Benthemplein
The world’s first water square

Rotterdam’s tools for Climate Change Adaptation Strategy

Aqua Dock’s water lots

Connecting Delta Cities shares knowledge and exchanges experience

Even with safe dikes, you need to stay alert
Rotterdam is a delta city and located in the delta of the rivers Rhine and Meuse. Via the Nieuwe Waterweg, the city has open links to the sea and is influenced by the tide.
Climate change has made delta cities a focus of interest. Population growth and density are particularly high in low-lying delta cities. The effects of rising sea levels and changing discharges, as well as longer dry spells, will be felt more strongly here.

Extreme weather events (e.g. superstorm Sandy, which hit New York in 2012) have increased this interest. The images of New York, but also those of New Orleans (2005), Bangkok (e.g. in 2011) and Jakarta (e.g. in 2007), are impressive. The high levels of precipitation which increasingly affect the Netherlands, are often taken as an example of the increase in extreme weather events. People wonder: how truly safe and climate-proof are our coastal and delta cities? Should we not take action?

Although Rotterdam is one of the safest delta cities in the world, it is vulnerable because of its location in the Dutch delta. In this publication, we will present how Rotterdam is setting about climate adaptation. The articles will give you an impression of what research and educational institutes, water boards, the private sector and the municipality of Rotterdam have undertaken to adapt the city to climate change. Also, we do not regard climate change as a threat, but rather as an opportunity to make the city more resilient, appealing and economically stronger. In this way, Rotterdam will remain a safe and liveable city in the Dutch delta, where people like to live and work.

Ahmed Aboutaleb  
Mayor of Rotterdam
Climate change adaptation… opportunities for present and future!

Benthemplein: the world’s first water square

Climate change adaptation emphasises opportunities

Rotterdam’s tools for Climate Change Adaptation Strategy

New: ‘aquatic spatial development’

Centre of expertise for floating constructions

Even with safe dikes, you need to stay alert

Putting dikes to greater use

‘Greenery is good for the urban climate and for the well-being of the residents’

The delta cities network is the ideal exchange platform

The city’s floating calling card

Entire cities could benefit from green roofs

3Di makes the invisible visible

Dry feet even outside the dikes

Working together on a vital and climate-proof district

Rotterdam: launch pad for the corporate sector

Rotterdam can’t do without the three water boards

Climate adaptation increasingly important in the Rotterdam area

Rockefeller Foundation selects Rotterdam
This magazine offers insight in Rotterdam’s take on climate change adaptation. Both the sense of urgency and the desire to seize the opportunities that come with change, are becoming increasingly commonplace in Rotterdam. The Floating Pavilion was the first stepping stone for floating construction. It now fulfils its role as new initiatives spring around the old Rotterdam harbour areas, such as AquaDock. Water square Benthemplein could prove to be of similar stature, as the Zomerhof district’s development shows.

The city of Rotterdam is in a state of transition, in more ways than one. The approach to water and adaptation is shifting to a more holistic, integral mode. Ambitions within the city are now combined with external conditions, such as weather patterns. Climate change adaptation, spatial development and local economy have all become part of the same equation.

**Freeze-frame**

Today’s situation is a freeze-frame, a single moment in a process of development that started over a decade ago. The first Rotterdam Waterplan, covering the years 2000-2005, was followed by policy that has included climate change since 2008. In 2013, the Rotterdam Climate Change Adaptation Strategy gave the city its future course, aiming to benefit the city as a whole, as well as its residents and companies.

**The Rotterdam showcase**

Beside solutions, adaptation provides business opportunities. In 2008, Rotterdam Climate Proof initiated a cycle of learning, innovating, implementing, showcasing and exporting. Businesses in the Rotterdam area receive orders from other (delta) cities New York City and Ho Chi Minh City, to name a few. At the RDM Campus, students work on the AquaDock. Institutions such as the Rotterdam University of Applied Sciences and the Delft University of Technology join overseas counterparts more and more, boosting international research and education, while offering students ‘real’ challenges from ‘real’ delta cities.

**Worldwide collaboration**

With its partners, Rotterdam could extend its profile of ‘community of practice’ for sustainable and resilient delta cities. By continuing the quest for innovation, strengthening the city and its surrounding area. By including more and more aspects of the city and the port area, such as energy and ICT, as promoted by the Rockefeller Foundation’s ‘100 Resilient Cities’ campaign. And by making sure others may benefit from these proven concepts, in the Netherlands and abroad. Networks like Connecting Delta Cities prove the value of collaborating peer cities.
Climate change adaptation... opportunities for present and future!

1. Connecting Delta Cities central meeting (June 2013)
2. Official opening of Floating Pavilion (June 2010)
3. The Royal Couple at the 2010 World Expo
4. Info market on green roofs at the DakAkkers (Rooftop Crop)
5. European cities meet in Rotterdam (October 2012)
6. Shanghai World Expo (May 2010)
7. 100,000 m² of green roof in Rotterdam (May 2012)
8. Official opening of Benthemplein water square (December 2013)
9. Rotterdam vice-mayor Pex Langenberg (Sustainability and Climate Change 2014)
10. Prince Willem-Alexander visits ‘Deltas in Times of Climate Change’ conference (September 2010)
The square’s steps are showing the first signs of wear from the skating,” notes Florian Boer, architect with De Urbanisten, the firm that conceived and designed the world’s first large-scale water square. This wear says something about the intensive use which young people and students from the surrounding areas make of the water square. Moreover, one should bear in mind that this intensive use of Benthemplein in its present state has only been going on for a little more than a year. The square is popular. “But it is also a success as far as water management is concerned,” says Florian Boer.

The world’s first large-scale water square kills two birds with one stone; when there is heavy rainfall, it collects a vast amount of water and then returns it to nature. The water square also embellishes the city. Students who take classes in the surrounding buildings spend many happy hours on the square, playing basketball, kicking around a ball, skating or simply talking to each other on one of the square’s steps.

A Wall of Water
When it rains heavily, the square turns into a water storage reservoir. The water from the schools and from the church located on the square is collected in two shallow basins. Water from the areas surrounding the square flows into the deepest basin, which can serve as a field for playing basketball or football when it is not raining. The flow of water on the square can easily be followed: it flows through wide gutters to the basins. When it rains extremely hard, the water from the surrounding areas pours into the deepest basin, a wall of...
water cascading down. The sections of the basins that fill with rainwater have been marked blue.

The water does not stay in the basins for very long; it is absorbed into the ground or drained into the nearby Noordsingel within 24 hours. Florian Boer: “In this way, the water flows back into nature and Benthemplein unburdens Rotterdam’s sewage system, which has difficulty handling a large amount of rainwater within a short space of time. Agreements have been made with the Municipal Health Service regarding the time in which the water must be cleared from the square. It should, of course, not present any danger to public health, and especially not irresponsibly expose young children to potential risks.”

Young children are not often to be seen on Benthemplein. The square is closed in by the Technikon school complex, which was designed in the late sixties by the well-known Rotterdam architect Huig Maaskant. “He was oblivious to outdoor areas,” says Florian Boer. “According to architectural practice at the time, the urban life of students could take place indoors. His design included a tower of gymnasiums, one on top of each other: the students had to play sports indoors; playing outside was for country folk.’

An unappealing expanse
For a long time, Benthemplein was an unappealing expanse of concrete paving stones which no one was very happy about, particularly the surrounding schools, Zadkine and the Grafisch Lyceum (a creative college for media, design and technology). It was, therefore, a unique opportunity to realise the first ‘We kick a ball around here whenever we can’

Whenever they have some time off from their study programmes at Zadkine, a regional college for secondary vocational education located on Benthemplein, Ferhat Guler (21) and his friend Ajene Wansing (21) can be found outside on the square. “Weather permitting, you’ll find us out on the square,” Ferhat says. “We send a text message to find out where the other is. Even if we only have a ten-minute break, we go to the square to kick a ball around.” Ferhat is following a course in International Event Management Studies, and Ajene is following a course in Fashion and Tailored Clothing.

“When the weather is good, I bring a basketball to school,” Ferhat admits. Ajene adds: “Sometimes there are more people on the square who then join us. Sometimes it’s just the two of us. When the weather is really good, the square is jam-packed.” They are quite aware that Benthemplein is not just any square. “They told us in school what it’s for,” says Ferhat. Ferhat adds: “When the square was being built, they explained to us what a water square was. You can see quite clearly that water plays a major role. When it’s raining, we don’t play basketball, since the square fills with water. When it’s better weather the next day, the water hardly causes any problems anymore, since it will all have drained away.”

Both students are happy with the square, since it gives them the opportunity to indulge in their favourite pastime. Ajene: “I think it’s a nice square. It’s just a shame that there’s only one basket on the playing-field, while there are two goals for footballers.” “I think it’s a nice square. It’s just a shame that it becomes dirty so quickly,” Ferhat adds. “When it’s dirty, fewer people come. There are only a couple of bins on the square – it wouldn’t do any harm to have a few more.” In particular, when it gets warmer they have noticed that a large number of people use the square. Ajene: “Some people come to sunbathe for a few minutes.” Ferhat: “The last time I was here, they had just started a photo shoot. It’s nice to see that the square can even serve such a purpose.”
large-scale water square here. Florian Boer: “The Maaskant school complex failed to acknowledge the function of the square. With the water square, the public space has reclaimed its position. A water square calls for specific forms – there should be as few obstacles as possible.”

Three workshops were held with all parties involved in order to agree on the right design. Locals from the Agniese district attended, as well as representatives from the church, the Hofplein Theatre (which borders on the square) and, of course, the schools. During the inspiring meetings, those present made it clear what elements they would like to see included in the square, and the use of water was understood to be an essential element. “Everyone thought the use of water was interesting and exciting,” says Florian Boer. This resulted in three designs, which incorporated the most preferred elements: a playing-field, a green space, opportunities to skate and a place where one could sit and do some people-watching.

