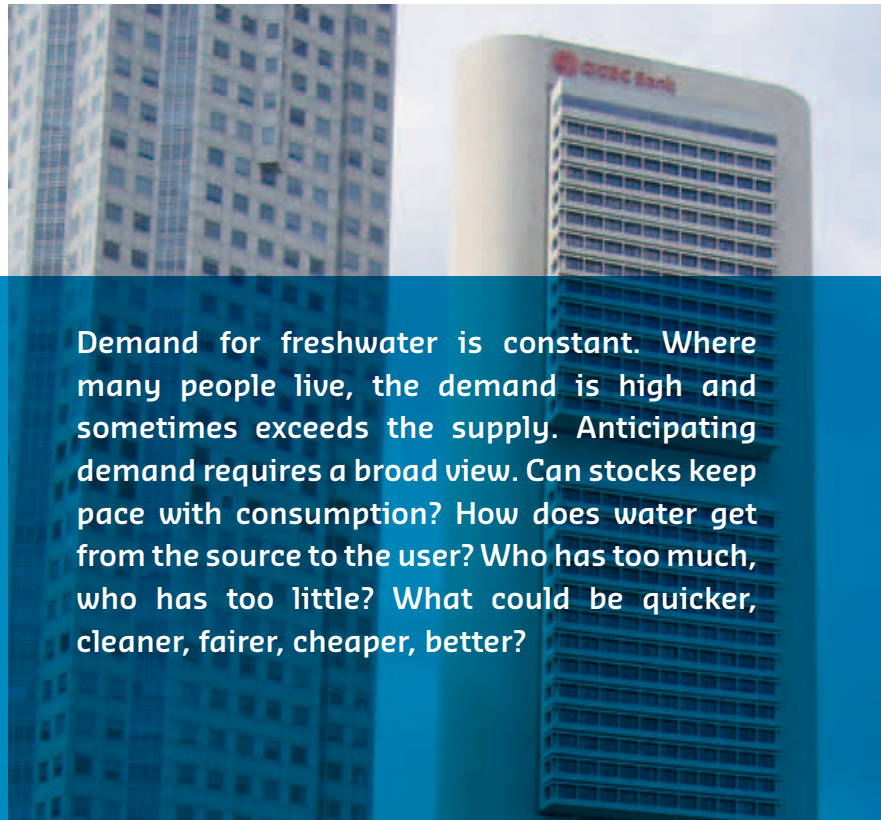




# How do we manage **water shortages**?



- Adaptation, but how?
- India: sustainable groundwater management starts locally
- Water quality issues in Singapore
- Where groundwater and surface water interact

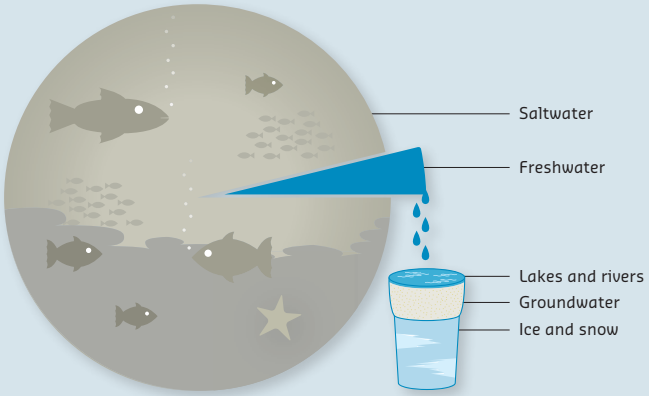


Demand for freshwater is constant. Where many people live, the demand is high and sometimes exceeds the supply. Anticipating demand requires a broad view. Can stocks keep pace with consumption? How does water get from the source to the user? Who has too much, who has too little? What could be quicker, cleaner, fairer, cheaper, better?

