Dry feet outside the dikes
New parks on the banks of the Meuse
Developing local districts
Pioneering on the water
International opportunities
Delta cities are very much in the spotlight as a result of climate change. Indeed, populations are growing fast and population density is high in low-lying delta cities. Rising sea levels, higher river discharges, as well as longer periods of drought, will be felt very keenly here.

Extreme weather conditions like storms, hurricanes, and tornados further highlight the problems. The images of the effects of these natural disasters in cities like New York (Hurricane Sandy in 2012), New Orleans (2005), Bangkok (2011), and Jakarta (2007) were unforgettable. The Netherlands, too, is being affected by excess rainfall with increasing frequency. This raises the question of how safe and climate-proof the country’s coastal and delta cities really are. Shouldn’t we be taking action?

Rotterdam is one of the safest delta cities in the world, but its location in the Dutch delta still makes it vulnerable. In this publication, we will be describing how Rotterdam is approaching the issue of climate adaptation. The articles illustrate what knowledge institutes, water boards, the private sector and Rotterdam City Council are doing in order to adapt the city to climate changes and to keep it safe.

An important new word in this context is ‘resilience’. It refers here to a city that is preparing itself for the future. Rotterdam’s position has been boosted by its inclusion in the Rockefeller Foundation’s ‘100 Resilient Cities Programme’.

We do not view climate change as a threat, but as an opportunity to make the city more resilient, more attractive, and economically stronger. In this way, Rotterdam will continue to be a safe and habitable city in the Dutch delta where large numbers of people can enjoy living and working.

Ahmed Aboutaleb
Mayor of Rotterdam
Table of Contents

6 Pioneering on the water
10 New parks on the banks of the new Meuse
13 Towards a resilient city
15 Dry feet outside the dikes
18 Bentemplein
20 “Greenery is good for the urban climate and for the well being of the residents”
24 The Rotterdam delta is safe, but vigilance is required
28 RAS is well underway
30 Rotterdam’s tools for Climate Change Adaptation Strategy
32 Developing local districts
36 Up on the roof
39 3Di makes the invisible visible
41 Delta cities network: the ideal platform for exchange
44 Rotterdam’s approach brings international opportunities
48 Water authorities: water safety should not be taken for granted
53 Postscript Vice Mayor Pex Langeberg
54 Delta City App
Building on the water is nothing new; it has been going on since time immemorial and projects involving floating structures can be found from Colombia to Canada. In the Philippines, there is even a floating village. What is new, is floating construction in old ports areas; bodies of water with an open connection to the sea including tidal movement.

Given that ninety percent of all large cities are located near water, the scope for building is considerable. Rotterdam, too, is surrounded by water, and the opportunities for floating structures are being carefully examined.

Aqua Dock
On the water of the Dokhaven in Heijplaat is Aqua Dock, a laboratory where research is being carried out into the options for floating structures, and even plans for a floating farm.

Building on the water is where the future lies. Cities all over the world are becoming increasingly congested, so more creative ways of using the available space is needed. The solution to this is to take to the water. In the harbours at Rotterdam there are floating homes, woods on the water, a laboratory for floating structures, and even plans for a floating farm.

Aqua Dock project manager Jaap Peters says, “Aqua Dock is making plots in the water available to interested parties who wish to experiment with floating structures. This involves not just building on water, but also issues of dealing with energy and adapting the city to climate change.” Aqua Dock fulfils an important role in Rotterdam’s ambition to be a pioneer in the field of urban climate adoption and smart green ports. Many port activities have moved westwards, and this has left a great deal of space available, especially on the water.

“Aqua Dock is the home of water innovation. Entrepreneurs and the regional education sector have shown a lot of interest in the water plots, and we are holding intensive discussions with them.”

Floating Pavilion
The Floating Pavilion in the Rijnhaven is one of the first examples in Rotterdam of sustainable construction on the water. This transparent complex consists of three floating spheres and, because the pavilion floats, it goes up and down with the tide.

The pavilion has been built with the help of specialists in the field of floating structures, DeltaSync and Public Domain. It was built in the Heijsehaven at RDM Rotterdam on Heijplaat, and towed from the Heijsehaven to the Rijnhaven.
Floating wood

A wood in the heart of the city, growing on the water: it sounds strange, and isn’t the first thing you might associate with the Rijnhaven. But there it is, next to the Floating Pavilion – a genuine floating wood. The floating wood is a concept by Jeroen Everaert, the founder of Mothership, based on the work of art entitled ‘In Search Of Habitus’ by artist Jorge Bakker, and is intended to make the port greener.

There are new trees growing on twenty old buoys that float on the water. This art project is designed to draw attention to climate change, innovation, and the importance of greenery to city dwellers. Businesses and individuals can adopt a tree.

Nassauhaven homes

Eighteen floating homes are being built in one of the oldest urban ports in Rotterdam, the Nassauhaven in Feijenoord. It will be the first housing project in a Rotterdam harbour basin.

“This is a challenge,” believes Marcel van Blijswijk, the project manager. “Due to its open links with the sea, the difference in tide is one and a half metres. The homes move according to the level of the water, which means they have to be robust, but light. Usually, it is the ground that has to be prepared, but in this case it is the shallow water that has to be dredged.

We put the sludge from ‘tidal park’, with the aim of creating a natural bank there. This is a way of bringing nature to the city and increasing biodiversity.”

The loft apartments, designed and developed by Public Domain Architecten and Van Hattum en Blankevoort, are detached, and can be adapted to every taste. Buyers can determine the size, the layout, and the finish themselves. These sustainably constructed homes are energy neutral and can be fitted with wind turbines and solar panels. There will be a mobility hub for electric bicycles, cars, and scooters adjacent to the homes.

The floating homes on Hulploot are being built on the water. This means hardly any inconvenience for the local residents. Once the shells of the homes are ready, they will be towed to the Nassauhaven.

The drains are connected to a circular system, so that waste water is clean when it flows into the river.

“During the Feijenoord residents’ consultation evening, the response to the proposed homes and tidal park was very positive,” says Marcel van Blijswijk. “You have the wonderful Nassauhavenpark, and now there will be a stepped bank, the tidal park, where nature can thrive, and these floating homes. The project is still at the pilot scheme stage, but if these floating homes are a success, we will be implementing it on a larger scale. Obviously there are certain issues that have to be tackled, such as who is responsible for the water on which the homes float.

When you build on land, then it is the owner of the home who is responsible for that land. But things are different when it comes to water. For example, if the sludge under a home builds up over time, who has to bear the costs if it has to be dredged again?”

Floating Farm

Another example of floating structures is that of the floating farm. In the middle of the city, on water! This is an initiative by Beladon, a company specialising in building on water. The floating dairy farm will be home to around forty cows grazing on their own field. City residents will not only be able to see how the cows are milked, they will also be able to buy dairy products like milk and yoghurt.

The construction of the dairy farm is planned for the Merwehaven in Rotterdam. Another purpose of the floating farm is to provide educational programmes relating to sustainability and agriculture, and to provide by-products, from fertiliser and urine, for example.
Anyone viewing the New Meuse river from the Erasmusbrug bridge will find it hard to believe that the water is teeming with fish. The open link to the sea means the river is tidal, with the fresh water mixing with the salt water, and this means that migratory fish are very much at home. This connection with the sea is unique in this delta, otherwise completely cut off by dams and barriers. The difference between the high and low tides in the centre of Rotterdam is an average of one and a half metres. The traces left behind on the river landscape by fresh and salt water and the high and low tides will be made more visible as a result of the development of the banks.

Walter de Vries works as an urban planner with the urban development section of the city council. He is in charge of the ‘De rivier als getijdenpark’ (‘the river as a tidal park’) programme on behalf of the ten collaborating parties. The aim is to enhance the leisure and nature-related qualities of the banks of the New Meuse. “We want to see the river as a natural part of the Dutch delta landscape, and not just as a highway for the shipping industry. We have traditionally only looked at the economic significance of the river. The grey quaysides and the basalt banks along the river look monotonous. We are now coming to realise that the river also has qualities as part of the landscape.”

An El Dorado for leisure seekers

Many people are discovering how enjoyable it is to spend their leisure time on the banks of the New Meuse. Walter de Vries points out, “If you let the grass grow down here along the banks of the New Meuse, then it won’t be long before people turn up with coolboxes, parasols and folding chairs to sit down and enjoy themselves. There is something about the river that people like- they are proud of it. Developing natural banks brings the city and nature closer together, people get closer to nature and are able to relax there. It also enhances water safety: a feature of tidal parks is the slowly rising river banks, which help break the waves at high water. That contributes to future-proofing the Rotterdam region. From the pedestrian bridge at the head of the Island of Brienenoord, which is a wonderful piece of nature in the city, it is already clear how attractively this can develop. The high and low tides wash water through a small tidal channel every day. There are birds galore there – sparrowhawks, hobbies, green woodpeckers, and kingfishers. A herd of Highland cattle are responsible for looking after the grass. Walter de Vries continues, “We are currently working on the ongoing construction of the Groene Poort at Rozenburg, where we are creating a gentle tidal strip in the river which will be several kilometres long, and will be a perfect spot for people to spend their free time.”

The Nassauhaven and the Mallegatpark will also get a tidal bank. There are five other locations that we are drawing up plans for. This is being done in collaboration with the World Wide Fund for Nature, Rijkswaterstaat, the provincial government, the Port of Rotterdam, the water boards, and other local authorities in the city region.”

Biodiversity

The transformation of the bare stone quaysides into a park with trees, reeds, and willows along a tidal river is unique...
in the Netherlands and will form a new area in which birds, fish, amphibians, and insects can live. Walter de Vries says, “Because of the mix of salt and fresh water, there is an enormous variation in vegetation. As you get nearer to the sea, you find samphire and sea-lavender, but the vegetation changes as you go further upstream. It is the combination of wet and dry banks and of salt and fresh water that produces the great variety of plants, birds, and fish. The more biodiversity you have, the more resilient the landscape will be. When creating the tidal parks, we make as much use as possible of natural processes. We refer to this as ‘building with nature’.

This means creating areas of beauty along the banks, which will all look completely different. There will be ‘wild’ nature, as well as specially designed parklands with jetties where people can walk, fish, or have barbecues. You cannot make tidal parks everywhere, however. It would not be easy in places where there is a strong current and where the river has to be deep enough for ships, for example. But it is clear that the tidal parks on the New Meuse will transform the image of the city, with more leisure opportunities in the region and an improvement to the ecological quality of the river, with salmon and sturgeon swimming to and from the sea, thanks to new rest areas and cleaner water. The river will increasingly become the city’s leading attraction.”