Florian Boer: “In the second workshop, the people who would make the greatest use of the square were given a choice. We combined the two favoured designs. We looked at things that could be improved. The amount of greenery was increased on the square. People liked the water, since it clearly formed part of the design. Although the water was, of course, not meant to be played in, everyone really wanted to be able to see the water flowing when it’s raining.”
Climate change adaptation emphasises opportunities

The Rotterdam Climate Change Adaptation Strategy as an inspiring story for the immediate future

Since the end of 2013, Rotterdam has had its own adaptation strategy. The Rotterdam Climate Change Adaptation Strategy has set out the course which the city wishes to take to prepare for climate change. The people who conceived the strategy saw it gradually gain momentum. That is largely shown by the future perspectives, which show how opportunities benefitting the entire city can be seized by working together.

Expertise in climate change forms the basis for the Rotterdam Climate Change Adaptation Strategy. Both national programs such as Knowledge for Climate and local studies and research provided information on the local consequences of climate change. The next step was to turn this expertise into an inspiring story and a clear and appealing coping strategy for Rotterdam.

“We knew that we had to come to such an adaptation change strategy, but we still didn’t know how,” says Corjan Gebraad, Climate Change Adaptation Adviser with the City of Rotterdam. “We used our common sense to determine what this would require.” When we had gathered all the knowledge, we were able to take the next step: to analyse and visualise the ways in which and the places where the city was vulnerable to the effects of climate change. Corjan Gebraad: “Our starting point was that Rotterdam had to become one hundred percent climate-proof. But what does that mean when you don’t have a relevant benchmark? You can only decide on an approach for a city’s vulnerabilities when you know what these vulnerabilities are.”

Opportunities

“By linking the climate effects to measures that were likely to be effective, the Rotterdam Climate Change Adaptation Strategy became more concrete,” says Dirk van Peijpe, an urban designer with De Urbanisten, the agency which combined the various components into an interesting and
coherent story. “It therefore became increasingly clear what kind of story we wanted to tell.” In this way, preparations for the strategy gradually got underway. Corjan Gebraad: “Throughout the process, we thought it was very important to consider not only the risks during our analyses, but also - and especially - the opportunities presented by climate adaptation. We really wanted to emphasise these opportunities from the start. This was also one of our criteria.”

By integrating climate adaptation with the other problems facing Rotterdam, the strategy created its own momentum. “The point was then to decide on the added value that we could create, and on the parties we could involve in climate adaptation,” says Dirk van Peijpe. Corjan Gebraad: “The robust system that was built in the city centuries ago forms the basis for the adaptation strategy. This system of flood barriers, dikes, sewers and pumping-stations functions properly. We can manage with this system for the time being if we continue to maintain and improve it. But that will not be sufficient in the long run. We will have to cast our nets wider. Why don’t we make use of the roofs? Why don’t we use the squares? By doing so, we will add a new layer of measures, linked to the public spaces. The city will also become more appealing, as a result. These spaces could be private property or public domain. This will also mean that a larger number of parties will be involved. We want to involve them. That’s what we called “riding piggyback” in the strategy: riding piggyback on the initiatives and projects of others. That’s the only way to climate-proof a city to which everyone is committed, and where the public authorities are no longer the only “players”.

**Perspectives**

Riding piggyback offers opportunities for connecting parties, for extending and combining initiatives. Together, the residents, businesses and public authorities can create the added value brought about by climate adaptation, the added value for the living environment, ecosystems, the economy and the community as a whole. To illustrate this, several perspectives have been outlined in the Rotterdam Climate Change Adaptation Strategy which show what cleverly applied climate-proofing can bring about. The perspectives have been worked out per district.

“It was just what the Rotterdam Climate Change Adaptation Strategy needed,” Dirk van Peijpe says. “It was an amazing process to work out these scenarios. The problems are known, and we know what measures we can take. For example, we have a dike, and we know that, in the long run, it’s better to heighten it. However, you can create added value by using this dike for other purposes: take a comprehensive approach to the dike, for example, by linking it to a park, or by widening it to make it suitable for road or building construction. We also made an inventory of the parties who are active in a particular area and who can take part. For example, the parties active in
the city centre are not the same parties as those active in the area outside the dike.”

A striking example of climate adaptation, according to the Rotterdam Climate Change Adaptation Strategy, is Bentemplein which was developed as Europe’s first large-scale water square. Corjan Gebraad: “It was an adaptive measure, whereby the water problem was linked to the public space which, in turn, was linked to the neighbourhood and the district. A European subsidy was granted for this purpose. The benefits are significant, both in economic and social terms: the square brings people together.” The next step is to investigate the possibilities at area level (e.g. in a neighbourhood or district), as is currently being done in the Zomerhof district. Dirk van Peijpe: “Then go and talk to all the parties concerned in such an area and try to link all the existing initiatives to climate-adaptive measures. You could say that we are implementing the adaptation strategy in the Zomerhof district. We can also do this in many other places in the city.”

Optimism
The people who conceived the adaptation strategy are very optimistic about the possibilities and opportunities the document offers. Dirk van Peijpe: “We are in the middle of a transition period. We are learning more and more about the implications of climate change for the city and its residents. Climate change adaptation therefore increasingly features on the agendas of city developers. That’s a nice task for the city planners. It is also interesting from an economic point of view, since adaptation pays off in all respects, both large-scale and small-scale.”
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 Tyron Serious Gaming.

Rotterdam’s tools for Climate Change Adaptation Strategy

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.
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.

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.
In 2013, the City of Rotterdam issued tenders whereby companies were invited to come up with plans and ideas on how to integrate this harbour into the city in the years ahead. This was to be done, not by filling up the harbour, but rather by using the water in an innovative manner whilst taking into account factors such as the rising sea level and the higher levels of river and rainwater. The companies were challenged to come up with surprising and innovative solutions for regenerating the Rijnhaven and integrating it into the dynamic surrounding areas of the harbour basin.

Radical changes

“The key question is how an area like the Rijnhaven can be made functional without making any radical changes, such as erecting tall structures around it,” says Maarten Nypels, creative project manager with Stadshavens Rotterdam, which includes the Rijnhaven. “Doing nothing with the water is not an option for Rotterdam. In any event, climate change has consequences, whether we like it or not. Despite the fact that many of the causes - and solutions - lie far beyond the municipality’s boundaries, we can explore the possibilities of how we can best respond to this.”

That is exactly what happened, resulting in the first spatial development on the water for Rotterdam. A bid book was compiled for interested companies. “This bid book imposed as few preconditions as possible, offered a 30-year concession period and emphasised that the municipality would not be able to invest money in the project,” says Sander Geenen, Business Project Manager for the City of Rotterdam for the Rijnhaven project.

The Rijnhaven is a unique testing ground. It was, therefore, not surprising that the moment Rotterdam’s municipal council unanimously adopted the masterplan Stadshavens Rotterdam in 2011, all eyes immediately turned to the Rijnhaven. This is where Rotterdam can show what it is worth as far as adapting to climate change is concerned. Our idea at first was to allocate “floating lots” in the harbour, on which companies could implement their ideas. “But why not take a different and better approach,” says Nypels, “and offer a concession on this entire harbour’s area, as a positive challenge to the corporate sector?”

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Several consortia make plans for the transformation of the Rijnhaven

The Rijnhaven, one of the oldest harbour basins on Rotterdam’s southern Meuse River bank, is at present locked in between a number of the most interesting areas in the city: Wilhelminapier and Katendrecht, two new residential areas currently being extensively developed, and older, colourful harbour districts, such as the Afrikaander district, which have undergone many changes over the past few years. It is this special place in the city which makes the Rijnhaven well-suited for a spectacular project: the development on the water in the Rijnhaven area.
Smart ideas

The bid book was completed mid-2013. Seven consortia responded. Their plans were assessed by an international Rijnhaven assessment committee, under the chairmanship of former minister, Pieter Winsemius. The jury included the Spanish architect Joan Busquets, Michael Braungart, author of the book “Cradle to Cradle”, and Patrick Janssens, the former mayor of the City of Antwerp. Three consortia satisfied the tendering requirements and have since received an interim assessment which they can use to further improve their plans.

It is a special process, since spatial development on water is a completely new phenomenon for all the parties involved. In consultation with the municipality, the consortia will further develop their vision into viable business cases. The consortia can look around and enhance their vision with intelligent ideas from the knowledge marketplace, where smaller businesses present their innovative plans. “In this way, we are also trying to make the playing-field as large as possible,” says Maarten Nypels.

Sander Geenen: “We are very curious about the results. It’s really one big experiment, with an open question: what should we do with this area?” The fact that the municipality will not provide any funds for the project, leaving the financing to the consortia, may be called unique and innovative. Maarten Nypels: “This will get the consortia to think even harder about coming up with unique solutions.” The Rijnhaven project is, therefore, unlike any traditional tender. The final objective is also different. “It’s about social benefit,” says Maarten Nypels, “which is entirely different when the focus is only on revenue and profit. In doing so, the consortia will also have to consider the social benefits, something they are not used to doing.”

International example

These social benefits include three important aspects. The development of the Rijnhaven should make a substantial contribution to the innovative response to climate change and, preferably, set an example for the world. It should also improve the quality of life of the residents in the surrounding areas, for instance by allowing them to participate fully in the activities that are to be developed and by creating more jobs for them. Finally, the plans should be an incentive for the changes that are taking place in Rotterdam, in which the city’s focus is increasingly on the river, as opposed to away from it. In all of this, the character of the Rijnhaven, as one of the oldest harbour basins of south Rotterdam, should be preserved. “Just imagine if the Rijnhaven were to become a meeting place for all the residents in the surrounding districts,” says Maarten Nypels.