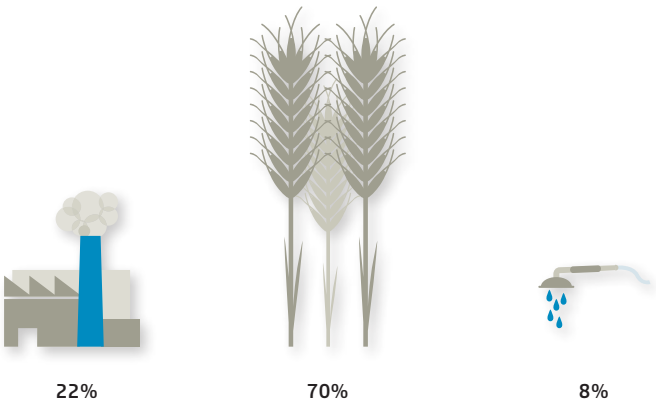




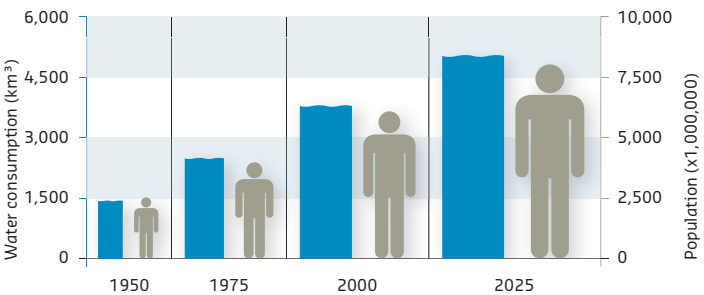
**GLOBAL DISTRIBUTION OF WATER**



**GLOBAL FRESHWATER CONSUMPTION**



**POPULATION GROWTH AND FRESHWATER CONSUMPTION**



Too much or too little? Polluted or clean enough? Freshwater is a matter of both quality and quantity. Where can we obtain water? How do we share it so that all users are satisfied? How do we ensure that natural habitats are not deprived and that ecosystems remain healthy?

Careful water resources management takes account of the interaction between surface water, groundwater and soil systems. It encompasses the entire route from source to user. It looks to the past and the future. How can we prevent stocks becoming exhausted and preserve the natural, social and economic balance? What will happen in fifty years' time if there is less rain, or more people rely on the same supply?

Deltares determines how much water is available, explores possibilities for regulating the supply and establishes what impact this will have on users and the natural environment. It does so, using sophisticated information systems for water quality and quantity management. Deltares converts knowledge into comprehensive strategies and provides specialist advice on water stocks, efficient use and remediation.

What are the options? Water resources management studies are multidisciplinary and require a structured approach. Deltares therefore uses a Framework of Analysis and Planning to guarantee an integrated and sustainable approach. Stakeholders are involved as a matter of course. The result is a well-founded, well-supported and workable strategy.

Like many delta areas, Bangladesh is vulnerable to the consequences of climate change, which include increasing drainage problems and salinity intrusion. The water infrastructure therefore needs to be adapted and managed appropriately. But which designs and strategies are most likely to be climate-proof?

To determine how best to invest in the improvement of drinking water supply systems and urban drainage systems in Khulna, Bangladesh, the Asian Development Bank completed a study in 2010 to assess the impacts of climate change on urban infrastructure and identify adaptation options. The core of this assessment was an analysis of climate and socioeconomic scenarios for Khulna in 2030 and 2050. This was performed by a Dutch-Bangladeshi project team, including consultants from Deltares who contributed water management and mathematical modelling expertise.



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## India: sustainable groundwater management starts locally



MARIJN KUIJPER

“Collaboration with local partners is a key objective.”

**Demand for freshwater for drinking and irrigation is huge in India, but supply is scarce. Wells can bring quick relief, but sustainable water management requires more. Knowledge of the groundwater system, for example, and water quality monitoring. Deltares is involved in groundwater projects in two states.**

### Toolkit for Orissa

Along with local NGOs, Deltares is teaching people in Orissa how to perform simple tests and interpret data. “The toolkit we have developed with NGO Gram Vikas allows villagers, after training, to check the water quality with regard to salts, bacteria and nitrate levels”, says Marijn Kuijper. “And to take measures if necessary. Experience in India has taught us that, in many villages, drinking water quality has never been tested. We visited several local NGOs and government bodies that are working to improve drinking water and sanitation. Time and again we see that the two are dealt with separately, even though leaking sewers and cesspits

are major drinking water polluters. E-coli, nitrates and pesticides from farmland and sanitation systems are the biggest threat to future drinking water supply in India.”

### Groundwater model for Gujarat

In Gujarat, with its extremely dry coastal zone, Deltares worked with NGO Ambuja Cements Foundation to develop a groundwater model. Irrigation and drinking water in this region largely comes from groundwater. Salinisation as a result of groundwater abstraction is a major problem, which is predicted to grow. The model allows anti-salinisation strategies to be analysed. In the absence of conventional data, indirect data can

be used in the model: what crops grow where, for example, and how much water they need.

Kuijper emphasises that collaboration with local partners and making knowledge applicable are important objectives for Deltares. “At the scientific and administrative level, and especially at local level – in villages, in the countryside. We seem to be succeeding, as evidenced by a remark made by the director of Gram Vikas, who said, ‘You demystify groundwater knowledge for us’”.