Impression tidal park Groene Poort

Walter de Vries is an urban planner in the urban development department of Rotterdam City Council, and programme manager of the region’s ‘De rivier als getijdenpark’ (“the river as a tidal park”) programme.

Impression tidal park Groene Poort

Rotterdam is an exemplary city for the Rockefeller Foundation

What makes a city resilient? Or, to put it another way, what makes a city sustainable and liveable? Rotterdam is among the leading 33 cities worldwide that have been selected by the Rockefeller Foundation for its “100 Resilient Cities” programme. Chief Resilience Officer Arnoud Molenaar says, “We have to learn to look at our city from a different perspective.”

Rotterdam is a dynamic innovative city on the brink of a challenging period. The fourth industrial revolution is almost upon us, and the city is expected to change enormously as a result of climate change, the new economy, and increasing digitisation. For organisations and citizens, relationships will shift, while new products and services will emerge at a rapid pace. With its 100 Resilient Cities programme, the Rockefeller Foundation is aiming to provide support to cities all over the world in order to make them resilient – anticipating and benefiting from the developments of the 21st century. In particular, this means being ready for transitions and gradual changes, such as climate change and digitisation, and being sufficiently resilient and flexible when faced with unexpected events.

According to Arnoud Molenaar, Chief Resilience Officer of the Resilient Rotterdam Programme, today’s challenges can only be met if cities become more sustainable, smarter, and more socially-oriented. “That requires a great deal of creativity. We were selected by the Rockefeller Foundation firstly because

The tidal parks have been made possible in part by LIFE funding from the European Union.
we are skilled in integrated water management and climate adaptation. Delegations from all over the world come to look at our dikes and water storage systems. By exchanging knowledge, cities can help strengthen each other. If you want to make a city resilient and future-proof, you have to look at the bigger picture and the city’s relationship with society. Rotterdam is one of the first cities in the Rockefeller programme that is taking an extensive integrated approach, looking not only at the climate changes that await us, but also socio-economic resilience, infrastructure, digitisation and automation, the energy issue, the port area, and the city’s administration. It is all very well talking about water safety, but if energy supplies suddenly run out during floods and the city’s 1000 pumping stations no longer work, you have a different kind of problem. And how do you retain people, who have lost their jobs in the port due to increased automation, for professions that are relevant to the needs of the future? If you plan for multiple scenarios, you will be able to anticipate in good time.

### Smart, circular, and sustainable

Many companies have a great capacity to learn, are changing rapidly, and embrace the idea of helping to create a resilient city by being smart, circular, and sustainable. Arnoud Molenaar explains, “This is happening with housing corporations, for example: there is an increasing awareness, with environmental and social aspects being factored into new buildings and renovation work. The increasing use of green roofs brings added value to the urban living environment. They capture fine particles, form a buffer for the purpose of rainwater drainage, cool the city, and look attractive as well. This makes an integral contribution to the resilience of the city, it is good for the health of its citizens (the social component), and also has a climatological and economic component. Additionally, with the use of solar panels, our homes will provide more and more energy in the future, so that citizens will be both consumers and suppliers. In the city council we wish to encourage and scale up existing initiatives by businesses and citizens who contribute towards making the city resilient. The flat roof landscape in the centre is a good place to start. Looking at things from the perspective of resilience must become second nature on the part of citizens, businesses, and social organisations. It is a marker of vulnerability or robustness. The role of the local authority will change in the future, but putting politics aside, I envisage a collective and facilitating role where we – together with the people of Rotterdam – look through the resilience lens at how we can keep the city liveable, resilient, and sustainable.”

### Rockefeller Foundation

To mark its centenary, the Rockefeller Foundation announced that it was making 100 million dollars available in order to improve urban resilience in the face of climate change. Cities were invited to take part in the ‘100 Resilient Cities Centennial Challenge’, and to submit their adaptation plans. Together with the Rockefeller Foundation and other partners, the 100 cities are better able to prepare themselves for climate change and other shocks and stresses in the 21st century, and are investing in a sustainable world. The selected cities form their own network and are able to share knowledge with each other. In addition, the cities can use a knowledge platform, which will eventually serve as a municipal question and answer forum, for becoming resilient. The cities also have to set out a strategy on how they believe the intended resilience can be achieved. Finally, each selected city will get its own Chief Resilience Officer (CRO) who will manage and supervise the process.

### Making areas outside the dikes safe from water

Rotterdam is unique in the Netherlands, on account of its port. It has more urban areas outside the dikes than anywhere else. The fact that these areas are so extensive is due to the way in which the port has developed over the years. The expansion of the city through the creation of new harbours was followed immediately by the construction of new homes. However, the harbours and many of these homes were located in areas that are not protected by the dikes. Some 40,000 people in Rotterdam now live in such areas.

Several areas of Rotterdam located outside the dikes, such as Noordereiland and Kop van Feijenoord, are dangerously exposed at high tides. Peter van Veelen is looking for an integrated model whereby long-term results can be achieved with the cooperation of stakeholders in the area. There are two choices: keeping the water out, or constructing water-resistant buildings. The resourcefulness of residents is of great importance in this situation.

Rotterdam centre for Resilient Delta Cities.

### Dry feet outside the dikes

The Noordereiland (citycenter Rotterdam) is an outerdike area

DELTA Rotterdam CONNECTING WATER WITH OPPORTUNITIES

DELTA Rotterdam CONNECTING WATER WITH OPPORTUNITIES
before any building took place there. Nonetheless, some parts of the areas outside the dikes are still vulnerable. The Noordereriland is one such area with large numbers of homes, which gets flooded once every two years, on average. Following the construction of the Maeslantkering barrier, the risk of flooding has receded. Older residents of the Noordereriland can still remember that floods used to be more frequent. Because of the low flow velocity, the damage to homes is usually limited to the interiors of the lower floors. Nonetheless, there is still a significant chance of such floods occurring again in the near future. Other vulnerable locations are the Scheepvaarthuiskwartier district on the northern bank of the New Meuse, and the Kop van Feijenoord near Nassauhaven and Heijplaat in Rotterdam-Zuid. Sound measures are needed for areas of this kind in order to protect them from high water.

Transformation phase

Similar measures are needed for new housing developments in areas outside the dikes as well. “Until fairly recently, we always used the methodology that was followed during the construction of the Kop van Zuid,” says Peter van Veelen, who was previously employed by the Rotterdam City Council and is now a researcher at TU Delft. “The methodology was based on the idea of demolishing everything, raising the area up, and then rebuilding. But times have changed, areas are no longer developed in that way. The economic model that was linked to those methods has run aground because of the economic crisis. For that reason, we are now in a transformation phase and we are looking for new development models.”

Looking for new models of this kind is exactly what Peter van Veelen is doing, a process that also involves seeking new ways of protecting existing areas in the Kop van Feijenoord and on the Noordereriland against high water. “Things only need to go wrong once on the Noordereriland for the consequences to be far-reaching,” he says. Examples that come to mind are power cuts and damage to homes and cars.

Making a new built-up area water-resistant outside the areas of the dikes is much more of an integrated task nowadays, incorporating all kinds of different social aspects. Peter van Veelen explains, “Developing areas has become a lot smaller in scale. In addition, it is about developing long-term value. There are also other aspects to be considered, such as fighting poverty, energy transition, and improving outdoor spaces. Nowadays, the focus is much more on taking a long-term integrated approach, looking about thirty years into the future.”

Among the measures being investigated is whether raising the quayides can be combined with improvements to the outdoor spaces and linked to the development of new buildings and investment in the area. For example, the redesign of the Maaflegat task rising water levels into account.

**Bathtub**

The Kop van Feijenoord, between Rosestraat and the New Meuse, is what Peter van Veelen refers to as ‘a bathtub’, and therefore an at-risk area. Something needs to be done here, but responsibility for the safety of the areas outside the dikes lies not just with the city council, the central government, or the water board - property owners also have a duty to protect their own buildings to prevent them from being damaged. It is important to look at who is active in the area.

As well as residents, this includes housing corporations and businesses, of which Unilever and Hunter Douglas are among the largest. Working with these parties is necessary when taking measures. “When it comes to water safety, these parties have everything to gain,” says Peter van Veelen. “It is therefore only logical that if the city council helps make the area water-resistant by raising and renovating the quayides, for example, the parties involved also help with the socio-economic development of the area. Among the ways in which this could be done is housing corporations renovating their properties more quickly, or businesses providing work experience for people from the area. These are matters that in many cases were being planned in any case, but which are being implemented more quickly than previously envisaged. It is a kind of trade-off.”

Peter van Veelen started his research by designing multifunctional water defence barriers, but his focus shifted increasingly to the phase preceding the design process. “How can I devise an instrument that links all the various factors involved in the development of an area, thereby leading to an innovative solution? That would make it possible to create a growth model that would bear fruit in due course.”

Calculations were made for the Kop van Feijenoord and the Noordereriland to work out exactly where the areas of greatest vulnerability are, which buildings would be worst affected by floods, and what would happen to electricity supplies if the water were to flow over the banks. An exact inventory was also made of the measures that need to be taken. Roughly speaking, it comes down to two different strategies. One is to keep the water away as much as possible by building walls, so that the areas outside the dikes stay dry. The other is to make buildings water-resistant by modifying them and making transformer vaults watertight.

**Workshops**

The residents have an important role to play. “We organised a number of workshops on the Noordereriland where we asked residents to contribute ideas for tackling the flooding problem,” says Peter van Veelen. “It was not just a matter of taking information with us, but collecting information while we were there.”

The main question was how we could reduce vulnerability to the water. It is impossible to offer total protection against water, but taking measures to limit the effects is certainly an option. Leaving cellars as empty as possible is just one measure. Another is ensuring that the residents invest in means to keep water outside for as long as possible or, in the worst-case scenario, having sandbags ready should they be necessary.

We also learned from the residents: they came up with the idea of emptying the underground waste containers on the street if the water looks as though it is going to rise very high, as experience shows that otherwise rubbish floats everywhere if this happens.” The cooperation of residents is crucial when making areas outside the dikes water-resistant. Peter van Veelen explains, “The days when the government took care of everything are behind us. There is so much that can be achieved by generating awareness among residents.” He is also looking at cities like London and New York: “The emphasis there is very much on the self-reliance of the residents, on community resilience. In Rotterdam, we have to take into account the emphasis should be placed on such self-reliance, and where a more collective approach on an area-wide level is more appropriate.”

The whole world is now looking to Rotterdam as an example of a city in which water and climate challenges are being integrated with urban development, and this is something Peter van Veelen regards as a great opportunity. “The task of adapting the city to rising water levels also provides opportunities for the business sector in Rotterdam. Look for example at how the city council is working alongside Rotterdam businesses to climate-proof Ho Chi Minh City.”