The two project managers expect the transformation of the Rijnhaven to receive much attention from abroad. “It’s a phenomenon which cities around the world will have to deal with. Harbours fall into disuse. So what do you do about them? That’s the major challenge for port cities around the world. The fact that we are realising spatial development here, on the water, on this scale, makes it unique.”
The waters of the Dokhaven in the Heijplaat district, rippling between the old warehouses of the former Rotterdamse Droogdok Maatschappij, are ready to develop into an enormous testing ground for what can be achieved on the water. Floating constructions, in particular, are high on the list of priorities, but developing, demonstrating and testing new, innovative products and technologies play an important role, as well. All these different elements should contribute to an appropriate answer to the question how a floating city can be realised in the near future.

This testing ground is called Aqua Dock. It forms part of the RDM Campus. All manner of parties have now committed themselves and contribute to it: the City of Rotterdam, the Port of Rotterdam Authority and the Rotterdam University of Applied Sciences are three of the partners which have developed Aqua Dock. Institutions such as TU Delft, Clean Tech Delta and the Delta Technology and Water Valorization Programme are also involved. The corporate sector is also fully involved.

Floating road
Aqua Dock makes water lots available to interested parties who wish to experiment with floating constructions or try out their innovations in the right environment. The lots border a floating road across the water, which was made available by the company Bayards. The road forms the backbone of the watery laboratory. Those who set to work on a lot can make use of the wealth of knowledge which the RDM Campus has at its disposal. It’s with good reason that the letters RDM now stand for “Research, Design and Manufacturing”.

“Aqua Dock is a physical testing ground,” says Gabrielle Muris (director of the RDM Campus) and Bert Hooijer (Director of Research & Education of the RDM Campus). “Everything is geared towards making the knowledge that has been acquired here accessible, testing it and developing it further. All kinds of different disciplines converge here. That’s also in the city’s interest. It goes far beyond just testing and demonstrating.”

Cooperation
Cooperation is the key to Aqua Dock’s success, not only by the parties which found each other when they set up Aqua Dock, but also with other (international) parties. This is an energetic community of practice. Bert Hooijer: “Although Rotterdam has a good reputation as far as water management is concerned,
it’s nice to have something to show for it. There is also a lot of interest from abroad for this. There are contacts with New York City, and with several of its universities.” Gabrielle Muris: “Moreover, we will join the Connecting Delta Cities network. As part of their study programmes, students can do a work placement with companies like ARCADIS. In this way, they get to go all over the world.”

Both directors emphasised that the comprehensive approach is Aqua Dock’s strength. “This is where it all comes together, the public authorities make it possible, other parties take part,” says Bert Hooijer. So this is not only about floating constructions, but also about dealing with energy issues and climate adaptation, about making a city resilient. “Of course, it also has everything to do with the inspiring power of ideas, with the plans that are being developed. We are, therefore, a kind of shop-window which allows us to show the Netherlands and far beyond what can be achieved,” Gabrielle Muris adds.

For example, a floating hotel will be realised in Aqua Dock’s showcase. The development and testing of a floating house and testing of the water quality below floating objects have also been planned. RDM Campus is also taking part in the international Horizon 2020 investigation, where tidal power generation is the main focus. Aqua Dock will serve as a test location in this investigation.

Aqua Dock’s water lots, alongside the RDM Campus, form a laboratory for innovation
Even with safe dikes, you need to stay alert

‘Residents should be more aware of the risks they run’

A flood in Rotterdam? Most residents find it difficult to imagine. This goes to show how the city’s safety has been taken for granted over the past decades. Climate change and socio-economic growth are nevertheless forcing us to take measures to further increase water safety. This not only includes taking preventative measures and building in a water-resistant manner, but also drawing up effective contingency plans as part of Rotterdam’s crisis management. Water safety is not as self-evident as it seems.

Primary dikes have held back the water for many years in Rotterdam. Rotterdam lies in the middle of a delta area. Because that is the point where the North Sea and the Maas, Rijn and Waal rivers converge, the risk of flooding has existed as long as the city has. Nowadays, a large part of the city is situated below sea level. Rotterdam is hemmed in by the water on two sides. “The city is confronted with the influence of the sea, which means a large amount of salt water. But there is also the influence of the river, which is fresh water,” says Nick van Barneveld, senior policy adviser for water safety and climate adaptation.

“If one of the primary dikes were to burst, this would have quite an impact on Rotterdam: the damage to houses and...
the infrastructure would be significant, and there would be fatalities.” In particular, North and North-East Rotterdam seemed to be highly vulnerable then: “A residential area like the Prins Alexanderpolder lies on low-lying land, far below sea level. The land rises towards the river, where the primary water defences are located.”

**Dike improvement**

That almost no one loses sleep over these doom scenarios is something which has evolved over the years. “We did a good job on the dikes,” Van Barneveld notes. “They are very safe here. The primary dikes are former sea dikes, which also held during the 1953 flood disaster. We have learned a great deal from that disaster, a combination of storm and spring tide. We proceeded with dike improvement and coastline reduction.” This has resulted in the addition of three important water barriers. Because the Maeslant Barrier, the Hartel Barrier and the Hollandse IJssel Barrier close at high water levels, they unburden, to a large extent, the dikes in the urban area behind it.

“People often claim that the port will become inaccessible if these defences are closed, but the point is that the port is safe,” says Nick van Barneveld, heading off potential critics. “Outerdike areas accommodate the port, one of the main driving forces of the economy. The closing of the flood barrier will guarantee the safety of this economic driving force.”

Due, in part, to the presence of the water defences, the dikes on both of the city’s river banks are quite high now. The “superelevation” of the dikes fits in very well with the current policy. Nevertheless, it would be ill-advised to sit back and do nothing, emphasised Nick van Barneveld. “Measures will definitely have to be taken. We still assume that the sea level will rise 35-85 centimetres by the year 2100. In any event, this means that, in the long term, the Maeslant Barrier will have to be adapted.”

**Risks**

Much has changed in the recent past as we have been developing policies to protect the city and its population from the water. Nick van Barneveld: “For example, we have started to think more in terms of the risk of flooding. You then don’t only consider the probability that a flood will occur, but also the potential effects of a flood. We used to think in terms of dike rings, of what could happen there. We are now able to make a better and more precise analysis of where floods could occur, and what their effects would be. It is much easier to make a visual representation of this. As a result, every dike structure is now given its own standard specification. We have to meet the highest possible standards since the Rijnmond region is a water-rich river area where there is a high risk of flooding. It is also of vital economic importance. Also, it is about the group risk, as the region is densely populated and a disaster would affect many people.”

A flood risk can be considered on three different levels: preventing floods by taking measures (prevention), making houses and infrastructure water-resistant at the level of spatial planning and drawing up proper disaster plans for crisis management if a disaster occurs. In particular, there is growing interest for the latter level, whilst realising that such plans should really already be in place. Nick van Barneveld: “If something were to go wrong in this region dominated by the sea, it would be almost impossible to evacuate people quickly. You therefore have to anticipate this, but how can you do that when the response time is so short? Without knowing if it’s really necessary, it’s also difficult for the authorities to make the decision to evacuate people as a precaution.”

**Evacuation plans**

The fact that the (presumed) safety of Rotterdam and its surroundings is taken for granted is a matter of some concern for Nick van Barneveld. “Many people don’t even know if they live in an inner or outerdike area.” Moreover, much still has to be mapped out as far as crisis management is concerned.
“Evacuation plans should be in place, and they should be clear,” says Van Barneveld. “Public authorities should know exactly what can go wrong and how many people can be evacuated within a short space of time. We cannot give any clear answers to these questions at this point.” It is, of course, difficult to predict the future and have a cut-and-dried solution ready for every possible risk that may occur. “But it would nevertheless be good if the government would inform its residents about the exact risks and about what the public authorities are doing and what citizens themselves can do if things go wrong. We still rely too much on general disaster management protocols for this.”

But there is still a lot we can do to get prepared. Rotterdam Climate Proof has carried out a few studies into the effects of (potential) floods in the Rotterdam region. For instance, they looked at what would happen if a dike burst were to occur in the Schie between Rotterdam and Delft as a result of extreme levels of precipitation or drying out of the peat embankment. The economic damage, in particular, would be enormous and would extend to all possible layers of society if the regional storage basin system were to inundate the Zestienhoven and Schiebroek polders. The infrastructural arteries such as the A 13 motorway, the main road connection to The Hague and Amsterdam, the High-Speed Railway Line (Hogesnelheidslijn, HSL), the RandstadRail light rail system and Rotterdam The Hague Airport would also be inundated and no longer serviceable.

Complicated

Even a general inventory of the potential effects of such a disaster makes developing an adaptation strategy possible and urgent. At the same time, working out such a strategy is an incredibly complex process, Nick van
Investing in protection is a matter of necessity

Providing protection from floods and ensuring sufficient freshwater are the focus areas covered in the recommendation for the Delta Programme 2014, made by the Rijnmond-Drechtsteden Steering Group, chaired by Rotterdam’s Mayor Aboutaleb. The steering group examined how residents of the Rijnmond-Drechtsteden region will stay protected in case of flooding and have access to sufficient fresh water in the long term.

The number of residents and the value of houses, businesses and infrastructure in this region have increased significantly since the sixties. The economic damage in the event of a flood would be enormous, many times greater than the 1953 flood disaster. Only by continuing to invest in the protection of the delta residents will be able to live and work safely in the region, also in the future.