### ■ INFORMATION

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## Water quality issues in Singapore



To safeguard their drinking water supply and improve quality of life in the city, the Singaporean authorities have converted the estuaries of Punggol and Serangoon into freshwater reservoirs, and have additionally joined them with a canal. The Public Utilities Board (PUB), Singapore's national water agency, requested advice from Deltares on their water quality management planning and execution. The two organizations are working closely together through the Singapore-Delft Water Alliance (SDWA), which brings together scientists and engineers from The Netherlands and South-East Asia.

*Johannes Smits, expert advisor:*

"Deltares has helped model the water system to produce scenario studies, a water quality plan and an operational management system. We also have trained staff of the PUB to use the various tools. Several Deltares computer models form the backbone of a range of water quantity and quality models containing information on the impact of pollutants from urban sources and precipitation. Simulating various situations allows you to devise effective management measures such as looking into the effects of reducing emissions from sources of pollutants versus

employing artificial aeration to reduce eutrophication. One question Deltares is looking into is: how effective is it to flush the water in the reservoir occasionally at reducing eutrophication? In short, we explore what will work, in both the long and the short term."

"The water system has to supply raw drinking water, it is used in urban development, and it has a definite recreational and aesthetic function. The formation of toxic algae needs to be curbed, and we help devise measures for this. We are also working on a modelling application to warn bathers

and water sport enthusiasts for toxic algae. In short, Deltares is helping the PUB with scenarios and forecasting, and operational management, for a clean and attractive reservoir."

### ■ INFORMATION

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**JOHANNES SMITS**

"Through simulations and scenario studies we can develop effective management measures."

## Where groundwater and surface water **interact**

**How does human intervention affect groundwater drainage? What impact does this have on surface water quantities? What does this imply for water quality? Deltares studies the relationship between surface water and groundwater. Three practical examples from 2010.**

### **Dutch-Belgian borderlands**

The zinc smelting industry has left its mark in the soil of the Dutch-Belgian Campine region. The groundwater contains heavy metals like zinc and cadmium. But to what extent and how fast are these substances spreading through the soil and are they ending up in surface waters? To find out, Deltares – as part of a cross-border team – developed a 3D transboundary model. The model simultaneously simulates substance transport and the drainage of pollutants to the surface water network, giving a comprehensive picture of current and expected pollution. This instrument also helps to establish the future status of relevant water bodies, as required by the European Water Framework Directive.



#### **■ INFORMATION**

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### **Lake Naivasha**

This important freshwater lake in Kenya is drying up, along with the surrounding area, due partly to the reduced inflow of groundwater to the lake. The groundwater is being abstracted in the area by horticulture/floriculture farms. But how do surface water and groundwater interact? Deltares and the University of Twente (ITC) are mapping the situation in collaboration with the WWF, Kenya's water authority, and European flower growers based in the area and therefore dependent on its water resources. Deltares' advice is to further develop the current knowledge and models with respect to surface water and groundwater interaction, including a model that will clarify this interaction.