Peter van Veelen also worked alongside with the Rotterdam City Council and worked on water-resistant areas situated outside the dikes. He received a PhD at TU Delft on the question of how water safety can be incorporated in urban development. Peter van Veelen currently works as an urban deltas coordinator/researcher at TU Delft.
“The steps in the square are already showing signs of wear and tear from the skating,” says architect Florian Boer of De Urbanisten, the firm that conceived the idea for the water square and designed what was to become the first large-scale water square anywhere in the world. The wear and tear is testimony to the intensive use that young people and schoolchildren from the local area make of the water square, and this despite the fact that the new-style Benthemplein opened to the public only a year ago.

“The steps in the square are already showing signs of wear and tear from the skating,” says architect Florian Boer of De Urbanisten, the firm that conceived the idea for the water square and designed what was to become the first large-scale water square anywhere in the world. The wear and tear is testimony to the intensive use that young people and schoolchildren from the local area make of the water square, and this despite the fact that the new-style Benthemplein opened to the public only a year ago. When it rains heavily, the square becomes a water storage point. The water from the schools and the church that is situated on the square runs into the two shallow basins. Water from the vicinity of the square runs into the deeper basin, which during dry weather can be used as a sports field for basketball or football. The course of the water is easy to follow on the square: it flows through wide gutters to the basins. Water from the surrounding area falls into the deeper basin like a curtain, or wall of water, whenever it rains very heavily. The parts of the basins that fill up during rain are indicated by a blue colour. During the past two years, the deeper basin has filled up two times. The water does not remain in the basins for long. It disappears within 24 hours, either into the soil or into the nearby Noordsingel. Florian Boer explains, “In this way, the water returns to nature and Benthemplein relieves the pressure on Rotterdam’s drainage system which struggles to deal with large quantities of rainwater in a very short time. Agreements have been made with the GGD (local health services) on how quickly the water must disappear from the square. There obviously can be no danger to public health, and small children must absolutely not be exposed to any risks on the square.”

On the other hand, small children on Benthemplein are few and far between. The square is enclosed by the Technikon schools complex, which was designed in the late 1960s by the well-known Rotterdam architect, Huig Maaskant.

“He had very different ideas about the use of outdoor space at that time,” explains Florian Boer. “The prevailing view among architects then was that the urban lives of schoolchildren should take place inside the buildings. That is why a tower consisting of a number of stacked gymnasiums formed part of his design – sport was something that school pupils did indoors, playing outside was for country folk.”

Drab expanse

For a long time, Benthemplein was a drab expanse of grey paving stones that nobody liked, not least the surrounding schools, Zadkine and the Grafisch Lyceum. That is why it was an outstanding opportunity to design the first large-scale water square here. Florian Boer continues, “Maaskant’s school complex wanted nothing to do with the square. But with the arrival of the water square, the public space is now demanding attention. A water square requires specific shapes; there should be as few obstacles as possible.”

Three workshops were held in order to arrive at the right design, in consultation with all the parties involved. Residents from the Agniesebuurt district were there, as were representatives from the church, the Hofpleintheater on the square, and of course the schools.

During these inspiring meetings, those present made clear what elements they wished to see included in the square, with water being a crucial feature. “The presence of water appealed to and excited everyone,” recalls Florian Boer. This led to three designs, in which the most desired components were incorporated: a sports field, an area of greenery, skating opportunities, and a place to sit and people watch.

Florian Boer says, “In the second workshop, the people who were going to use the square the most were able to choose which designs they preferred. We combined the two most popular designs into one and looked at what could be done better. The greenery was brought closer to the square. Water was very highly valued, as it formed a clear part of the design. It is not the intention for people to play in the water, but everyone is keen to see the water flow when it rains.”

Finally, the water square is an excellent motivator for climate-proofing the whole of the Zomerhofkwartier and Agniesebuurt districts. This means making the city streets greener, capturing rainfall locally, fewer asphalt and concrete surfaces, and a reduction in the number of parking spaces in favour of wider pavements and strips of greenery. Florian Boer says, “We are going to capture all the rainwater locally. The aim is for not a single drop of rain to find its way into the drainage system, anywhere in the district.”
“Greenery is good for the urban climate and for the well-being of the residents”

“People feel cooler when they see vegetation”

Wiebke Klemm has studied city-dwellers’ heat perception. One of the conclusions of her research: green contributes to the thermal comfort of city-dwellers. In fact, just seeing greenery makes that people feel cooler. More urban green helps combat heat stress. That does not necessarily mean great big new parks, small additions are also welcome. The more, the better. The cumulative effect ensures that every little bit will help.

If we do not take any action, cities will only heat up. “Cities are already warmer than their surroundings areas,” says Wiebke Klemm, researcher at Wageningen University and Knowledge for Climate participant. “This means that the likelihood of heat stress in cities is increasing. Cities develop; they expand and become more compact. So the number of buildings and paved surfaces increase, resulting in the retention of heat for a longer period of time. This not only affects the urban climate, but also the health and well-being of the residents.”

People who sleep under a flat roof do not sleep as well during a heat wave. People who sleep poorly do not perform as well, while their performance is already negatively affected by the heat. “Particularly older people and young children are vulnerable,” notes Wiebke Klemm.

“People from all parts of town go there,” said Wiebke Klemm. “Parks are favourite places; it is clear that people prefer them to paved areas and places where there is water.” Their choice is understandable; city-dwellers simply want to be where it is the coolest. “The measurements taken with the carrier bike confirm this. It’s on average 1° C cooler in the parks than in the city centre.”

Psychological aspects
It sounds obvious. “Indeed,” says Wiebke Klemm. “Many people say to me “Surely, we have known this for a very long time!” And this has now been borne out by my research of Dutch climatic conditions and backed up with figures.

There also appears to be a psychological aspect: people do not feel the heat as much when they see greenery. “In general, people are aware of their thermal comfort,” said the researcher. “They try to cool off when it gets too hot. They try to adapt, for example, by walking on the shady side of a street or by sitting under a tree. Needs vary. Many older people know exactly which benches to sit on in a park. Young people know where they can enjoy the evening sun the longest in a park.”

Creating new, extensive green recreation areas is one of the recommendations of her research. “But cities do not always have room for this,” the researcher explains. “You could also think of providing good or better access to major parks. You could create small green spaces, such as pocket parks, which can make a real difference.”

The greenery in a city helps to improve the urban climate, she stresses. The greener, the cooler. Minor elements also contribute to this. The effect is a cumulative one.

Green roofs lower the surface temperature. At street level, trees help to improve the thermal comfort of pedestrians. My research shows that there is a difference in mean radiant temperature of 4° C between streets with trees and ones without.”
**How an urban climate can be influenced**

The basic assumption of the book "Weather conditions in cities", published by nai010 publishers last year, is that designers can do a great deal to make a city more livable. In her book, landscape architect and urban designer, Sandra Lenzholzer, gives designers practical tips for taking urban climate into account in urban design, and for influencing the urban climate at city and micro-level. At city level, this concerns laying out parks, whereby parks with trees cool down the environment during the day and parks with open grass fields cool the environment down at night, or creating ventilation between different parts of town and avoiding barriers.

For the micro-level, a roughly 100-page catalogue of possible measures has been included, classified according to changes relating to temperature, wind, precipitation and perception. To prevent heat stress, plant-covered pergolas can be placed in front of buildings, or trained trees can be used to shade buildings. Climbing plants, trained plants or fruit trees on outside walls are also quite effective in stopping walls from heating up as much: this can sometimes make a difference of up to 30° C. "Green outside walls often add a distinctive touch to the architecture," writes Lenzholzer.

Attachable constructions of foliage or green boundary partitions could be used to shade buildings. Trees are also effective in providing shade and making a city more pleasant at the micro-level. The book includes lists of all kinds of trees that can provide the greatest amount of shade, thereby lowering the air temperature or that are moderately to extremely drought-tolerant. Trees can be planted anywhere: in gardens, squares and parks, but also in parking places to provide shade.

Designers can also use materials that absorb less heat. Wood is an attractive alternative. This also applies to paving: asphalt absorbs most of the heat and increases heat stress. It therefore makes sense to replace asphalt with light and porous materials wherever possible. Good results have also been achieved by combining water and greenery. Water storage reservoirs can also have a cooling effect, for example on a flat roof: an old method which, according to Lenzholzer, "could have new life blown into it."

**Climbing plants**

It is also possible to take advantage of the psychological effect of greenery at street level. Just seeing the greenery improves your perception of heat.

"This is also the case with plants growing up the outside wall, or in front of buildings or in the front garden. It only takes one climbing plant to improve one’s perception of thermal comfort. Every resident can contribute to this, not only in the city. This can then have all kinds of auxiliary benefits, such as promoting social cohesion, when the residents in a street collectively undertake to make their neighbourhood greener. And greenery improves the biodiversity and the appeal of the living environment. It is a win-win situation for everyone."

Wiebke Klemm is a doctoral candidate in landscape architecture at Delft University. She is an experienced researcher and designer in the area of the urban landscape.

**Shadow in the Zuiderpark**

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The Rotterdam delta is safe, but vigilance is required

“Residents should be more aware of the risks they are exposed to”

A flood in Rotterdam is something most of its residents can barely imagine. This shows the extent to which the safety of the city has been taken for granted in the past few decades. Nonetheless, climate change and socio-economic growth have made it necessary to take measures to counter the potential dangers posed by water. This involves preventive measures and constructing buildings capable of withstanding threats from water, but also having sound action plans for managing a crisis. Water safety is nowhere near as routine as it would appear.

For years, primary dikes have protected Rotterdam from water. Rotterdam lies in the heart of a delta region; the North Sea, and the Rivers New Meuse, Rhine, and Waal converge here, as a result of which the risk of flooding is as old as the city itself. Much of the city lies below the Amsterdam Ordnance Datum, and the water comes from two fronts. “The city is influenced by the sea, and there is thus a significant level of salt water. Then there is the river, which of course carries fresh water,” says senior policy advisor on water safety and climate adaptation, Nick van Barneveld. “If any of the primary dikes were to break, Rotterdam would be very badly affected - the damage to homes and infrastructure would be enormous, and there would be fatalities.” The north and north-east of Rotterdam in particular appear to be very vulnerable. “The residential district of Prins Alexanderpolder, for example, is very low-lying, well below sea level. This landscape runs towards the river, where the primary defences are situated.”

Defences

Hardly anyone is concerned about such pessimistic scenarios, a tendency that has only grown over the years. “We have done very well with the dikes,” says Nick van Barneveld. “People are very safe here. The primary dikes are former sea dikes, which held during the 1953 flooding disaster. We have learned a great deal from that disaster, which was a combination of a storm and the spring tide. We have pursued policies on strengthening dikes and shortening coastlines.”