Existing dikes, flood barriers and river bed widening will continue to form the basis for safety in this region, the Rijnmond-Drechtsteden Steering Group advised. Nowadays, dikes are increasingly improved and heightened on a case-by-case basis. A comprehensive design offers the best opportunities for spatial quality here. The Rijnmond-Drechtsteden region is large and diverse and the measures are comprehensive. However, they do not all have to be implemented at the same time. The Rijnmond-Drechtsteden region has a relatively large number of ouderdike areas where people live and work. All port industries are situated in this areas. Parties in this region have agreed on developing a safety strategy for the entire ouderdike area.

Barneveld emphasises: “Many of the trends which arise from future expectations are uncertain. That’s what makes devising such an adaptation strategy so complicated. You want to take measures that serve a purpose; you don’t want to end up in an endless process of precautionary measures that eventually turn out to be completely useless.”

The study done for the Zestienhoven polder showed that a number of measures are definitely feasible, now and in the future. Building proper water defences and blocking off the storage basin system can quickly halt a flood. Much can be done, particularly on a small scale. “That was an eye-opener for us,” says Nick van Barneveld. “Regional water defences make it possible to properly control risks. We were surprised by the extent to which this is possible. You could also ask yourself if we should adapt, as we build, for example, a new housing development in a polder like Zestienhoven. It makes good sense to make your investments in water-safety measures largely in the partitioning of the storage basin system and the protection of vital infrastructure.”

The interests involved in creating safety are significant; there is much at stake. Nick van Barneveld: “Water safety is something that connects us. It affects everyone, albeit in different ways.”
Putting dikes to greater use

Rotterdam developed the multifunctional terraced dike: a heightened dike that can be used for different purposes whilst retaining its original function. The first terraced dike will be constructed in South Rotterdam as part of the spatial development connecting the Afrikaander district with the Kop van Zuid district.

Some time ago, Joep van Leeuwen, who works for the City of Rotterdam as a senior adviser, conceived the idea of a multifunctional dike: a terraced dike. A terraced dike can hardly be recognised as a traditional dike, since wide “terraces” have been created on both sides of the heightened dike body. These terraces can be used for road construction, landscaping and even for building construction without affecting a dike’s original function as a water barrier.

“The larger a dike, the more revenue it will generate and value it will create,” says Joep van Leeuwen, highlighting one of the benefits of a terraced dike. “Its overdesign is one of the characteristics of a terraced dike. Excess soil can be used to heighten the dike and create terraces. In this way, by creating allocable land or by raising the quality of public space, a wide dike with level terraces can create added value. If you make a dike this large, people no longer realize that it’s a dike.”

In the Netherlands, dikes are subject to strict rules. The water boards watch over dikes so that they retain their strength and continue to serve their purpose, i.e. to hold back the water, whenever necessary. Rotterdam would nevertheless like to use the areas on and along a dike. Joep van Leeuwen: “In this city, it remains necessary to develop the riverfront and, at the same time, guarantee water safety. Constructing new dikes is a very costly business. However, if you take a smart and multifunctional approach to existing dikes, this turns out to be an interesting and affordable option.”
The concept of a terraced dike was groundbreaking, but proved difficult to put into practice. The economic crisis had a considerable negative impact on the construction sector and its productivity. All this will now change. The multifunctional dike will play an important role in South Rotterdam, specifically at the point where it is planned to realise the connection between the Afrikaander and Kop van Zuid districts. For many years, railway yards and a dike separated the two districts. This connection should eventually be realized as part of the Parkstad project. The tracks have been removed. The dike will be heightened from both sides.

“The dike has become a conduit in urban planning,” claims Marcel van Blijswijk, the Afrikaander district project manager with the City of Rotterdam. “Within the parameters set by the water board, the dike has been designated as a regional green route.” Because the dike is as an important (main) water barrier, close consultation with the Hollandse Delta Water Board was necessary when the plans were drawn up. “With the water board, we examined how we could deal with the dike as intelligently as possible,” says Hans van der Aar from the City of Rotterdam’s Engineering Department. “As a result, the municipality’s plans and the water board’s requirements were merged into one. In this way, the dike is no longer an obstacle, but a connecting link. Part of the success is that the municipality is quite aware of the dos and don’ts with respect to a dike.”
‘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.
**Carrier bike**

For her research, she carried out a study in three large cities (Utrecht, Arnhem and Rotterdam), largely concentrating on taking measurements in the microclimate and collecting data. In all three cities, she asked about 180 people from every age group and district what kind of urban space they preferred on warm days. For her research, she went with students through the city of Utrecht on two carrier bikes equipped with measuring equipment to gather information about the heat in a city.

In a city like Rotterdam, the temperature difference between the city and its surrounding areas is sometimes as high as 8° C during hot spells, as shown by measurements taken by her fellow researcher, Bert Heusinkveld. But significant differences can also be recorded within a city during a heat wave. There, the greenest spaces are also the coolest. The places in a city that hardly have any greenery, but where buildings and asphalt dominate, are the hottest.

The interviews revealed that city-dwellers mostly escape to a city’s green space during a heat wave. Wiebke Klemm: “That is where they feel most comfortable. This applies to all three cities where we interviewed people. 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, because they know they are in the shade. Young people know where they can enjoy the evening sun the longest in a park.”

In Rotterdam, the Kralingse Bos stands out from the other parks as the best place to escape the heat in the city. “People from all parts of town go there,” said Wiebke Klemm. The quality of the park is of overriding importance here. “Many people want to relax on hot, summery days. Some people look for a cool place in the shade while others prefer a sunny spot next to water. The Kralingse Bos offers both and is therefore very popular. The Kralingse Bos can also be easily reached. That’s important, as people are often pressed for time.”

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.”
Climbing plants
It is also possible to take advantage of the psychological effect of greeneries at street level. Just seeing the greeneries 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 greeneries improve 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 Wageningen University. She is an experienced researcher and designer in the area of the urban landscape.

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, Sanda 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.”
The delta cities network is the ideal exchange platform

The Connecting Delta Cities (CDC) network currently consists of thirteen cities from around the world. Other cities are queuing up to join the network. In the six years of its existence, the CDC has gained in strength, playing an important role as a platform where delta cities can share knowledge and exchange experience.

The network of delta or coastal cities was initiated in 2008 in Japan’s capital city of Tokyo. The C40 Cities Climate Leadership Group, a network of forty of the world’s largest cities, held its first conference on adaptation there in October of that year in order to take joint action against the effects of climate change. The call to put words into action did not fall on deaf ears. Although Rotterdam is not a megacity, it is involved in the C40 network as an “innovator city”. The city took on the challenge and presented the idea for a network of delta cities, marking the birth of the Connecting Delta Cities network.

Vulnerability

“This concerns a network of coastal cities, i.e. vulnerable waterfront cities,” said Chantal Oudkerk Pool, water and adaptation adviser with the municipality of Rotterdam. “Although the cultural, institutional and economic differences between the delta cities are sometimes significant, they are nevertheless faced with the same challenges. The emphasis within the network is on water; the link that connects all the network’s cities.”

Eight cities immediately joined the network. In addition to Rotterdam, these include Tokyo, New York, New Orleans, London, Jakarta, Ho Chi Minh City and Hong Kong. Copenhagen and Melbourne joined at a later stage. Halfway through 2014, Venice, Changwon and Singapore joined the network. The cities are global front-runners as far as climate adaptation is concerned. The main objective of CDC is to
“The Connecting Delta Cities network is very practically oriented. We benefit a great deal from this,” says Lykke Leonardsen, Head of the Climate Unit in the Danish capital of Copenhagen. Copenhagen had already started to draw up a plan for climate adaptation, but a sudden downpour on 2 July 2011 changed things dramatically. “We knew that it was going to rain harder,” says Lykke Leonardsen, “but no one had expected things to get so heavy on that day. It was only then that we realised how extremely vulnerable we are as a city and how dependent we are on all kinds of basic amenities, such as electricity. People do not realise just what can happen. They use the basements of their houses for living, which it is very unwise because they can flood during such downpours.”

The value of a network such as Connecting Delta Cities became apparent in the aftermath of that unforgettable downpour. Lykke Leonardsen: “Within the network, we were able to consult other cities that had also been affected by extreme weather conditions, such as New Orleans, which had been hit by hurricane Katrina, and New York, which had been hit by hurricane Sandy.” It was easy to exchange experiences. This resulted, amongst other things, in a plan to be prepared for such eventualities in the future. The plan, for which Copenhagen was divided into seven different catchment areas, covers a total of about 470 activities. “This does not mean that all these activities should be realised at the same time,” clarifies Lykke Leonardsen, “since that would take 20-30 years. We also regard it as an opportunity to further improve the city.”

Implementing the plan is an exciting process. Lykke Leonardsen: “That’s because everything is still new. As public authorities, we have to work with different parties. That is still uncharted territory for us. This also applies to water management. People find it hard to visualise. If a cycle track is too narrow or too wide, you take appropriate action. However, water is altogether different, it is much more abstract. It is also difficult to explain that the plans involve a great deal of money.”

Lykke Leonardsen is the head of the Climate Unit at the City of Copenhagen. She is responsible for the city’s two large and ambitious climate plans: The Climate Action Plan aiming at a carbon neutral capital by 2025, and the Climate Adaptation Plan.