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### **Puridrain**

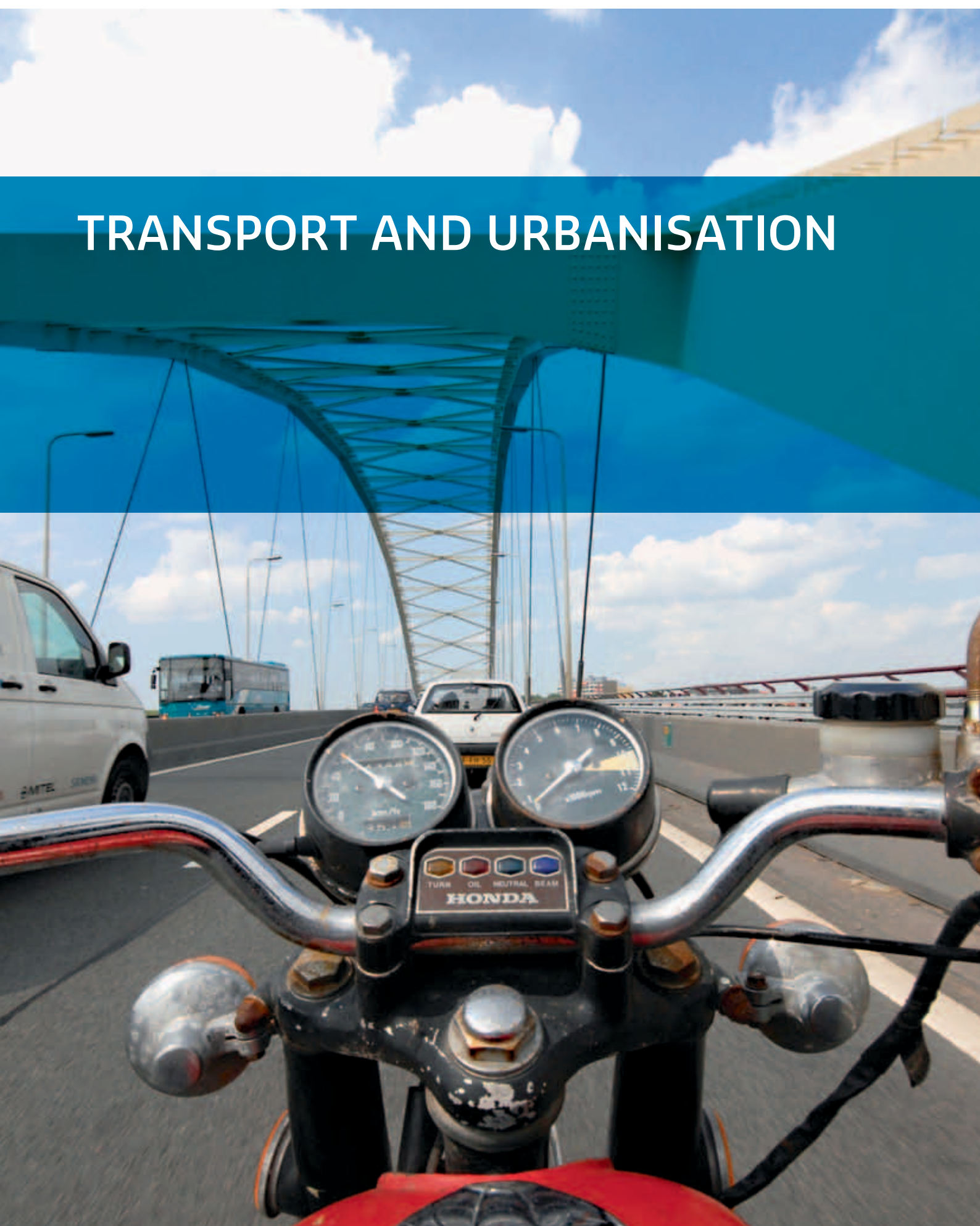
Despite major efforts to improve water quality, Dutch surface waters still contain more nutrients (nitrate and phosphate) than they should. One important source is drainage water from agriculture. In collaboration with other research institutes, Deltares has been investigating innovative ways of purifying drainage water. Initial results show that simple materials like wood chips can be used effectively for this purpose.



#### **■ INFORMATION**

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# TRANSPORT AND URBANISATION





# How do we manage the pressures of population growth?



- Ship Ahoy!
- Forensic geo-engineering
- Cities benefit from closed water cycles
- Energy from beneath
- Hydraulics meets geotechnics

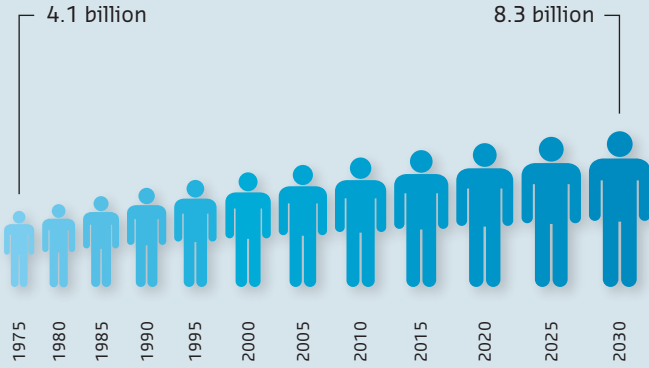


Large numbers of people live, work, eat and move around within relatively small areas. More and more people are living in an urban setting. Space is limited and is therefore under pressure. Clever building and ways of living can reduce that pressure. Urban space can be used more flexibly. Functions can be combined more effectively. Progressive urbanisation needs good ideas and specialist knowledge.