This has resulted in the addition of three important defences: the Maeslantkering, the Hartelkering, and the Hollandse IJsselkering, which close at high tide, thereby providing considerable relief for the dikes further inland in the urban areas.

“People often bemoan the fact that the port is inaccessible when the defences close, but it is actually about keeping the port safe,” is Nick van Barneveld’s response to any criticism on this point. “The outer dikes offer protection for the port, one of the most important drivers of the economy. Closing the flood barriers guarantees the safety of that economic driver.”

Due in part to the presence of the flood barriers, the dikes on both banks of the river in the city are on the high side. In the light of current and future developments, the ‘excess’ height of the dikes is a good thing. Nonetheless, it does not make sense to sit back and take no further action, stresses Nick van Barneveld. “Measures are needed, certainly. We are currently assuming a rise in sea levels of between 35 and 85 centimetres by 2100. This means that the dikes and the Maeslantkering will have to be altered in some way in due course.”

Better understanding of flood scenarios

The process of devising policy for protecting the city and its population against the water has undergone extensive changes in recent times. Nick van Barneveld explains: “We have started to think more in terms of flood risks. That means looking not just at the likelihood of a flood taking place, but also at the possible effects of a flood. In the past, we used to think about dike-rings - areas of land that were protected by a single dike - and what could happen there. Nowadays, we are able to better and more precisely analyse where flooding could occur and what the consequences could be; it has become much easier to visualise. The result is that a specific set of standards will apply to each dike project by 2017. The process of getting the whole system in order will take until 2050. We are currently working to the highest standards, so things will soon be even safer.

The Rotterdam delta is safe, but vigilance is required

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Improving crisis management

Taking the apparent safety of Rotterdam and its surrounding areas for granted is a cause for some concern for Nick van Barneveld. “Many people do not even know if they live inside or outside the areas protected by dikes.” There is also much to be done when it comes to crisis management. “Evacuation plans must be in place, and they must be clear,” says Nick van Barneveld. “Government bodies must know exactly what could go wrong and how many people can be evacuated in a short time. There are currently no clear answers to these questions.” It is obviously difficult to predict the future and to have ready-made solutions to every possible risk that could occur. “But it would be useful if the government was able to tell its citizens what the risks are and what it would do – and what the citizens themselves could do – if anything should happen. At the moment, we rely too heavily on general protocols for dealing with emergencies. Together with the water boards, the Safety Region and Rijkswaterstaat, we are currently working on a pilot scheme entitled ‘Optimalisatie van crisisbeheersing’ (‘optimising crisis management’). We are using a 3D flooding model that shows the possible consequences of a flood in more advanced detail. We have taken the heavily populated area near Meuseboulevard as an area that could be flooded, and are identifying what would happen if a heavy storm were to occur and the Maeslantkering flood barrier did not work. We then carry out a flooding analysis and look at how we would respond if gas and electricity supplies were cut, for example, and when and how you would start evacuating people. The chance of a dike being breached in this area is very slim, but there must still be a plan in place in case anything goes wrong. The process of considering flood risks involves three levels: preventing floods by taking preventive measures, making homes and infrastructure flood-resistant in terms of spatial planning, and drawing up proper crisis management plans for dealing effectively with a crisis in the event that disaster strikes.”

It is in relation to the latter in particular that the realisation is growing that plans of this kind should be in place. Nick van Barneveld continues: “If anything goes wrong in this area, where storm surges at sea are such a major factor in the risk of flooding, there are hardly any ways of evacuating people quickly. That means you have to be ahead of the game - but how can you manage that if the window of opportunity for responding is so small? It is also difficult for those in authority to decide whether to evacuate people as a precaution without knowing whether or not it will be a false alarm.” There is a lot at stake when it comes to creating safety. Nick van Barneveld explains: “Water safety is something that binds us. It affects each of us, but in different ways.”
RAS is well underway

The Rotterdam Adaptation Strategy is the basis for the future

The Rotterdam Adaptation Strategy (RAS), which dates from 2013, sets out the course along which the city aims to prepare itself for climate change. The strategy is now being implemented in full and has acquired extra dynamism as the years have passed.

Rotterdam is vulnerable to risks related to water safety, heavy precipitation, drought, and heat. The objective is for the city to be climate-proof by 2025. Sustainable project manager Lydia Hameeteman says, “This requires systematic integration of adaptation into every spatial development in the city – at least, wherever any problems exist or are expected. Maximising that kind of integration will help us save costs and reduce inconvenience for the citizens of Rotterdam.”

With the help of the RAS, Rotterdam is seeking to benefit from the opportunities offered by climate adaptation to strengthen the economy, improve living environments and nature, and increase the involvement of the people of Rotterdam with their city. Lydia Hameeteman continues, “The challenge is to implement the strategy in plans, programmes, projects, and processes, and to inculcate it into the people both inside and outside Rotterdam City Council. We are very much aware that the city council is not the only player in the game. Our approach therefore involves working together with other parties such as the private sector, other government bodies, utility companies, and of course the people of Rotterdam. We have a good system of flood barriers, dikes, drains, and pumps, which will allow us to manage for the time being as long as they are maintained and improved. However, this will not be sufficient in the long term. For that reason, three pilot projects have also been set up in these areas for the purpose of investigating what solutions are possible for limiting and preventing floods. The pilot projects are being carried out in the Zomerhofkwartier (Zoho), Rubroek, and Leonidas districts.”

The implementation of the strategy is most advanced in Zoho. This is where Bentheimerplein is located, home of the first large-scale water square to have been developed in Europe. It is an example of an adaptive measure, in which the challenges related to water management have been linked to public spaces and therefore to the neighbourhood and the district. It brings many benefits, both economic and social gain, with many people using the square as a meeting place. Together, residents, businesses and government bodies can join forces to bring added value to a climate-proof city.

“However, the areas inside the dikes can also be affected by flooding during very heavy rainfall, for example. For this reason, three pilot projects have also been set up in these areas for the purpose of investigating what solutions are possible for limiting and preventing floods. The pilot projects are being carried out in the Zomerhofkwartier (Zoho), Rubroek, and Leonidas districts.”

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Adaptation monitor

Is climate change taking place more quickly or more slowly than expected? Do the objectives of the RAS have to be adjusted upwards or downwards, and to what extent have adaptation measures been taken? Are we moving quickly enough, or do we need to pick up the pace? To gain an idea of this, an adaptation monitor is currently being developed, in which records are kept on how the risks are evolving. The aim is to learn from it: what is going well, what is not, and why not? This will help to improve the approaches adopted. Knowledge of climate change lies at the very foundation of the Rotterdam Adaptation Strategy, and has been acquired from multiple sources inside and outside the Netherlands. Sharing knowledge provides opportunities for parties to link up together, to expand initiatives, and to pool resources.

Lydia Hameeteman

is a sustainable project manager with the Rotterdam City Council. She is involved with the themes of adaptation, resilience and heat.
**The Rotterdam Climate Game**

This game – sponsored by the Rotterdam Climate Proof programme, the National New Urban Developments and Restructuring Delta Programme and the Water Governance Centre – makes players aware of the dilemmas involved in climate-proof construction/restructuring and spatial developments, both inside and outside the network of dikes. Players can experiment with a realistic representation of the Rotterdam Feijenoord district. While playing the game, they will also start to become aware of the multilayer safety approach. In addition, measures can be weighed against one another. Considerations of budget and the possibility of applying for a grant are also part of the game. The game was developed by Tygron Serious Gaming.

**Climate adaptation barometer**

A step-by-step plan has been developed to follow the progress of the development of a climate adaptation strategy: the climate adaptation barometer. This step-by-step plan consists of eight steps which are followed sequentially (a problem analysis, followed by measures, etc.), but in practice has a cyclical character. New insights, extreme events, other funding options or experiences with measures may result in the re-examination of priorities and/or other measures and implementation schemes. The progress which the party concerned has made per step is eventually assessed in qualitative terms, after which a score is assigned.

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**The Effects of the interactive Climate Change Atlas**

The Climate Adaptation Services Foundation has produced an interactive atlas on the effects of climate change for the city of Rotterdam. This atlas shows what will befall Rotterdam as a result of climate change in terms of water safety, flooding, heat waves and dry spells: now and in 2050. Various climate scenarios have been matched with potential bottlenecks and problems. In this way, you can see, at a glance, what is happening now, how this will develop over time for the various scenarios and what parts of the city require extra attention. This instrument was also used to develop the Rotterdam Climate Change Adaptation Strategy.

**Rotterdam Climate Societal Cost Benefit Analysis (SCBA)**

The Rotterdam Climate SCBA supports the implementation of the Rotterdam Climate Change Adaptation Strategy. A SCBA assesses costs and benefits of investments for society as a whole. To be able to properly value the benefits, the full effect of a project needs to be defined.

This involves comparing two different scenarios: one scenario showing what the world would look like if the project was not implemented (the ‘zero’ alternative), and one showing the results if the project was implemented (the ‘project’ alternative). The difference between these two scenarios is the effect the project would have on society.

What makes this SCBA special is that, for the very first time, an urban climate adaptation model has been constructed that does not just looks at the effects of a single project, but takes a whole range of measures into consideration and employs a dynamic calculation model used for strategic planning. Adaptation measures which are incorporated in projects at an early stage show a positive SCBA outcome.
Developing local districts

Climate adaptation in practice

To be future-proof, neighbourhoods need to be energy-neutral, climate-proof and green, and they need to have good social cohesion. For the latter, resident and business participation is crucial. How can this be achieved? The answer is to involve them in the process from an early stage.

Zomerhofkwartier

For a long time, the Zomerhofkwartier district (ZoHo) was a forgotten area at the periphery of the centre of Rotterdam. Office buildings stood empty, new plans were put on hold because of the economic crisis, and it became increasingly unsafe. A number of parties, including the Havensteder housing corporation, De Urbanisten (who also designed the Bentheimplein water square in this area), the Schieland en Krimpenerwaard regional water authority, STIPO (office for urban development), and Rotterdam City Council, decided not to demolish the neighbourhood, but instead opted for a process of gradual urban development, or 'slow urbanism'. Linking this development to solving the problems of flooding after heavy rain turned the Zomerhofkwartier district into a laboratory for spatial adaptation, where new applications and concepts can be tested and demonstrated.

Zomerhofkwartier project manager Bart Peters says: "We started to encourage and facilitate bottom-up initiatives. Because of the low rents, more businesses started returning to the district. ZoHo and the adjacent Agniesebuurt district are very stony in appearance. That is why we made the new tenants responsible for making the outdoor environment greener.