It is good to be able to share experiences in this process. “The feedback from other network cities is very valuable,” emphasises Lykke Leonardsen. “It is good to receive this feedback, since you always bear in mind that your approach could still contain blind spots, elements which you have failed to take into account. We therefore seized the opportunity with both hands to exchange experiences. The lines of communication in the network are very short: if we have any questions, we can also put them to other cities directly. The network not only provides feedback, but also gives inspiration. It is very practical to receive a clear answer quickly. Fortunately, it is not an academic approach, with vague answers for the longer term.”
exchange knowledge and experience with each other and benefit from this exchange

**Platform**

Network cities usually have their hands full with climate adaptation. The network aims to achieve a maximum effect with a minimum of effort. CDC chairwoman Paula Verhoeven: “The CDC is not a network for the sake of having a network. It’s intended to provide assistance and make suggestions for solving problems related to climate adaptation. As a network, we provide a platform. The participants can use any of the submitted information that serves their purposes. Knowledge and experience are exchanged by, for example, webinars. Cities are, of course, free to consult amongst themselves. This way, our network continues to provide tailor-made solutions.”

The network also organises meetings, like the three day workshop in Rotterdam, in June 2013. A total of 23 cities took part, a much larger number than the ten cities that formed the actual network at the time. “The participants could talk shop,” said Chantal Oudkerk Pool. “Moreover, they also had visual contact, improving mutual contacts and relationships. That’s usually what happens and it’s really one of our principles: get people into contact with one another, connect them. If this results in bilateral contacts, that is all for the better. We don’t have to do everything with the ten of us of course.”

**Balance**

In the six years of its existence, the CDC has proven to be an active network, undertaking many activities. The network’s website is well visited. “Once you have such a strong group, suddenly everyone wants to join,” declares Chantal Oudkerk Pool. “However, we are selective about this. There is a ballot, and we would like to strike a balance in the network between cities that provide information and those that request information.” A number of cities are now potential members.

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**Volume III on delta cities and climate adaptation**

The book “Resilient Cities and Climate Adaptation Strategies” was published in early 2014. The book deals with the question of how delta cities around the world deal with the effects of climate change. “Resilient Cities and Climate Adaptation Strategies” is the third volume of a series of books published by the Connecting Delta Cities network. The first volume, published in 2008, largely presented an image of the problems and challenges facing delta cities, and was aimed at raising awareness. The second volume, which was published in 2010, explored the best practices in a scientific, analytical manner. All three books were developed under the editorial supervision of Jeroen Aerts (VU University Amsterdam), Piet Dircke (ARCADIS) and Arnoud Molenaar (municipality of Rotterdam).

The book was published as a hard copy, but it can also be obtained in digital format (free of charge) on: www.deltacities.com.
A striking construction dominates the view of Rotterdam’s Rijnhaven: a complex of three floating globes. This floating pavilion is one of the first examples of a sustainable, floating construction. Not only the technology and climate-proofing applied during the construction were innovative, but the entire construction process of the pavilion was innovative, as well.

The first things that catch your eye on the waters of the Rijnhaven are the three transparent semi-globes floating on the water, glittering in the sun. The total surface area of the globes is equal to that of four tennis courts. All kinds of activities can take place here. The pavilion floats on the tide. It was opened in the summer of 2010 and has since welcomed thousands of visitors. “The floating pavilion has become one of the city’s calling cards,” says John Jacobs, a strategic adviser with the municipality of Rotterdam’s Public Works Department. “That’s what we wanted, and that’s what we got: every possible news medium has visited the pavilion, from the regional De Havenloods to CNN.”

The journey
The realisation of the floating pavilion was an innovative journey in itself. While its construction was already underway, intensive studies were being conducted on how to make the pavilion as sustainable and climate-proof as possible. “The aim was to construct not only a floating building, but also a building which proved to be much more sustainable than other buildings,” says Bart Roefen, Creative Director of DeltaSync, the firm that developed the floating pavilion together with PublicDomain Architecten. “If you really want to proceed further with sustainability, you need to adopt a fresh approach to buildings.”

Sustainable floating constructions had never been attempted in Rotterdam before, certainly not in a harbour basin, which is directly connected to the sea and has a considerable tidal range. However, enthusiasm for the plan grew. “We received the go-ahead in the spring of 2009,” John Jacobs recalls. “However, this meant that we had to be ready within one year.” Because of this time restriction, the project organisation was also extremely innovative. Jacobs: “We worked with a construction team because that seemed faster and more efficient. Because all the parties involved formed part of this team, the lines of communication were short, there...
were no hold-ups and all the risks were shared. It was quite a unique process, but one that produced results. We made it in time.” Bart Roeffen: “The pavilion was built in the Heijsehaven on the RDM Campus/Heijplaat, where it served as a work-based training programme for students of the Rotterdam University of Applied Sciences and Albeda College. It was towed from the Heijsehaven to the Rijnhaven.”

**Featherlight**
The transparent semi-globes are made of elements of a transparent film, which is many times lighter than glass. The pavilion floor consists of light polystyrene, while heavier concrete holds it all together, which is why the pavilion floats stably on the water. “Because of its climate-control system, the pavilion resembles a greenhouse,” Bart Roeffen explains. “There is an open space which usually serves as a reception hall and can largely be heated and cooled by natural means. We wanted to waste as little energy as possible on this. Controlled indoor climate is essential in other spaces like the auditorium. These spaces have been extra-insulated. They are cooled by phase-change materials and solar energy.”

Waste water formed a another problem. “That’s always difficult in constructions that float on the tide,” says Bart Roeffen. “We looked for alternative innovative systems whereby pure water is eventually discharged.” Regulations also formed an obstacle every now and again. John Jacobs: “For example, how should the pavilion be secured? If we had used anchors, it would have qualified as a ship. Now that it’s fastened to mooring posts, it qualifies as a house, although it is still not entirely clear what the definition of a floating building is.” Because of the strict requirements regarding escape routes on floating objects, the number of crossings had to be doubled: from one bridge to two bridges.

“That often made things very exciting, as well,” says John Jacobs. “The good thing is that, although many people lost sleep over it, no one lost their enthusiasm. And it worked! After four years, you can say that the pavilion is very stable, that the technology used works well.” In any event, the pavilion has raised DeltaSync’s international profile. DeltaSync has since received a commission from California for the design of a floating district. The pavilion also sets standards for floating construction projects. “The crisis did not help to expedite developments”, says John Jacobs. “But we never stopped thinking about the project. The floating pavilion is just the beginning, and will pave the way for larger-scale applications. It could become a good export product for Rotterdam.” Bart Roeffen: “This is the first example of a floating construction in a tidal region. The next step: can we realise floating constructions on the sea?”

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**1. Expanded polystyrene, alias styrofoam, keeps the construction light and unsinkable**

**2. The ETFE foil on the spheres is 100 times lighter than glass**

**3. The Floating Pavilion is transported from the Heijsehaven**

**4. The Pavilion’s official opening in the Rijnhaven**

**5. The Floating Pavilion is open to the public on selected days, and a setting for events concerning sustainability**

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**Bart Roeffen** is a co-founder and board member of DeltaSync, a leading specialist in the area of floating urbanization. As an architect, he was closely involved in the design and realisation of Rotterdam’s floating pavilion.

**John Jacobs** works for the municipality of Rotterdam. He was responsible for preparing and implementing Waterplan 2 Rotterdam. This plan formed the basis for the Rotterdam Climate Proof programme, which he was involved in from the start.
Rotterdam is making good progress with its creation of green roofs. Heleen Mees, researcher at Utrecht University, drew this conclusion from her research, in which she compared the green roof policy of four different cities with that of Rotterdam. Rotterdam awards grants to those wishing to create a green roof, thereby helping to promote the general acceptance of green roofs in the city. However, the researcher thinks this policy should be followed up: “You can’t award grants forever.”

In the Netherlands, Rotterdam is in the lead as far as the creation of green roofs on new and existing buildings is concerned. “The municipality has placed green roofs on its agenda, and has developed a grant policy because it recognises the great importance of green roofs,” says Heleen Mees, who will obtain her doctorate this year from Utrecht University for her research.

Heleen Mees compared Rotterdam’s policy with those of other cities in the Western world striving to increase the number of green roofs. Basel and Stuttgart are the front-runners in respectively Switzerland and Germany. London is the front-runner in the United Kingdom, and Chicago in the United States. When Rotterdam’s findings are compared with those of other cities, significant differences appear. Rotterdam actually did not develop its policy on green roofs until very recently; the municipality has been active in this area only since 2008. Cities like Basel and Stuttgart have been active for a much longer period of time: Basel since 1996 and Stuttgart even before that, since 1986. This policy has also been on the agendas of Chicago (2003) and London (2004) for a longer time than Rotterdam.

Less expensive
Basel and Stuttgart also differ from Rotterdam in terms of their approach. As far as new construction or renovation work is concerned, the creation of a green roof is obligatory in both cities. Heleen Mees: “Basel started with a policy similar to that of Rotterdam’s, grants were awarded for the creation of green roofs. However, this became obligatory from 2003 onwards. That is also how it started in Stuttgart. Despite the grant, it is still relatively expensive to create a green roof in Rotterdam. It is much cheaper in Basel and Stuttgart. By making it obligatory, a market was created for
these roofs. Because businesses compete with each other, the prices dropped. As a result, the costs of green roofs are not that prohibitive in Basel and Stuttgart. Although people no longer receive any grants, they do benefit from a tax benefit if they have a green roof.”

The policy in Stuttgart and Basel has resulted in an enormous increase in the number of green roofs. More than one million square metres of green roof surface area is now to be found in both cities. In Basel, a quarter of all roofs have now been greenified. In comparison: in Rotterdam, hardly one per cent of the roofs are green. “It was a deliberate policy in Basel: people were first prepared mentally to see the beauty of green roofs. And as a result of this awareness, making green roofs obligatory was a logical next step.”