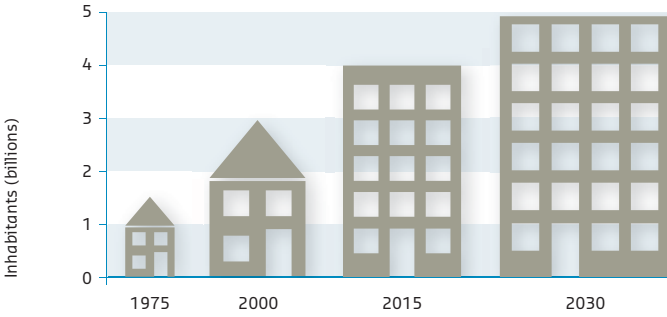




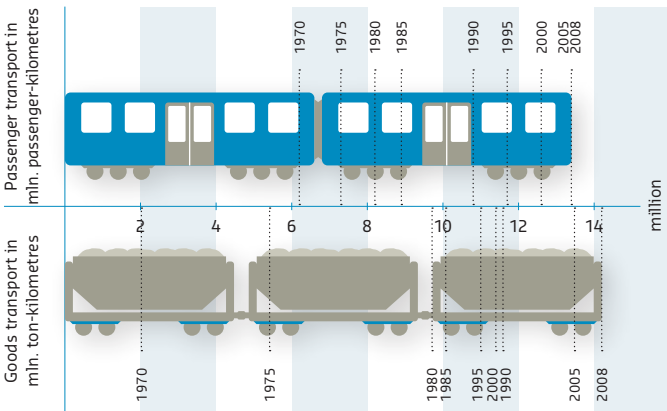
**GLOBAL POPULATION**



**GLOBAL POPULATION LIVING IN CITIES**



**TRANSPORT, OECD COUNTRIES**



The global population continues to grow and cities continue to attract new residents. Urban life just gets busier and we all feel the effects. Two major challenges for urban developers are how to make the best use of the space available, and how to use the resources at hand to reduce the pressure on cities. One way is to regard water, soil, subsurface, space and buildings as a single whole, to create closed cycles and to combine functions. Deltares researches urban water and subsurface management, materials and resources, and the multifunctional use of space, to help create the innovations we need.

There is plenty of space available below ground for many purposes, from parking to sustainable underground thermal energy storage. Underground spaces like car parks can also be used to temporarily store excess water. But urban water is not only a potential problem, it is also a resource for small-scale urban agriculture, a valuable feature of the urban landscape. And water can cool heat-stressed cities.

Urbanisation means more people, more buildings, more infrastructure. More roads, railways, ports, bridges, tunnels and pipelines to transport substances, goods and people. Creating urban infrastructure often comes down to the individual square metre, amidst all the existing buildings. It is not possible without geotechnical expertise and good risk management. Deltares has this expertise, as well as tools for risk and process management. Whether it's planning, consultancy or forensic engineering that is needed, Deltares helps guarantee sound, progressive urbanisation.

### Name?

JIP HAWAI/HAWAII: Joint Industry Project for Shallow Water Initiative.

### Why a JIP?

Complex research takes time and money. Research and industrial organisations collaborate to share the costs and benefits.

### What's the problem?

When LNG carriers (ships used to transport Liquefied Natural Gas) are moored in shallow waters, low-frequency waves can cause excessive vessel motion.

### Research

Wave conditions in shallow water are complex. Combining hydrodynamic and coastal engineering expertise in JIP HAWAI (2005) improved our understanding of the interaction between waves, vessels and terminals. Follow-up JIP HAWAII (2009) is seeking to establish practical methods for the design of terminals in shallow and intermediate water depths of 15 to 40 metres.

### Initiators

Deltares, Maritime Research Institute Netherlands (MARIN), Bureau Veritas and SHELL.



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## Forensic geo-engineering



**MANDY KORFF**

“The aim is to learn from mistakes.”

**An access ramp to a tunnel lifts up spontaneously. Excavations on a building site flood. Homes subside due to construction work, or foundation pile rot. The behaviour of the subsurface can be unpredictable, particularly in urban areas where buildings and infrastructure are in close proximity. Predictive models can help forecast and reduce risks. And if something does go wrong, Deltares can investigate and recommend measures.**

“We seek out the causes of accidents and incidents”, says Mandy Korff of Deltares. “This is the essence of ‘forensic geo-engineering’. The approach has to be methodical and careful, as there are always many interests at stake. Deltares is regularly called in as an independent expert, by property developers involved in construction, by the courts, or by the construction industry’s arbitration council. The main aim is to learn from mistakes and prevent repetition, by adapting building methods and organisation in such a way that the problem cannot arise again.”

In November 2010 the Dutch Ministry of Infrastructure and the Environment commissioned her colleague Joris van Ruijven to investigate why the access ramp on the eastern carriageway of the Vlaketunnel, in the province of Zeeland, suddenly lifted up, causing damage to vehicles and the road surface, and leading to closure of the tunnel. “We were immediately called to the scene to perform a quickscan and assess whether the situation was safe”, he says. “Then we began our detailed systematic investigation into possible causes, as well as considering an appropriate way to repair

the road. We also assessed the effects of the major pumping operation that would be needed. Everything is connected in a project like that, and we had to account for the surrounding area too.”