This led to the creation of the rain garden and the Katshoek Rain(a)way Garden. These are among the many solutions for reducing flooding on the streets, which in turn relieves the burden on the drainage systems and curtails the level of flooding.” More plants, flowers, and trees mean not just a greener appearance, but also offer a more pleasant living environment. Greater social cohesion is created, because residents and businesses work side-by-side in the gardens.

“In the Zomerhofkwartier, we are combining climate-proofing measures with local development, wherever possible. Increasing greenery and improving outdoor spaces go hand-in-hand. For example, maintenance work on the drains can be combined with putting extra greenery in place.”

The Zomerhofkwartier has gained new life as a result of all these developments. Around 100 businesses and residents are now actively involved. Working on the district both top-down and bottom-up leaves greater scope for innovation, generates support among the population, and enables the work to be carried out more quickly.

Robert Fruinstraat

Another local project in Rotterdam is the Robert Fruinstraat in the Middelland district, between the centre and Delfshaven. The street consists of residential addresses and various organisations, including a primary school and an artists’ cooperative. On the face of it, it is a pleasant and lively tree-lined street, home to many families. However, it does have a problem - during heavy rain, the back gardens become flooded.

“The drains have to be replaced and a new electricity network is going to be installed,” says Laurence Peels, the Robert Fruinstraat project manager. “Given that the street has to be dug up, we are going to see if there is anything else we can do. Public spaces have always been tackled in a one-dimensional manner - physically. But what actually makes a district liveable? Are the people in this area happy? What could be improved? We decided to ask the residents and now we’re organising workshops with them and with other interested parties. The water stays in the gardens, which are not public spaces, so we have involved the housing corporations and homeowners as well. We have delivered flyers and asked a few key people in the street to help organise this. Of the almost sixty addresses in Robert Fruinstraat, seventeen people have indicated their willingness to contribute ideas on the future of the street, which is quite a high number.

You need a small group of committed residents: it is a question of quality, not quantity. We will be using workshops to explore with the people in question what they believe to be important, and will be discussing such themes as greenery, water, energy, and social cohesion. The aim is to create a robust and energy-neutral street that the residents can be proud of.

For the Katshoek Rain(a)way Garden, 100 metres of parking spaces have been converted into areas of greenery. A special tile, the Rain(a)way tile, captures excess rainwater on the façade and ensures that the water is absorbed slowly into the ground.

This means that there is less of a burden on the drainage system during periods of heavy rain. This is a new concept by designer Fien Dekker that has been inspired by Japanese architecture.
A street where people say, “I want to stay here.” A district with dry rear gardens, with solar panels on the roofs, for example, where children can play without a care. If we bring all our various dreams and plans together, the street could become an example for all streets where the drainage system has to be replaced in the future. Once all the plans are clear, we will be organising a party for the whole neighbourhood.

Leonidas
In the De Esch district, building work is underway on a remarkable residential area. The former Leonidas hockey site is going to be home to detached sustainable houses in a green setting, and buyers will be able to design their own homes. Leonidas will be a sustainable district, with buildings made as much as possible from natural materials, and with little or no energy consumption. An innovative climate-adaptive building method has been chosen, whereby the ground is not preloaded and therefore may not be raised. That means that the homes have to rest on a special construction so that they ‘float’ on the peat or on the water, or stand on piles. Leonidas project manager Henk Koedijk says, “Only forty percent of the area may consist of hard surfaces, with the remainder being left for water storage. With most construction projects, you force the water out of the ground and puddles appear elsewhere. Using this method of building allows the water to seep down into the ground. We now have no problems in this area, although things could be different in ten years’ time, as a result of climate change. However, using this method means we are able to anticipate the problems.”

Bart Prins
is involved with complex urban development projects that enhance social, economic and ecological value. He graduated in economics from the University of Amsterdam and took his Master in City Development at Erasmus University Rotterdam.

Laurence Peels
has been working as a project manager for Rotterdam City Council since 2007. She is involved mostly with water-related innovation projects and large-scale maintenance of the major bridges in Rotterdam.

Henk Koedijk
has been working for the ‘Stadsontwikkeling’ (urban development) cluster in various positions since 2014: area development programme coordinator, food markets process manager, and Leonidas project manager.

Bart Prins

Laurence Peels

Henk Koedijk

Leonidas

The tidal parks have been made possible in part by LIFE funding from the European Union.
Moreover, green roofs capture fine particles, giving a kind of sponge that forms a buffer for draining rainwater. Green roofs function as overburden during periods of heavy rain. If you cover roofs with substrate, plants, and mosses, they can hold back so that the drainage system would not be overburdened. Rotterdam faces challenges in relation to sustainable energy generation, in order to help maintain dry conditions. Rotterdam faces congestion, and around the centre in particular, green roofs are needed for anything else. In the areas with a lot of stone surfaces in the city, a water buffer, the generation of sustainable energy, and new places for people to meet. Stadsontwikkeling (urban development) programme manager Paul van Roosmalen says, “It originally all started with green roofs, but we are now moving towards a complete colour palette of roofs.”

The colour palette of Rotterdam’s roofs

A unique roof landscape is evolving above the city. The possibilities are endless – a greener city, a water buffer, the generation of sustainable energy, and new places for people to meet. Stadsontwikkeling (urban development) programme manager Paul van Roosmalen says, “It originally all started with green roofs, but we are now moving towards a complete colour palette of roofs.”

The surface area of the flat roofs in Rotterdam amounts to around 15,000,000 m². As a result of the post-war reconstruction work, many flat roofs were added – from low in the port to very high in the city centre. In a city that is becoming increasingly congested, roofs offer space for multifunctional uses. Paul van Roosmalen continues, “There is enormous potential here; there are different functions that can be allocated to the space on roofs, which are not used for anything else. In the areas with a lot of stone surfaces in and around the centre in particular, green roofs are needed in order to help maintain dry conditions. Rotterdam faces challenges in relation to sustainable energy generation, water storage, cooling, and making the city greener. There is plenty of space on the city’s roofs for these purposes. With the aim of water storage in mind, we looked at how water could be held back so that the drainage system would not be so overburdened during periods of heavy rain. If you cover roofs with substrate, plants, and mosses, they function as a kind of sponge that forms a buffer for draining rainwater. Moreover, green roofs capture fine particles, give a pleasant green appearance to the city, and ensure that the roof in question lasts longer.”

Green roofs

A green roof can take different forms: from a roof planted with moss and succulent plants (extensive green roof) to a fully-fledged roof garden (intensive green roof). Sustainability advisor Eveline Brandsijk explains, “There are many options; it can serve as a functional space that you can use as you see fit, and where you can relax and enjoy the feeling of being outside. The possible options include flowers, a herb garden, a vegetable garden, or keeping chickens or bees on the roof. Green roofs promote biodiversity in the city, because they attract birds and insects. An extra benefit is that temperatures are lower under a green roof in the summer than in the case with a black roof. This results in energy savings due to lower cooling costs – undoubtedly a significant advantage for shopping centres with flat roofs. In addition, the combination of solar panels and a green roof is ideal, because the latter has a cooling effect on the roof.”

Although green roofs have many advantages, they also have their limitations: they only capture some of the rainfall. Paul van Roosmalen explains, “In July 2011, Copenhagen, where green roofs are compulsory, experienced extreme levels of rainfall. Around 150 millimetres fell, causing billions of euros of damage to the city. For them, it was a wake-up call. Green roofs absorb only ten percent of rainfall. We are now in the process of building water depots on roofs, so that more water can be stored. This is an idea that we are currently developing. The result is that roofs will be green and blue.” At present, there are 220,000 m² of green roof in Rotterdam, and the aim is to increase this to 600,000 m² by 2025.

Colour palette

The future roof landscape in Rotterdam will consist of so-called green, blue, red, and yellow roofs. Each colour represents a particular function – yellow for solar energy, green for vegetation on roofs, and blue for extra water storage. Red roofs have a social function; the roofs are increasingly being used as meeting places. This is a welcome expansion of public spaces in cities, which are becoming more and more congested. Organisers Joep Klubbers and Léon van Geest aim to stimulate the use of roofs: every year, they organise the Rotterdamse Dakendagen (Rotterdam roof days). There are festivities on various roofs in the city, with yoga lessons, a cinema, disco, rooftop bar, and performances, and visitors get to see the city from a different perspective. Many people are inspired by this ‘red’ roof variant and seek to do more with their roofs.

School playground on the roof

Having developments at different heights is nothing new, and indeed goes back to ancient times. Paul van Roosmalen explains, “Look at the Hanging Gardens of Babylon – a city built on terraces that had an innovative water system and a fabulous green appearance. Goats have been grazing on Scandinavian roofs for a long time now. And in the Netherlands, we started building green roofs thirty years ago. The pre-War ‘de Bijenkorf’ department store in the centre of Rotterdam used to have a roof terrace. It shows that roofs can be put to very effective use. A city’s parks are born on its roofs. Roofs are more than just a ‘roof over your head’. They can have many functions – one primary school in Rotterdam even has its playground on its roof. In another example, football pitches had to be removed for the construction of a new branch of IKEA in Utrecht, but IKEA has laid new pitches on the roof of their car park instead. Encouraging sport in this way is a form of socially responsible enterprise. You start to look at roofs from a completely different angle, they have so much future potential. Amazon is using drones to make deliveries, by way of an experiment, but where can they land? On the roof. Your roof as a new front door. So now there is another function to add – logistics. What colour would that be? Purple?”

For more information, visit DakAkker Schieblock and DakAkker Rotterdam.
**Bees on the roof**

High up in the heart of the Rotterdam city centre live around 150,000 bees. On the green roof of the Thornico building on Westblaak, beekeeper and operational manager Richard Capelle is himself as busy as a bee with the building, the greenery and his bees.

Danish entrepreneur Christian Stadil, the owner of the building, believes in company karma – if the business is doing well, it should also do good things, for people and the world. That is a philosophy with which Richard Capelle entirely concurs. “The greenery on the roof was his idea and is a real-life representation of his green way of thinking.

A green landscape has been created here on two roofs, covering a total area of 480 m². It is covered with sedum, and there are other lovely plants blooming here in the summer. There are three beehives on the roof, each housing 50,000 bees. The greenery is good for biodiversity as it attracts insects, which in turn attract birds.

I come here every day – to think that I was once afraid of bees! When the owner came up with the idea of keeping bees here, I thought I would do a theory course, but that someone else could actually be the beekeeper. But once I started the course, I became so fascinated by these insects that I decided I would like to be the beekeeper myself. I harvest the honey that we sell in jars, and make the world’s oldest alcoholic drink from it – mead. We get regular visits from school classes who are amazed to find out that this is all possible up here on this high roof. They are astonished how green Rotterdam looks from above.”