Taboo
That is how things should be approached in Rotterdam, considering the significant additional water storage problem due to climate change, reflects Heleen Mees. However, making something obligatory is likely to be considered taboo in the Netherlands. So how should we go about it? “Rotterdam should explore the possibility of cooperating with the major players (e.g. housing associations),” says Mees. “It should then be possible to obtain benefits in the city’s predominantly paved areas. I think it should be possible to make agreements.

A few years ago, when the roof of Alexandrium Shopping Centre was due for replacement, the key question facing Corio, the owner, was: “Should we again cover the roof with gravel, the way it was, or can we go about this in a more sustainable manner?” We finally opted for the latter. Guillaume Kriek, Facility Manager of the Alexandrium Shopping Centre on behalf of Corio: “The creation of a green roof fits in perfectly with our company’s sustainability philosophy. We started on the renovation in 2011 and completed the work towards the end of 2013.”

It was quite a job. “Every roof had to be cleared, the gravel was vacuumed up, shopkeepers’ equipment that had been installed on the roof, especially for air-conditioning, had to be disconnected and reconnected at a later stage,” said Guillaume Kriek. The immense shopping centre has several roof levels, which were worked on one by one. They were again bituminized, but were then not covered with gravel but with sedums.

Neighbours who look out onto the roof now have a view of no less than 22,000 square metres of greenery, in varying shades. The sods of sedum were carefully rolled out over the new roofs. Because some sedums flourish better on one part of a roof than on another, in time colour differences arise, further enhancing the view.

The shopping centre’s green roof, Europe’s largest green renovation roof, was realised in cooperation with the shopkeepers, local residents, the City of Rotterdam, the Prins Alexander submunicipality and the Schieland and the Krimpenerwaard District Water Board. The latter three parties awarded a grant for the extensive project.

Guillaume Kriek expects that a green roof will have only benefits: “When it rains very heavily, the roof can store 730,000 litres of water, and can therefore also serve as a water storage reservoir. The roof absorbs more particulate matter and muffles ambient sounds. Shopkeepers will see the new roof reflected in their energy bills, since a green roof exposed to the sun is up to 35 per cent cooler than a gravel roof. Air-conditioning units, therefore, do not have to operate at full capacity. Local residents briefly experienced discomfort from the work, but they were then rewarded with a much better view. We also benefit: the life of a green roof exceeds that of a traditional roof by 15 years."

Although a terrace has not yet been realised on the green roof, shoppers can experience a tangible result: the roof now has its own bee population, which produces a large amount of honey. Alexandrium honey was put on sale in the shopping centre this year for the first time.
with housing associations to deal with problem areas in terms of climate adaptation.” With these major players (e.g. housing associations) in particular, it should be possible to increase the number of green roofs quickly and significantly. “You will then be able to make some real progress,” says Heleen Mees. “This also applies to agreements with the owners of shopping centres, which often have flat roofs that can be used for a variety of purposes. Although a number of them are already green, this number can be further increased. Things could then suddenly take off.”

The policy which Chicago is pursuing differs in other respects. Although green roofs are not obligatory here, those who submit a planning application for a building with a green roof do not have to wait as long for their planning permission as those who submit a planning application for a building without such a roof. London’s regulations are the least ambitious; a builder only has to explain why he has not included a green roof in his plan. How this regulation is implemented differs in each of the city’s 33 boroughs.

The birds and the bees

In the Netherlands, Rotterdam was the first to develop a policy on green roofs. The grants are very generous; there is a very large budget for this. “Rotterdam’s water storage problem is huge,” Heleen Mees explains. “Green roofs can play a major role here.” As her research progressed, Heleen Mees became increasingly convinced of the necessity of green roofs. “Green roofs have a cooling effect in the summer and add a friendly touch to the city: it is nicer to look out onto greenery than onto a wide expanse of asphalt. Moreover, they benefit the city’s natural world: the birds and the bees. The roofs of new buildings could be made accessible so that they can serve as gardens and public green spaces.”

It would be even better if the green roofs could be combined with other sustainable priorities, such as installing solar collectors and further provisions for water storage and heat stress prevention. Heleen Mees: “Basel has already made much progress developing the right combination of solar panels and green roofs and developing seeds that germinate on a roof and then create their own ecosystem. Smart innovations such as these come about thanks to the various active market players.”

Green roofs in Rotterdam enter new phase

Rotterdam is trying to promote the creation of green roofs in several ways. One of these is the grant scheme, which makes it financially very attractive to create a green roof. Whenever possible, green roofs will be realised on municipal properties. The creation of green roofs on the properties of third parties, such as housing associations and businesses, is also encouraged. “The grant scheme has been a great success over the past few years. Approximately 150,000 m² of green roofing has now been realised,” says Paul van Roosmalen, Green Roofs Programme Manager with the City of Rotterdam. “The grant scheme will expire towards the end of 2014. In the coming years, we will promote and facilitate the creation of green roofs in other ways. In addition we will consider the results that have already been achieved in Rotterdam and the effects of measures taken in other cities. I expect that an increasing number of Rotterdam residents will see the benefits of green roofs and that the green roof surface area will also increase further without a grant scheme.”
3Di makes the invisible visible

An unexpected dike burst, extreme levels of precipitation: we can take preventative measures, but the effects of such a disaster are still difficult to imagine. This has recently changed. Thanks to a significantly faster calculation method, the 3Di simulation programme not only calculates, but also makes the effects of floods and extreme downpours visible. Everyone involved in water management can gain access to this revolutionary system.

“You can compare it to the difference between walking and going by car”, says Wytze Schuurmans, director of Nelen & Schuurmans (a water management consultancy firm), which has developed the 3Di computer programme over the past five years, together with TU Delft and Deltares. It used to take days to calculate potential water-levels. When the results finally came in, much precious time had been lost. That does not matter during a design process, but you simply have not got the time for this when a disaster (e.g. a dike burst, extreme levels of precipitation) occurs.

Emeritus professor, Guus Stelling, initiated the development of 3Di. Wytze Schuurmans: “He presented his idea for calculating water levels a hundred times faster than is now the case.”
These remarkable time savings appealed to Schuurmans. “Although an increasing amount of data is becoming available - also on water management - our current models and equipment cannot handle this amount. If we could make calculations a hundred times faster, we would be able to set to work with the available data.”

Benefits
The time savings offer unprecedented benefits. Schuurmans: “These time savings are particularly relevant in urban areas, where the water depths vary almost metre by metre. When something goes wrong in the city, everyone will want to know what is happening in great detail, preferably as quickly as possible. Whereas before, you had to wait days to find out, you can now receive this information almost immediately. Although the new calculation is a purely mathematical innovation, its applications are most interesting.”

3Di uses the calculation method to give an immediate visual representation of the effects of a disaster on screen. It can also be used to visualise the effects of a change in the urban space. “The latter makes interactive design possible,” Wytze Schuurmans explains. “You can indicate where you would like to realise a green roof. The effects can then be immediately visualised. This is a new approach to design, which can be done comprehensively and collectively, since the calculation can be immediately carried out on the internet. No special equipment is required; anyone can do this using his/her PC or iPad.”

Several water boards and the major cities of Amsterdam, Rotterdam, The Hague and Utrecht have already subscribed to 3Di’s computing service. A subscription enables you to carry out calculations and make visualisations. Click on a rain shower and you will immediately be shown an accurate 3D representation of the possible water nuisance. Clicking on the symbol for a tap makes a flood visible.

3Di in Rotterdam
The Waterplan 2 Rotterdam update and the Rotterdam Adaptation Strategy (RAS) describe, amongst other things, how the municipality approaches water safety and the prevention of flooding as a result of extreme levels of precipitation. The municipality is looking for comprehensive solutions for the creation of water storage reservoirs and, at the same time, for embellishing the city and for ways to make it greener and economically stronger. “We use the latest technology to ensure dry feet in a resilient Rotterdam. The entire city of Rotterdam is, therefore, visually represented in 3Di so that we will be able to identify the largest bottlenecks in the water system and public space in the short term, also in the event of extreme levels of precipitation in the future,” says Jorg Pieneman, the Rotterdam Water Programme Manager. It is now also possible to examine which (innovative) measures will have the greatest effect, at the district, street and even building levels. “The municipality can use an instrument such as the Rotterdam rain radar to proactively work towards preventing floods and limiting the damage arising from floods as much as possible.”

Thimbleful
“When our model simulates a flood, the margin of error amounts to slightly over a thimbleful,” says Wytze Schuurmans. That is machine precision and a ground-breaking improvement. Years ago, people used scale models to show the possible effects of a flood. These gave a clear, albeit far from accurate, picture. The results of computer calculations were then represented graphically and in tabular form, but only specialists were able to decipher them. Because 3Di can process almost all the available data and uses this data in its calculations - the visual representation that is created is very true to life. “The invisible becomes visible again,” says Schuurmans.
Dry feet even outside the dikes

A few outerdike areas in Rotterdam, such as the Noordereiland and the Kop van Feijenoord, are at risk when the water levels are high. Peter van Veelen is searching for a comprehensive model which, with the cooperation of the parties concerned in the area, can be used to achieve results, also in the longer term. There are two options: keeping the water out or creating adaptive water fronts. At any event, a self-reliant community is very important here.

The world port makes Rotterdam a unique city in the Netherlands. There is no other place that has such an
extensive urbanised outer dike area. The fact that the outer dike area is so extensive has everything to do with the port’s development over the years. When the city expanded with the construction of new harbours, this was immediately followed by the construction of new houses. However: the harbours and many of these houses were located in outerdike areas, unprotected from the water by dikes. About 40,000 Rotterdam residents now live in outer dike areas.