“In emergencies you are happy to have input from an expert”, says Jacob van Vliet, project manager at the ministry. “Not only to identify the cause, but also to suggest and work out solutions. Thanks to this, we were soon able to reopen the tunnel – a vital connection for the entire province of Zeeland.”

### ■ INFORMATION

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## Cities benefit from closed water cycles



**A city is a parasite, living off the surrounding area, taking its water, energy and food from it and dumping its waste there. Deltares helps cities move away from this process, by learning how to close the urban water cycle and by regarding it as an opportunity to save energy.**

In 2010 Deltares performed several exploratory studies with titles like Flows to a Closed City and a study into the cooling effects of urban surface water. The focus of urban water management is slowly shifting from better control to better use of water, and to closing cycles. We can learn a lot from other countries. Take Australia, for example, where residents in water-sensitive cities have a huge rainwater collection tank for flushing the toilet and watering the garden.

### Sustainable use

Cities must learn to make the best possible use of their own resources. By collecting rainwater, and also relatively clean drainage water, for example, and using it for low-grade applications like irrigation, firefighting and flushing the toilet. And by using the energy and nutrients in water more effectively. These ideas are opening up new perspectives in the Netherlands, too. Prospects of more sustainable water consumption, for example, and clean energy supply.

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### Dutch Dialogues

Deltares puts new knowledge on how to close urban water and energy cycles to good use in other countries. In New Orleans, for example, it took part in Dutch Dialogues: a design workshop for more sustainable urban water systems.

## Energy from beneath

**How to reduce CO<sub>2</sub> emissions? Underground thermal energy storage is a promising technique that uses the subsurface to supply renewable energy.**

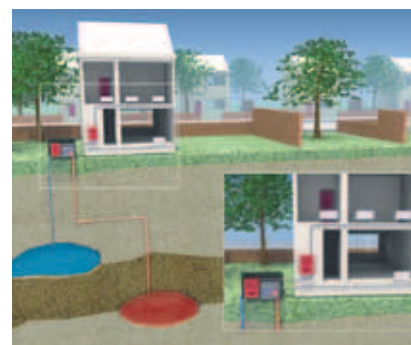
In the summer groundwater is pumped up to cool the building. Having absorbed the excess heat the water is returned to the ground to heat the building in winter. In 2010 Deltares and several partners completed a national research programme on the effects of underground thermal energy storage: an example of advanced research into sustainable soil and land management.

Another is the EU research project Holistic Management of Brownfield Regeneration (HOMBRE). As coordinator, Deltares leads studies on promising methods like thermal energy storage combined with soil remediation, use of wastewater and industrial process water for heating and cooling and the use of industrial heat surplus in offices and homes.

### ■ INFORMATION

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[hans.vanduijne@deltares.nl](mailto:hans.vanduijne@deltares.nl) (HOMBRE)



## Hydraulics meets geotechnics

On behalf of engineering consultancy JP Kenny, Deltares has defined the optimum design for a rock fill berm to protect an underwater pipeline from currents, waves, anchors and their chains. Hydraulics meets geotechnics.



*Tim Raaijmakers, hydraulics specialist:*  
 “We used scale models of the berm to study the effects of currents and waves, subjecting different designs in our Atlantic Basin to currents and waves that occur only once every 200 years. We built the scale models using the client’s design. The test conditions were based on

information on wave conditions, current speeds and seabed properties in Australia. Underwater cameras and 3D photographs recorded what happened during a storm, and the 3D reconstructions from before and after the test were compared to reveal distortions, and identify the most stable structure.”



*Dirk Luger, geotechnics specialist:*

“To find out what happens when an anchor and chain are dragged over the berm and ultimately the anchor’s flukes penetrate the rock fill, we tested the scale model, with anchor and chain, in our GeoCentrifuge, a testing facility that artificially increases gravity. This allowed us to simulate on a small scale what happens in the real world. The results of the hydrodynamic and geotechnical tests were combined in a comprehensive report recommending an optimum design for the berm, including variations – in terms of the quantity, size and shape of the stones – for different pipeline trench depths. This combination of hydraulics and geotechnics is something we do every day at Deltares, and forms the basis of studies on other structures like drilling rigs, wind turbines and dikes.”

### ■ INFORMATION

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**TIM RAAIJMAKERS AND DIRK LUGER**

**DIRK LUGER:**

“The testing facilities let us simulate in miniature what happens in the real world.”

# DELTARES IN FIGURES





# DARE TO SHARE



Deltares board of directors, from left to right: Erik Janse, Harry Baayen, Ron Thiemann and Huib de Vriend.