**3Di makes the invisible visible**

A computer program for instantly visualising water management

An unexpected breach of a dike, extreme rainfall – we can take all the measures we like, but predicting what the consequences of a disaster would be is still a difficult task. However, the recently introduced innovative 3Di simulation program means that it has now become much easier. It allows calculations of the consequences of floods and extreme rainfall to be made much more quickly, and also gives a visual representation of the situation. This revolutionary system is accessible to anyone involved in water management.

“It is comparable to the difference between walking and going by car,” says Wytze Schuurmans, the director of the Nelen & Schuurmans water management consultancy organisation, who have spent the past five years developing the 3Di computer program in collaboration with TU Delft and Deltares.

In the past, the process of calculating possible water levels took many days. By the time a particular result was known, a great deal of valuable time had already been lost. In a design process this does not matter, but if a disaster such as a dike breach or extreme rainfall occurs, there is simply no time to make calculations of this kind.

It was emeritus professor Guus Stelling who set the ball rolling on the development of 3Di, explains Wytze Schuurmans: “Stelling showed how the calculation of water levels could be done a hundred times faster than was previously the...
case.” This much faster process greatly appealed to Wytze Schuurmans. “More and more data is becoming available nowadays, including data relating to water management, but existing models and equipment make it impossible for us to process it all. If we can carry out the calculations a hundred times faster, then we will be able to use all the data.”

Benefits

The faster process offers unprecedented benefits. Wytze Schuurmans continues, “In urban areas in particular the faster process is especially significant, as the differences in water depth vary from one metre to the next. If anything were to go wrong in a city, everyone would want a detailed picture of what is happening, and preferably as quickly as possible. In the past, you would have to wait several days, but now the information is available more or less immediately. The new calculation is a mathematical innovation, but the most interesting aspect is the information it creates.”

Thanks to the new calculation method, the consequences of a disaster are shown by 3Di on a screen. The same effect can be achieved in the case of a proposed urban development project. “The latter makes interactive design possible,” explains Wytze Schuurmans. “You can indicate where you would like a green roof and you will see straight away what the effects of this would be. This is a new way of designing in an integrated way in collaboration with others, because the calculations can be done online in an instant. There are no limitations in terms of equipment – anyone can do this on their computer or iPad.”

Various water boards and the major cities of Amsterdam, Rotterdam, The Hague, and Utrecht have already signed up to the service offered by 3Di. Signing up means gaining the option of carrying out the calculations and making visualisations. A single click on a rain shower will immediately show the problems it will cause in accurate 3D models, while clicking on the tap symbol will show where flooding will occur.

3Di in Rotterdam

The Waterplan 2 Rotterdam plan (including the amended version) and the Rotterdam Adaptation Strategy (RAS) describe among other things the approach taken by the city council towards water security and preventing flooding caused by extreme rainfall. Integrated solutions are being sought for creating water storage and, at the same time, to make the city more attractive, greener and economically stronger. “We are using the latest technology in order to keep our feet dry, and we have already eliminated many problems in the water system and more outlying areas. The whole of the city of Rotterdam is currently being modelled in 3Di, so it will be clear in the short term where any problems remain, including during periods of heavy rain,” says Jorg Pieneman, the senior advisor on urban water and drainage at the Rotterdam City Council. It is also possible to use 3Di to see what measures will be most effective, at district, street, and even individual building level. “By combining 3Di with an instrument like the Rotterdam Rain Radar, for example, the city council is better placed to contain flood damage more easily.”

Shot glass

“Whenever our model simulates a flood, the margin of error compared to reality is not much more than a shot glass’ worth,” says Wytze Schuurmans. That is machine precision – and a ground-breaking improvement. In the past, scale models were used in order to show what could happen during floods. They gave a clear picture, but they were not particularly accurate. This was followed by computer calculations, given in the form of graphs and tables that only specialists were able to decipher. Because 3Di is able to process almost every piece of available data and incorporate it into its calculations, it produces a visualisation that is almost identical to the real situation. “The invisible is being made visible,” says Wytze Schuurmans.

Delta cities network

the ideal platform for exchange

Everyone wants to join Connecting Delta Cities

The Connecting Delta Cities (CDC) network now encompasses thirteen cities worldwide. Other cities are clamouring to join the network. In the eight years of its existence, CDC has gone from strength to strength and now plays an important role as a platform for delta cities to share knowledge and experiences.

The first steps towards the creation of the network of delta or coastal cities were taken in Tokyo in 2008. In October of that year, the first adaptation conference of the Ci40 Cities Climate Leadership Group, a collaboration of forty of the largest cities in the world, was held in order to take joint action in tackling the consequences of climate change.

The call for actions which spoke louder than words was not ignored by the Rotterdam delegation. Rotterdam itself is no ‘megacity’, but is involved with the Ci40 network as an ‘innovator city’. The city took up the gauntlet and launched the idea of setting up a network of delta cities. Connecting Delta Cities was born.

Vulnerable

“This is a network of coastal cities – those that are situated on water and therefore vulnerable,” says Chantal Oudkerk Pool, senior policy advisor at the Rotterdam City Council. “Although they are sometimes very different culturally, institutionally, and economically, they still face the same challenges. The emphasis in the network lies on water – that is what links all the affiliated delta cities together.”

Eight cities joined the network straight away. As well as Rotterdam, they were Tokyo, New York, New Orleans, London, Jakarta, Ho Chi Minh City, and Hong Kong. Copenhagen and Melbourne followed later on, as did Venice, Changwon, and Singapore in mid-2014. Worldwide, the cities are at the forefront of climate adoption. The chief aim of CDC is to exchange knowledge and experiences and to derive the benefits that that entails.
“Network offers rapid answers and inspiration”

“Connecting Delta Cities is a very practically oriented network, that is greatly beneficial to us,” says Lykke Leonardsen, head of the Climate Unit in the Danish capital, Copenhagen. Copenhagen had been preparing a climate adaptation plan for some time, but a sudden bout of heavy rain on 2 July 2011 drastically changed everything. “We were expecting a lot of rain,” explains Lykke Leonardsen. “But everyone was taken by surprise by the fact that it was so heavy. It was only then that we realised how very vulnerable we are as a city, and how much we depend on all sorts of primary amenities such as electricity. People do not stop to consider all the things that can happen. They use the cellars of their homes as living quarters, which is not really advisable, as they can flood when there is such heavy rain.”

The value of a network like Connecting Delta Cities became all too clear in the aftermath of that memorable downpour. Lykke Leonardsen explains. “We were able to hold discussions with other cities in the network that had also been affected by extreme weather conditions, such as New Orleans, which had had to deal with Hurricane Katrina, and New York, with Hurricane Sandy.” Exchanging experiences was easy. It helped lead to a preparedness plan for this type of extreme rainfall in the future—a plan for which Copenhagen had been divided up into seven different flood areas, and which entails a total of 470 activities. “Not that every aspect has to be carried out at once!” clarifies Lykke Leonardsen. “Another good reason for receiving feedback is that you always have to bear in mind that your own approach may involve particular blind spots, or aspects that you had overlooked, perhaps. That is why we were pleased to take the opportunity to share experiences. The connections in the network are very close: if we have any questions, we can put them bilaterally to other cities. The network offers not just feedback, but also inspiration. It is a practical way of getting quick and clear answers; it is not an academic exercise with vague answers for the future—it is something people can put into practice.”

Lykke Leonardsen continues, “That is because everything is new. As a government, we have to work in partnership with different parties, which is unexplored territory for us. The same thing applies to water management. It is something people find difficult to imagine. If a cycle path is too narrow or too wide, you simply do something about it. But things are different when it comes to water: it is much more abstract. Also, it isn’t easy to explain that these plans are costly.”

In such a process, it is good to be able to share experiences. “The feedback we get from other cities affiliated to the network is really useful,” emphasises Lykke Leonardsen. “Another good reason for receiving feedback is that you always have to bear in mind that your own approach may involve particular blind spots, or aspects that you had overlooked, perhaps. That is why we were pleased to take the opportunity to share experiences. The connections in the network are very close: if we have any questions, we can put them bilaterally to other cities. The network offers not just feedback, but also inspiration. It is a practical way of getting quick and clear answers; it is not an academic exercise with vague answers for the long term.”

“On these occasions, we often invite other C40 cities in order to maximise knowledge exchange. The participants can discuss matters of substance together,” says Chantal Ouderkik Pool. “The fact that they actually meet face to face improves the contact and relationships that they share. It means, for example, that the European CDC members can join forces when applying for EU funding. Cities may also decide to deepen their bilateral relationships in a specific area. It is all about bringing people together so that they can link up, thereby achieving the best-possible result. We don’t have to do everything together as a group of thirteen, obviously.”

Balance

In the eight years of its existence, Connecting Delta Cities has evolved into an active network that spares no effort to achieve its objectives. The network’s website attracts many visitors. “Once you have such a strong group, everyone suddenly wants to become a member,” notes Chantal Ouderkik Pool. “Although we are keen to disseminate our knowledge far and wide, we are picky about who we share it with, in order to achieve maximum effect. Ballots are held; we want to retain a balance in the network between cities that bring information and those that use that information.” There are various cities that potentially could become members.

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Paula Verhoeven

Paula Verhoeven is head of the Climate Unit of the Copenhagen City Council. She is responsible for two ambitious municipal climate action plans—the Climate Action Plan which aims to make the city carbon neutral by 2025 and the Climate Adaptation Plan.

Chantal Ouderkik Pool

Chantal Ouderkik Pool is a senior policy advisor with responsibility for the implementation of the Rotterdam Adaptation Strategy and for international collaboration.
Water has always been integral to Rotterdam’s existence, and the city has an exemplary role to play when it comes to climate adaptation. Government bodies, knowledge institutes and the private sector are exploring new avenues for finding innovative solutions. For the private sector, the focus on Rotterdam can act as a useful springboard for orders from elsewhere in the world.

The Netherlands has a long history of urban water management. This is especially true of Rotterdam: eighty percent of the city is below sea level. Traditional solutions like dunes, dikes, defence barriers, and quaysides protect it from water.

In Rotterdam climate change is seen as an opportunity to make the city more attractive. With innovations like water squares, rain gardens, and floating buildings, Rotterdam is a living showcase and inspiring example for other delta cities.

The RDC is a regional partnership between education institutes, knowledge institutes, government bodies, design companies, and firms of engineers and architects that specialise in water technology, water management, and urban development. Tim van der Staaij, who has been involved with the RDC since its founding in 2015, says, “Sustainable water management is the worldwide challenge for the next few decades. There is either too much water, too little water, or water which is too contaminated. For example, this spring the north-west of Pakistan experienced heavy rainfall, which led to serious flooding. Water contamination can have other adverse effects, too: it recently emerged that the concentrations of antibiotics in Chinese rivers are too high, causing local residents to develop resistance to them.