That may not sound very safe, but not all of Rotterdam’s outer dike areas are in immediate danger of a rising sea level and rising water flow levels in the New Meuse. Rotterdam is one of the safest ports in the world. That is largely because of its high embankments. Moreover, urbanised areas such as the Wilhelminapier and Kop van Zuid were heightened before they were developed.

Nevertheless, vulnerable areas can be identified in the urbanised outer dike areas. The Noordereiland is such an area in the city. Its many houses occasionally flood when the water levels are high (on average twice a year). The risk of flooding has decreased as a result of the construction of the Maeslant Barrier. Older residents of the Noordereiland recall that there were more floods in the past. Because of the low rates of flow, the damage to their houses is often limited to the interiors of the lower floors. Floods such as these are, nevertheless, very likely to occur in the near future. Other vulnerable areas are the Scheepvaart district on the northern Meuse River banks and the Kop van Feijenoord near the Nassauhaven and Heijplaat in South Rotterdam. Measures will definitely have to be taken to protect these areas from high water levels.

**Transformation phase**

Such measures are also indispensable in new housing developments in outer dike areas. “Up until not so very long ago, we always based ourselves here on the methodology followed during the construction of the Kop van Zuid,” says Peter van Veelen, who works for the City of Rotterdam and is a researcher with TU Delft. “This methodology was based on demolishing everything, filling up the area and then redeveloping it. But times have changed. Spatial development no longer works this way. As a result of the economic crisis, the economic model connected with this approach has become obsolete. We therefore now find ourselves in a transformation phase, and are looking for new development models.”

The search for such new models is exactly what Peter van Veelen does, not only in his work for the municipality, but also in his research for the university, for which he hopes to obtain a doctorate. This also includes looking for ways to protect existing areas in Feijenoord and on the Noordereiland from high water levels. “Because if things ever really go wrong on the Noordereiland, this will have major consequences (e.g. power failure, damage to houses and cars),” he declared.

Making the built-up outerdike areas (that are to be newly developed) water-resistant has now become a much more comprehensive task, for which a variety of social aspects come together. Peter van Veelen: “Spatial development has been downsized. In addition, it also concerns value development in the longer term. This will involve other aspects, such as poverty reduction, energy transition and improving the public spaces. The course is now rather a comprehensive approach in the longer term, whereby we look ahead for up to thirty years.” One of the measures being investigated is whether heightening the embankments can be combined with improving public space and can be linked to new developments. Rising water levels will be taken into account during the redevelopment of the Mallegat.
The Kop van Feijenoord, situated between the Rosestraat and the New Meuse, is what Van Veelen refers to as a “bathtub,” i.e. a risk area. Something has to be done there, but the public authorities do not have much money to spend, and you would not achieve much with traditional spatial development. It is therefore important to see who is active in the area. This includes, in addition to residents, housing associations and companies, Unilever and Hunter Douglas being the largest. It is necessary to work together with these parties when taking measures. “As far as water safety is concerned, these parties will also benefit from this,” says Peter van Veelen. “It is, therefore, a logical step to involve them in developing measures.”

Van Veelen started his research by designing multifunctional water barriers, but his attention turned increasingly to the stage preceding the design stage: “How can I develop an instrument that will link all the different factors in spatial development so that this will result in an innovative solution? In this way, it will be possible to develop a growth model that will prove fruitful in the long run.”

A study was carried out to identify the greatest vulnerabilities of Feijenoord and the Noordereiland, the buildings that will be the most adversely affected by floods and what would happen to the power supply if the waters burst the banks. The measures that need to be taken have also been identified and listed. This roughly comes down to two different strategies. The first is to keep the water out as much as possible by erecting walls so that the outerdike areas will not be flooded. The second is to build in a water-resistant manner, for example, by adapting homes and waterproofing transformers in power grids.

**Excursions**

An important role has been set aside for the residents. “Providing input is not something they have gotten used to yet,” notes Peter van Veelen. “We should change this soon. We will start to examine what residents themselves on the Noordereiland can do this year. This will be done by arranging excursions, for example, to Dordrecht, which has made considerable progress in this respect. Moreover, we must also make sure that residents have sandbags ready for when they are needed.”

It is essential that residents cooperate in making outerdike areas water-resistant. Peter van Veelen: “The days that public authorities took care of everything, are over. Much can be achieved by raising awareness within the community.” He continues: “In cities like London and New York, a community’s self-reliance is emphasised more, as is its resilience. In Rotterdam, we should distinguish more between residents’ responsibilities and situations that call for more collective action.” Peter van Veelen regards the fact that the whole world is now looking towards Rotterdam as a model city, where water and climate problems have been integrated with urban development, as a major opportunity. “The challenge to adapt the city to rising water levels will also create opportunities for Rotterdam’s corporate sector. See how the municipality, together with Rotterdam-based companies, is working on making Ho Chi Minh City climate-proof.”

**Bathtub**

Peter van Veelen is an urban designer with the City of Rotterdam, working on water-safe outer dike areas, alongside working to obtain a doctorate from TU Delft on the question how water safety can be integrated into urban development.
The Zomerhof district as a testing ground for putting climate policy into practice
For a long time, the Zomerhof district was locked in between the Heer Bokelweg, the Schiekade, the Teilingerstraat and the Noordsingel: a forgotten area on the edge of Rotterdam’s city centre. The district was built shortly after the war, mainly to accommodate businesses and schools. The train ran over the Hofplein viaduct right through the area. The situation has changed to a great extent. The train track is now out of operation and many buildings have been vacated. The housing association, Havensteder, wanted to turn the district into a quiet and attractive residential area. However, when it became apparent that the plans for demolition and new housing would not be implemented for the time being, the housing association decided on a different approach: stepping back for a period of ten years to let the district take initiatives for further development.

Jeroen Laven and his company Stipo (a team for urban strategy and city development) have moved into the “Yellow Building” on the Zomerhofstraat. “Havensteder asked us if we would like to establish ourselves here. We did, but only if we could fill the building with collaborative parties and implement the concept of “slow urbanism,” in cooperation with the housing association. Ten years is a proper amount of time for giving the area a chance. Many of the people here don’t mind at all that Havensteder doesn’t have an investment budget. They see it as an opportunity and say: then we’ll do it ourselves.”

Artisanal
A large number of companies and institutions have moved into in the Zomerhof district over the past few months. Jeroen Laven: “This largely concerns artisanal and small-scale manufacturing companies, architectural firms, cultural parties and expertise centres.” They feel very strongly about collaboration, and adapting the district to climate change appears to be the connecting link for making the area attractive. This can be achieved by opening up the plinths of the buildings. However, public space that has now been laid out as a business park, are ideally suited for climate adaptation.

“City’s appeal is closely related to the various purposes and possibilities for use of public space,” said Dirk van Peijpe from De Urbanisten, the agency which designed Benthemplein in the Zomerhof district, the world’s first large-scale water square. “The water square is only the first stone in the pond,” says Van Peijpe, as De Urbanisten have other plans for climate-proofing the Zomerhof district. “Public space is the meeting place. However, there are only a limited number of attractive green spaces here. Moreover, the Zomerhof district has a climate problem, especially as far as extreme levels of precipitation and drought are concerned.”

Dirk van Peijpe: “The point is to put the Rotterdam Climate Change Adaptation Strategy into practice. Because the Zomerhof district is a very suitable location, we would like to continue after completion of the water square. We would really like to know if we can realise the climate-proof city at district level, not only top-down, but also bottom-up. The dynamics which can increasingly be felt here will work to our advantage.”

Staying power
The aim of this development is not to draw up extensive master plans, but rather to gain a future perspective, together with the enthusiastic parties in the area. Jeroen Laven: “But you do need staying power for such a directional perspective. Because there’s so much going on here, I think this will be possible.
Havensteder is supervising the process and the municipality is facilitating. The area has aroused the interest of the political establishment and Dutch Minister Blok recently paid a visit.

Climate-proofing and spatial development go hand in hand in the Zomerhof district. Two workshops have already been held, during which the parties that are active in the Zomerhof district identified promising climate projects. These include replacing superfluous parking spaces and excessively wide roads and pavements in public green spaces. The city will, therefore, be able to act more as a sponge, absorbing rainwater into the ground. The second project focuses on laying out three “summer gardens.” In addition to the water square, a “polder roof” with room for water storage and food production on the roof of the Katshoek car park may very well be realised. The third project focuses on converting the Hofbogen, the former Hofpleinlijn railway, into a green route. “That’s probably the most complex task, but I expect to achieve success here, as well,” says Jeroen Laven. De Urbanisten already have, with a great deal of assistance from others, laid out the first part of the rain garden in front of the Yellow Building. Residents assisted in the planting process.

Jeroen Laven also sees financial opportunities. “The district is bursting with so much energy that new economic activity will automatically be generated. When someone starts to invest in the area, others will follow. That’s because everyone is working on the same thing, and the prevailing opinion is that you can achieve more by working together.” Dirk van Peijpe: “Moreover, we can ride piggyback on investments in, for example, sewage pipe replacement to order climate-proof public space.” The municipality has now allocated €100,000 for greenification! We are really setting to work now.”
Jeroen Laven is a partner of Stipo and a Rotterdam resident and enthusiast. As a developer for public projects, he works on a variety programmes: from slow urbanism in Rotterdam’s Zomerhof, Eindhoven’s housing vision to the renovation of the Nieuwezijds Voorburgwal in Amsterdam and a plinth strategy in Stockholm.