In 2010, Deltares moved further down the road leading to the ultimate objective: a position in the international top flight in our field. We have boosted our international position in close collaboration with the corporate sector, research institutes and the government.

For example, we were successful in 2010 in the European Framework Programme for Research and Development (FP7). At Deltares, everything is about developing and applying knowledge in the area of water, the subsurface and infrastructure. Fortunately, more and more clients from home and abroad – both government authorities and companies – are finding their way to our door. Deltares staff worked in more than eighty countries in 2010. Sometimes on large projects, sometimes on small ones, but the common denominator has always been a knowledge-intensive question. High-quality knowledge is at the heart of what Deltares does. And the knowledge position audit has shown that we have that knowledge. For the first time, an international committee made an appraisal of the standard of Deltares knowledge. We were happy with the committee's positive rating and we are taking their recommendations to heart. Deltares does more than develop and apply knowledge; we are also committed to disseminating and sharing that knowledge. Simply because this accelerates

the development of knowledge. That is why we are always engaged in a global search for interesting knowledge partners with whom we can collaborate, either structurally or on specific projects. And so we also share knowledge by making our software available to others. Our software products are used throughout the world and their quality is internationally accepted. Some of the Deltares software products – of the total of about 150 – are 'open source'. This means that the computation cores or the source codes for those software packages have been made public. The contributions and ideas of experts and other research institutes initiate and accelerate new developments. This enhances the Deltares international knowledge position but, more importantly still, it enhances the worldwide knowledge base in the area of water, the subsurface and infrastructure. So everybody benefits. Even at this stage, our conclusion is that 'open source' works. So we will be continuing down that road. Deltares dares to share. We are happy to share with you. Now and in the future.

## BALANCE SHEET AS AT 31 DECEMBER 2010 (after appropriation of results)

	31 december 2010 € (x 1,000)	31 december 2009 € (x 1,000)
<b>ASSETS</b>		
<b>Fixed assets</b>		
Tangible fixed assets	36,707	32,970
Financial fixed assets	197	102
<b>Current assets</b>		
Stocks	94	5,531
Accounts receivable	20,667	19,352
Shares	111	1,081
Cash and cash equivalents	17,692	5,539
<b>Total assets</b>	<b>75,468</b>	<b>64,575</b>
<b>PASSIVA</b>		
<b>Equity</b>		
Capital deposited and withdrawn	38,069	35,982
<b>Provisions</b>	<b>3,031</b>	<b>2,375</b>
<b>Long-term liabilities</b>	<b>8,936</b>	<b>0</b>
<b>Current liabilities</b>	<b>25,432</b>	<b>26,218</b>
<b>Total liabilities</b>	<b>75,468</b>	<b>64,575</b>

## INCOME AND EXPENDITURE ACCOUNT 2010

	€ (x 1,000)	€ (x 1,000)
Nett turnover	112,952	110,309
Outsourcing	25,927	21,059
Total operating costs	85,054	89,218
Financial income and expenses	26	447
Results of holdings	90	10

**SHARE OF TURNOVER 2010 (IN%)**



Deltares ended the 2010 financial year with a positive net result of € 2,087,000, which has been added to its assets. Net turnover rose by 2.4%. Thanks in part to an increase in the subcontracting of work, the gross margin fell by 2.5%. The operating result rose from € 32,000 in 2009 to € 1,971,000 in 2010.

Domestic turnover in 2010 was 83.7%, overseas turnover was 16.3%. At the end of the year, Deltares employed 864 staff.

**ALLOCATION OF TURNOVER 2010 BY REGION (IN %)**



In 2010, Deltares worked in 84 countries. The largest proportion of our international turnover came from Belgium (€ 2.9 million, mainly the European Commission), the United States (€ 2.4 million), the United Kingdom (€ 2.2 million), Singapore (€ 1.4 million), Azerbaijan (€ 1.3 million) and Mongolia (€ 1 million). Turnover in The Netherlands was € 95.4 million.

# DELTARES STAFF

## STAFF AS AT 1 JANUARY 2010

Number of staff

873

Number of FTEs

806

## STAFF AS AT 31 DECEMBER 2010

Number of staff

864

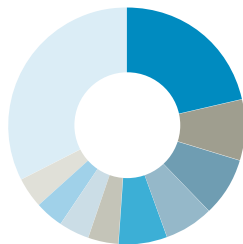
Number of FTEs

800

An FTE, or full-time equivalent, reflects a proportion of a full-time position. One FTE represents the working hours of a full-time member of staff.

## NATIONALITIES

Staff with a foreign or second nationality.