In the Rotterdam region, we possess extensive expertise in the area of dikes, locks, and flood barriers, and also when it comes to innovative solutions. This could help many cities tackle the water related challenges they face.” The RDC brings its partners into contact with cities all over the world. “With local stakeholders on the ground we analyse what is needed, and what the challenges are. When searching for possible solutions, we also consider ecological, economic, and social opportunities. And of course innovation is key. Following this phase, the intention of the RDC is to generate business for its partner.”

Several RDC partners are now working in Mexico City, where there is a shortage of water. Ways of getting its water management in order ecologically are now being looked at. Ringsted, in Denmark, is subject to flooding whenever there is heavy rain. The redevelopment of a park has therefore been carried out in conjunction with the creation of additional water storage. Several RCD partners are now involved in Ho Chi Minh City with the redevelopment of District 4, a port area outside the dikes that struggles with floods caused by the river and tropical rainfall. “They are organising workshops here, in collaboration with local government bodies. The aim of the workshops is to create co-ownership. The key to achieving sustainable, climate proofed areas is an integrated approach with collective responsibility.”

Tim van de Staaij is a water and environmental manager with Rotterdam City Council, specialising in interdisciplinary and international collaboration on climate adaptation and resilience projects.

**Bundling Rotterdam’s expertise**

Many of the world’s cities face major challenges from threats posed by water. This is an opportunity for Rotterdam’s businesses and organisations by deploying joint know how and experience, the Rotterdam approach can serve as a model for the whole world. It was for this reason that the Rotterdam Centre for Resilient Delta Cities (RDC) was set up in 2015.

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**Rotterdam’s approach brings international opportunities**

A springboard for the private sector
### Dutch knowledge in America

“Rotterdam plays a crucial and very active role in the international city network,” remarks Piet Dircke, Global Water Management Leader of the Arcadis firm of consultants and engineers. The water division of Arcadis is based in Rotterdam. “Other countries are keen to see what exactly we do in the Netherlands, and they can see that the country is highly dynamic and that new knowledge is being developed here.” The Dutch private sector played an important part in the recovery after the floods in New Orleans. “After the city had been hit by Hurricane Katrina, an American delegation came to Rotterdam to see how we protect ourselves against the water. They learned a great deal about the Moeskerkering (flood barrier), IJOM Campus, the city’s port area, and other aspects. Our battle against the water, but also the way in which we live alongside it, is well-known throughout the world,” says Piet Dircke. “The trick is to develop a sustainable revenue model in which Dutch companies involved with water management can work together.”

### Business in New York

Rotterdam design companies ZUS, 75B, and De Urbanisten are working together with the renowned Massachusetts Institute of Technology (MIT) on the New Meadowlands project for New York and New Jersey. A total of 150 million dollars has been allocated for their innovative and extensive plan, which is aimed at different ‘flood districts’ with different requirements. Architect Rem Koolhaas’s Rotterdam firm of architects, OMA, is also getting involved. A sum of 230 million dollars has been allocated for their innovative and extensive plan, which is aimed at different ‘flood districts’ with different requirements.

### Opening Rain(a)way Garden by Henk Ovink

**Rotterdam - test laboratory and source of inspiration**

Rotterdam is a global player in the field of adaptation and resilience. When it comes to climate proof cities, Rotterdam based companies are involved all over the world. "The Netherlands’ first water tsar, Henk Ovink, says: "Water will be one of the biggest challenges of the coming century and the Netherlands has much to offer in rising to that challenge. Rotterdam will be an exemplary partner in this scenario." Rotterdam is an example for the world. That becomes clear from all the rankings relating to architecture, travel, economic opportunity, and leadership. The port, its industry, the public sector, and knowledge and culture institutes are all on board."

The city is showing that thinking smartly and acting smartly go very well together and really do have an impact this makes the city both a test laboratory and source of inspiration,” says Henk Ovink, the Netherlands’ first ever water tsar. He is the ambassador for the country’s international water ambitions, and is helping to improve the international marketing opportunities for the Netherlands’ knowledge and skills. “I work all over the world, with numerous partners such as Rotterdam on raising water awareness, crisis management, and new projects. Wherever there are problems of excess water, water shortages, or polluted water, I can help. This mainly involves city based tasks, problems in river areas, or questions of international diplomacy. After all, water is no respecter of man made boundaries. Together with the UN, the World Bank and our international partners, I am now working on a programme for targeting global water related investment in innovations that will inspire the world to do things differently. Rotterdam is not only a partner in this context, but also a showcase.”

The whole world is looking with interest at how the Netherlands, and Rotterdam in particular, deal with water. In October 2015, Rotterdam organised a Network Exchange programme as part of its role in the 100 Resilient Cities programme, targeted entirely at the integrated approach to water used by the Netherlands. Chief Resilience Officers and other representatives from Bangkok, Thailand; Berkeley, USA; Mexico City, Mexico; New Orleans, USA; Norfolk, USA; Rome, Italy; Surat, India; and Vejle, Denmark were invited by Rotterdam to visit the city in order to learn and to exchange knowledge. Rotterdam has been host to the International Architecture Biennale Rotterdam for more than fifteen years. The integrated approach involving collaboration and innovation is being continuously tested in many locations around the world, including in Rotterdam of course. This design approach strengthens innovation and quality, and good designs create value. If we do it right, we will generate new prosperity.

This makes the city not just an example and a source of inspiration, but also an initiator and organiser of knowledge exchange relating to the urban approach to water and climate change. Henk Ovink says, “Mayor Aboutrikhe has an important role to play here. He knows better than anyone the opportunities that can be gained if we successfully create links, enter into genuine working partnerships, and show that we are world leaders in climate adaptation.”

The strong international partnerships between governments, the private sector, and knowledge partners have enabled businesses in Rotterdam to get a real head start compared to many other partners. Henk Ovink continues, “These partnerships are important: the innovative projects that have been accomplished in the past from relocating the old ports to the west, to the water squares and water storage under car parks have always been carried out jointly by the relevant parties in Rotterdam.”

### Emergency airport

In 2013, the Rotterdam City Council launched the Rotterdam The Hague Emergency Airport (RHEA) initiative together with Schiphol Airport Amsterdam for offering smart, rapid, and effective help to areas that are struggling. The concept is still under development, with the market in the rescue, relief and resilience sector currently being approached.

RHEA brings together the expertise from the leading regional sectors and makes it possible for knowledge and material to be made available for flooded areas, for example. Linking existing networks like the ROC with experts in a knowledge centre helps create new innovations, which can help ease the burdens faced by international organisations and government bodies during times of emergency.

For example, it is possible to allow drones to fly over flooded areas as a way of gaining a rapid picture of the situation. This also involves working closely together with other recognised aid organisations. The ultimate aim is to add to existing structures and organisations and for all parties to excel in their roles, thereby limiting the emotional and economic damage that disasters leave in their wake.

In the Rotterdam approach, everything is combined a pleasant and attractive city to live in and work in, with water safety and economic opportunities. It is all about contributing Dutch knowledge, what the city has learned from the Delta Works, as well as what has been learned from these things that have not gone so well! It is about determining what measures are appropriate to what areas, and adapting them to the local culture.
Water authorities

water safety should not be taken for granted

“With a joint robust water plan, we can really get to grips with the challenges we are facing”

The city of Rotterdam deals with three water authorities, as far as water management is concerned. On the northern bank of the Neu Meuse, this is the Schieland en de Krimpenerwaard regional water authority and the Delfland regional water authority. On the southern bank, it is the Hollandse Delta water authority. When carrying out climate adaptation measures, Rotterdam cannot ignore these organisations. What do the water authorities do exactly, and how has their position evolved? We asked two ‘dike wardens’ and a ‘deputy dike warden’ (water authority chairmen).

How would you describe the water authorities? Hans Oosters, the chairman of the Schieland en de Krimpenerwaard regional water authority, replies, “Rotterdam was originally an urban development in the much larger Schieland region. So, from the very creation of the water authority, we experienced the growth of the city as it happened. The water authorities in the Rotterdam region have a major part to play in Dutch water management, in terms of their range of duties. The importance of the various duties can be measured by their intensity. The substance of our work is always determined by current events. That makes our work varied and interesting and places a great deal of responsibility on us. We could be working on water safety, making room for water, having clean water, combating drought and salinisation; our core tasks can all take priority as a result of changing circumstances. In carrying them out successfully, there are four key aspects. These are the art of anticipating by innovating, the capacity to work together or to entrust the work to others, acquiring scope for change, and working more sustainably. Good water management is about always being one step ahead of changing circumstances.”

Jan Geluk, the chairman of the Hollandse Delta water authority, continues, “We are the oldest administrative layer in the Netherlands, but also the most modern. In 1950, there were around 2500 different water authorities. As a result of mergers, that figure is now 22. We work innovatively, purifying water with high-tech equipment, for example. We are also efficient and very business-like in how we operate. We are a functional, democratic organisation and we are careful in handling our financial resources. The remarkable thing is that in the Netherlands, we have created a separate administrative layer for water, which is elected by the people – citizens and businesses alike. That makes the system unique, because it means that water is always treated as a priority in the decision-making process.”

Hans Oosters adds, “That is indeed unique. It means that you make the right choices even in times of crisis. Many countries are quick to wrongly prioritise as soon as the economic picture becomes less favourable. That might mean reduced spending on maintenance of dikes or equipment, as a result of which the likelihood of flooding increases. Take a look at one of our pumps – they look as though they were only installed yesterday. In other words, ours is an administrative layer that guarantees safety. I am convinced that of all the government administrative layers, the water authorities are best placed to give people the feeling and confidence that the government is there for them. Our tasks and our work are found in the front and rear gardens of both citizens and businesses.”

Marcel Houtzager, the Deputy Chairman of the Delfland water authority, says, “That independence – of our organisation – is a good thing. Apart from water, there are no other considerations that we have to weigh up when making decisions. However, we cannot do it by ourselves; I have noticed that we are increasingly turning outwards. Together with other parties, such as local authorities, businesses, social organisations, and residents, we are looking for acceptable solutions for the water-related challenges facing us. In Rotterdam, the three water authorities have decided to act jointly as one body, which makes things much clearer. We work together really well and our working relationship with the Municipality of Rotterdam is also excellent. With a joint robust water plan, we can really get to grips with the challenges we are facing.”

Hans Oosters adds, “I always enjoy talking about how the role of the water authorities came into being. Their functional task can be traced all the way back to the thirteenth century, when Count Floris the Fifth set up the first water authorities in this area. It was in an area of boggy marshland with rivers that regularly flooded over the land, and people quickly realised that by digging a ditch, the land would dry up. However, it would also cause the land to sink. Whenever you construct water-related features like dikes, dealing with flooding becomes manageable. This was not a private matter – it had to be a public one, which is why the Earl appointed administrators to take charge of the process. Everyone had to get digging with their spades. This was followed later by a financial contribution towards water safety, levied in the form of a tax. In exchange, people were given a say on the management of the water authorities. That’s how it all started, and that’s how things are today. The good thing is that this administrative layer stems directly from the physical environment of the low-lying delta.”

Marcel Houtzager says, “What people often forget is that we live and work in a region that is below sea level. Without our dikes, our system of ditches, canals, and waterways, and the pumps that remove the excess water, some areas around Rotterdam would be three to even six metres under water. I would venture to say that in most places we have our main tasks well under control. However, the city is still expanding. There are more and more hard surfaces, as a result of which the rainwater is no longer absorbed into the ground, but instead flows directly into the drainage systems. Space to accommodate water is becoming ever scarcer. Meanwhile, the changing climate, the effects of which we are seeing increasingly frequently with heavy rain showers, means that we actually need more space in order to hold water. So our work is never done. It requires a different, smarter approach from us as water authorities.”

What is the greatest challenge for the water authorities? Jan Geluk answers, “Sea levels are rising and the land is sinking. This is a geological phenomenon with consequences for our dikes, just like climate change. If more precipitation falls, the rivers have to be able to cope. Both Rotterdam and Dordrecht are faced with the
problem that the water is almost lapping at their doors. Accommodating new dikes in these urban areas is an enormous challenge. It is also much costlier than in rural areas. This is one of our most important tasks, but it requires spatial planning measures as well, which are in the remit of the cities and the provincial government. In addition, because of the predicted low level of river discharge, there will be problems relating to the intake of fresh water. So water from the sea is advancing and that leads to salinisation. These are major concerns.”

Hans Oosters explains, “We have to prove the value of what we do every day. If we continue working on water safety as we have done since 1953, then we will stay ahead of the developments and threats associated with climate change. Good cooperation is key. Flooding in urban areas can only be resolved if government bodies are prepared to look beyond their own areas of responsibility and if people in organisations are prepared to operate in a more interdisciplinary manner. We have to end the increasing use of stone and asphalt and raise water awareness across the board. This applies particularly to Rotterdam, which has been chairman of the Schieland en de Krimpenerwaard regional water authority since May 2015. He is responsible for the water safety, urban water management, and climate adaptation portfolios. Prior to that, he was the deputy mayor of the Delfland water authority since September 2005. He also has been the chairman of the Dutch Water Authorities on 1 January 2016, in which function he has the water safety, crisis management, and e-governance portfolios, among others.

Jan Geluk says, “As far as raising awareness is concerned, the experiences of other countries are helping us. Look at what happens when there’s a hurricane like Katrina, or Sandy. Such events are constantly in the news and that makes people think. But it is true – people here are quick to say that everything is fine. In propagating that awareness, there is a task for the cities and also for the water authorities. I see a difference here between the countryside and the cities: farmers often know exactly what is going on, more so than the people in the cities. That is why we really want to get people from the cities on board – that is the big challenge that we face. To that end, the water authorities have to have the right people. What also helps is that the water authorities have made various apps – for example for water safety and for the blue link between the Zuiderpark and the Old Meuse.”

Can the centuries-old water authority administrative model be a successful export for climate adaptation in other countries? Marcel Houtzager answers, “It is already being exported. We receive many foreign delegations and share our knowledge. The economic damage after a flood is enormous and so it is only right to share the tools that we have. Examples include the rain radar that shows future weather patterns in close detail and 3DIs that uses rapid calculation models to show the effects of a dike breach or sudden burst of extreme rainfall, thereby identifying the problem areas. We are particularly keen to learn from each other’s projects and solutions. All this knowledge has been pooled on the recently launched digital platform, Water Window, which is accessible to everyone.”

Jan Geluk says, “We get asked a lot of questions from people in other parts of the world, of whom are effectively asking whether they can create the same system as we have. In South Africa, we are in the process of setting up water authorities in the Durban region along the lines of the Dutch model. In that sense, our administrative model can certainly be an export item.”

Hans Oosters adds, “The water authority is definitely exportable. First and foremost, it is about the technical knowledge we possess: delta technology, like building dikes and purifying water. Dutch collaborative partnerships and innovations in water management and waste water purification, such as AquaReluse and RINEW, are very much the subject of interest from abroad. The way in which we organise water management here is also exportable. Several years ago, for example, we were asked to help with a polder in Semarang on the Indonesian island of Java that used to fill with water twice a day, while the soil was sinking due to water being extracted from it. Our work, then, is in shaping the organisation – water management is delegated to an elected board that is responsible for dikes and for maintaining installations. Taxes are levied for this. Indonesia has adopted it as a model that can also be used in other cities.”

The roof park lies on one of the dikes of the Delfland District Water Board

The degree to which water safety is taken for granted in the Netherlands is very high. Everyone assumes that the country is safe. How can the water authorities deal with that?

Hans Oosters replies, “There is indeed a lack of awareness. People have the feeling that there is nothing to worry about and are unaware of the risks. We also know now that if we want to reach our climate objectives, both in terms of preventing problems and of limiting the rise in global temperatures, then every little helps. This is not some idealistic dream, but a necessity that we have to explain, again and again, what the problems are, and we want to paint a visible role in doing so. As water authorities, we have already achieved a great deal because in recent years we have grown closer together and mutually strengthened each other. But together, we can paint a fuller picture and run faster.”

Marcel Houtzager says, “We are experiencing intensive bursts of rain and longer periods of drought with ever-greater frequency, which has significant consequences for city dwellers. They will be affected by flooding and by heat more often. The solution to these problems can be found on the streets. I believe that the city and all its streets (capillaries) offers opportunities for improving the climate and helping us better adjust to it. Sixty percent of the space in the city is owned by its residents. We will be strengthening ties with citizens and businesses, since they often produce excellent initiatives for improving their living environment. An example is the Natuurlijk Spongen residents’ initiative, which is intended to make the Spangen district greener, more sustainable, and more attractive. Together with the city council, we are supporting their plans for a water school playground, a permeable car park near the Sparta stadium, and sustainable solutions in enclosed gardens.”

Jan Geluk says, “We get asked a lot of questions from people in other parts of the world, of whom are effectively asking whether they can create the same system as we have. In South Africa, we are in the process of setting up water authorities in the Durban region along the lines of the Dutch model. In that sense, our administrative model can certainly be an export item.”

Hans Oosters adds, “The water authority is definitely exportable. First and foremost, it is about the technical knowledge we possess: delta technology, like building dikes and purifying water. Dutch collaborative partnerships and innovations in water management and waste water purification, such as AquaReluse and RINEW, are very much the subject of interest from abroad. The way in which we organise water management here is also exportable. Several years ago, for example, we were asked to help with a polder in Semarang on the Indonesian island of Java that used to fill with water twice a day, while the soil was sinking due to water being extracted from it. Our work, then, is in shaping the organisation – water management is delegated to an elected board that is responsible for dikes and for maintaining installations. Taxes are levied for this. Indonesia has adopted it as a model that can also be used in other cities.”

Roeing course combines three functions: (top) sports, a multi-purpose recreational area and a water storage (Schieland and the Krimpenerwaard District Water Board)
Things have remained eerily quiet in the cities in the period following the revolutionary Paris climate agreement. What has happened to all that energy and euphoria? Cities are becoming increasingly important in the world economy, but they are also the worst producers of pollution. The time has come for action.

The Paris climate agreement was a historic breakthrough, because every country expressed the wish to limit the rise in temperatures to ‘well below two degrees’. Even during the conference, administrators from major cities worldwide were involved in discussions on the measures to be taken.

Rotterdam was very much at the heart of the discussions, precisely because we are aware of the damage that a contaminated area can inflict on life and well-being. The urgency in our city is very clear, and it is that urgency that prompts us, together with experts, the people of Rotterdam and its businesses, to work on cleaning the air and controlling global warming.

Many organisations around the world have taken the agreements seriously and are hard at work. Shell is going to invest in wind energy, while the Rockefeller family will be leaving Exxon Mobil in the near future. The Rockefeller Foundation is convinced that the world’s major cities are the most important driving force behind innovation and collaboration.

However, it seems to be these very cities that have found the historic Paris climate agreement swept away by the avalanche of other news events, both large and small. But this does not mean that the urgency is no longer there; more than ever, it is cities that are needed to produce practical solutions.

The Paris climate summit offered opportunities to tackle environmental problems quickly. Cities should be taking action now and coming up with new measures. In Rotterdam, we are well aware of the risks of climate change. We have always had to arm ourselves against the water in our low-lying delta city. Being water-safety conscious is in our genes.

The ‘Duurzaamheid dichter bij de Rotterdamer’ (‘Making sustainability a way of life for Rotterdam’) programme was recently adopted almost unanimously by the Rotterdam City Council.

Nearly every political party agreed to a whole series of sustainable measures. However, we have to strike while the iron is hot, which is why Rotterdam has come up with an additional package of measures on top of the sustainability programme. Which city will be next?

Pex Langenberg
Vice Mayor for Sustainability & Mobility, City of Rotterdam
Discover delta city Rotterdam with the
Delta City App

Rotterdam is a Delta City par excellence. Due to its location next to the river Meuse and close to the North Sea the city, port and region need to be protected by a network of water barriers. The Delta City Rotterdam App is a great way to explore Rotterdam and at the same time discovering the measures the city takes to protect itself against the ever present water: sea, river, rain and ground water.

Unique hotspots let you discover the broad network of innovative solutions such as multifunctional dikes, water plazas and the Maeslant Barrier. Learn about the actions Rotterdam as a Delta City takes to protect itself against flooding as a time, where new challenges present themselves as a result of climate change. Smart spatial design and multifunctional solutions contribute to a more attractive and economically strong city. Discover how Rotterdam connects water with opportunities.

With the Rotterdam Delta City App you can easily locate and visit the places and constructions that keep Rotterdam safe, dry and attractive. Additional information in the hotspots gives you all the insight on how and why these measures work and how they are part of an integrated strategy for the entire city. Navigate your way across the sustainable world port city of Rotterdam!

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DELTA Rotterdam       54
CONNECTING WATER WITH OPPORTUNITIES

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Text
Ben Maandag
Monica Verhoek

Coordination
Lieke Smets
Nicoleen Wenschell

Layout
Uit de Kunst

Photography
Rogier Bos, C40, Roel Dijkstra,
Eric Fecken, Luuk van Kaathoven, Johannes Odé, Jan van der Ploeg, 12 Provinciën,
Gemeente Rotterdam, RNW

Conceptdesign
De Urbanisten, Rien Zilvold

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