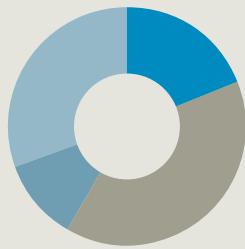
Germany	16
Great Britain	6
Italy	6
United States	5
France	5
Australia	3
Egypt	3
Portugal	3
Spain	3
Other <sup>1</sup>	24
<b>Total</b>	<b>74</b>

The Deltares staff comprises 28 different nationalities. In addition, 57 of in total 104 trainees who worked at Deltares in 2010 were from abroad.

<sup>1</sup> Other nationalities: Albania, China, Colombia, Ireland, India, Indonesia, Iraq, Iran, Malta, Mexico, Morocco, Nepal, Nicaragua, New Zealand, Ukraine, Poland, Thailand, Czech Republic, South Africa.

# DELTARES STAFF

## STAFF EDUCATION LEVEL (in %)



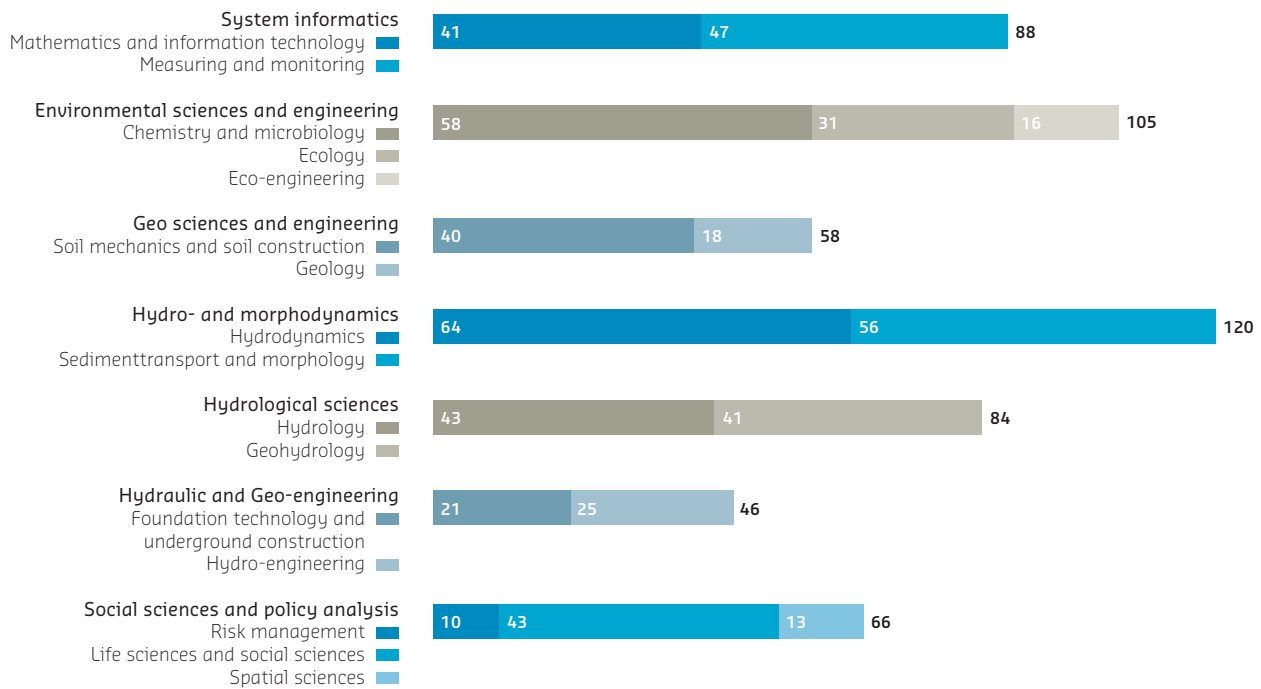
19.1% Doctoral degree (PhD)  
 39.5% Academic degree  
 11.0% Professional degree  
 30.4% Other

## PHD CANDIDATES

Six PhD students successfully defended their thesis in 2010. On 31 December 2010, 75 PhD students were associated with Deltares of which three were from universities abroad.

## DISCIPLINES OF KNOWLEDGE

Staff in the primary process, categorised by key discipline



## COLOPHON

Deltares, September 2011

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### Infographics

Rijkswaterstaat, 2010, *Nederland leeft met water*  
Deltares, 2008, *Onze Delta – Feiten, Mythen en Mogelijkheden*  
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<http://esa.un.org/unpp>  
[www.unpopulation.org](http://www.unpopulation.org)  
[www.internationaltransportforum.org/statistics/trends](http://www.internationaltransportforum.org/statistics/trends)

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