Dirk van Peijpe is an urban designer and director of De Urbanisten. He was recently involved in the Rotterdam Climate Change Adaptation Strategy, the ‘delta testing ground’, Climate-proof Zomerhof district and Rebuild by Design in New York/New Jersey.
Rotterdam: launch pad for the corporate sector

Companies spread their wings and go around the world with Rotterdam as their showcase

Rotterdam is a model city as far as climate adaptation is concerned. The public authorities, research and educational institutes and the corporate sector are busy making new inroads and finding innovative solutions. For the corporate sector, the focus on Rotterdam can mean a welcome launching pad to assignments elsewhere in the world.

It is the firm conviction of Piet Dircke, Global Leader Water Management with ARCADIS (a design and consultancy firm), that for a Dutch company a sound home base is indispensable for success abroad: “a home base which not only gathers knowledge, but also makes it clear what is on offer. As far as I’m concerned, the Netherlands is one big living showcase. The outside world wants to see exactly what we are up to in the Netherlands: they want to see that the country is on the move, that new knowledge is being developed here.”

Although the Netherlands may be one big testing ground, “Rotterdam is our delta city,” said Piet Dircke. “It’s an iconic city, one which has traditionally dealt with water. It is also a place where knowledge is being developed: at the RDM

Source: Courtesy of The BIG Team
Rotterdam companies set to work in the US

After the states of New York and New Jersey were hit by hurricane Sandy in 2012, they put climate adaptation high on the agenda. New York and its surrounding areas are taking the climate-proofing of the city and its surrounding areas very seriously. The large-scale Rebuild by Design project, an international design competition which challenges businesses to come up with urban solutions for the rising sea level and hurricanes threatening the states of New York and New Jersey, forms part of this.

Henk Ovink works as an adviser to the American government on the reconstruction of the New York area. “I have developed Rebuild by Design for the New York area from a real Dutch-American perspective: a comprehensive design approach with communities, local alliances, a competitive process with winners and a billion dollars for its realisation. In this way, talent, process and funding come together in an innovative way for a truly resilient region. It’s hardly surprising that many Dutch companies take part and can be counted among the winners. Our designers and engineers make the difference around the world. The Netherlands also act as a model for our comprehensive approach to design and water management. This water culture is Rotterdam’s culture: the city whose cultural strength always comes first. Rotterdam shows that it can handle dynamics and complexity. At the same time, there is still much to gain for the Rotterdam region. The international position and appeal and the Rotterdam assignment and approach are the opportunities for the city to take steps forward again. Water, space, and people: together they make this delta city strong. The agenda for the future can inspire the world, given the strong coalition of Rotterdam’s businesses, public authorities and research and educational institutes. Perhaps it’s time for a Rotterdam Rebuild by Design?”

Winners

In early June, Shaun Donovan, the American Secretary of Housing and Urban Development, announced the winners of Rebuild by Design. These winners include a striking number of innovative and ambitious Rotterdam companies. The Rotterdam design agencies of ZUS, 75B and De Urbanisten are working with the prestigious Massachusetts Institute of Technology (MIT) on the proposal New Meadowlands project for New York and New Jersey. $150m will be made available for their innovative and comprehensive plan, which focuses on several “flood areas.” A unique infrastructure and disaster plan will be developed for each area.

OMA, the Rotterdam-based architectural firm of architect Rem Koolhaas, is included among the winners. $230m has been reserved for the prestigious project in New Jersey, whereby an ingenious system of water pumps, water storage and landscape alterations will protect the cities of Jersey City, Hoboken and Weehawken against the rising sea level.

ARCADIS (a design and consultancy firm), whose Water Division is based in Rotterdam, is also included among the winning teams. The Big Team has been given the go-ahead for a gigantic project Big U project, which will protect Manhattan against the risk of flooding. $335m has been allotted for this project.

Many of the winning teams consist of collaborations between different international agencies and companies. This includes the Interboro Team, consisting of the Rotterdam-based Palmbout and Rebel Group, as well as others. The team worked on the Living With the Bay proposal in Nassau County, Long Island in order to realise safe, clean and natural bays along the coast of Long Island. $125m has been allocated for the implementation of their proposal.

Example

Of course, Rotterdam is not a metropolis like New York, London or Jakarta. “But,” emphasises Piet Dircke, “we can think very carefully about the example we wish to set for the rest of the world.” Thanks, in part, to the role which ARCADIS plays in projects in Rotterdam, the company has been able to expand its sphere of activity far beyond our national borders.

Campus and the TU Delft, which is only a stone’s throw away from Rotterdam. The fruits of their labour are there for all to see: the floating pavilion in the Rijnhaven, the Maeslant Barrier in the Nieuwe Waterweg ship canal, which closes at high water levels. All of these are part of Rotterdam, the delta city we should cherish.”
“We played an important role in New Orleans after it was hit by hurricane Katrina.”

ARCADIS is also active in New York. The company forms part of the consortium that is drawing up a plan for the Big U, a 16 km ring around Manhattan’s southern tip, intended to prevent flooding. Since it was hit by hurricane Sandy in 2012, New York is determined to take climate-adaptive measures. In addition to the Big U, ARCADIS is working on the Seaport City project, which should protect the south-eastern point of Manhattan. Piet Dircke: “This concerns flood protection, spatial development and, possibly, land reclamation. For us, the multifunctional dike plays an important role here. We have assessed all kinds of variants for such a dike, but Dutch multifunctional dikes (e.g. those in Noordwijk, Scheveningen, Katwijk and Rotterdam) form the basis.”

As a result of increasing urbanisation and population movements to urban areas, many delta cities simply lack the space to house residents and provide flood protection.

“This problem affects Jakarta, where we are working on the Great Garuda Project,” notes Enrico Moens, Adapting Cities Programme Manager for Grontmij (an Rotterdam-based engineering consultancy). Every year, Jakarta’s ground subsides further; floods are the order of the day. An elongated sea dike will have to prevent the risk of flooding. The surface area of this dike and the bay that will be created between the dike and the city can be used for development purposes. The Dutch state and corporate sector collaborate with Indonesian and Jakartan public authorities on the further development of this extensive plan. An idea is a new city in the shape of a garuda, Indonesia’s national symbol.

Revenue model

“The trick is to develop a good revenue model in which Dutch companies involved in water management can participate,” said Piet Dircke. Enrico Moens also stresses the importance of such a model: “It’s important to create opportunities and, as a nation, to continue to play an international role in water management so that the Dutch corporate sector will be able to

Piet Dircke is Global Leader Water Management with ARCADIS and working experience delta cities, such as Rotterdam, New Orleans, New York and Jakarta

Enrico Moens is employed by Grontmij (an engineering consultancy) as a development manager, and is actively involved in the Knowledge for Climate research programme and contributes to the global marketing efforts of developed knowledge.
reap the benefits. This requires a link between public, private and research and educational institutes.”

Such a link was created in Ho Chi Minh City, where Grontmij developed a climate adaptation strategy in close cooperation with the City of Rotterdam. Ho Chi Minh City resembles Rotterdam in several ways. Enrico Moens: “The city also borders on a river and, like Rotterdam, its port has gradually shifted from the city towards the sea, creating room for urban development.”

The Dutch played an advisory role in setting out Ho Chi Minh City’s adaptation strategy. “When the project was launched in 2011, we first made an atlas in which the problem was made visible. We then worked on a strategy for making the city climate-proof. This strategy had six main features: taking the water system as the starting point for spatial development; working step-by-step on water safety at several levels; preparing the urban water system for higher levels of precipitation in the future; combating salination as a result of advancing sea water; combating ground subsidence and creating green-blue networks in order to keep the city liveable when the temperature rises. The key message was to do this in such a way that not only problems are solved, but value is also added to the city.”

**Intensivity**

At about the same time, Rotterdam was working on an adaptation strategy. Enrico Moens: “Both strategies were actually completed at about the same time. Both cities collaborate intensively, and one can conclude that many of Rotterdam’s ideas have been integrated into Ho Chi Minh City’s strategy.”

“Following the atlas and the adaptation strategy, the third stage consisted of drawing up ‘the third A’: the action plan,” says Enrico Moens. “This is an important point: to what extent can the Netherlands contribute to the application of the adaptation strategy in the city? One of the key questions in Ho Chi Minh City is whether or not dikes should be constructed there. At present, there are almost none. We can contribute our Dutch know-how here and the lessons we learned from our Delta Project (e.g. regarding water quality). The point is always to decide on the right measures for a particular area.”

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*Henk Ovink*

is a senior adviser to US Secretary Donovan and Principal of Rebuild by Design. Prior to that, he was deputy director general for spatial development and water affairs with the Dutch Ministry of Infrastructure and the Environment.
As far as water management is concerned, the City of Rotterdam is associated with three different water boards: the Schieland and Krimpenerwaard District Water Board, the Delfland District Water Board (headquartered in Delft) on the northern Meuse River bank and the Hollandse Delta Water Board on the southern Meuse River bank. Rotterdam needs these relevant parties to implement climate adaptation measures. What do water boards actually do, and how did this come about? Are such organisations not outmoded? We put this question to two water board council chairmen and a council member.

How would you characterise a water board?

Hans Oosters, Chair of the Schieland and the Krimpenerwaard District Water Board: “Rotterdam was originally an urban development in the much larger Schieland area. Since the formation of this water board, we have, therefore, had to deal with the city’s growth. A water board has several responsibilities, the importance of which is assessed in terms of their intensity. One of these is water level management: we make sure that people can live and work here with as little flooding as possible. Other responsibilities: making sure the dikes and embankments are sturdy, ensuring a good quality of water and arranging the waste water treatment of some 800,000 people. In terms of assuming their share of responsibilities, the water boards..."
in the Rotterdam region have contributed greatly to overall water management in the Netherlands.”

Jan Geluk, Chair of the Hollandse Delta Water Board: “We are not only the oldest, but also the most modern level of government in the Netherlands. In 1950, there were about 2,500 different water boards. As a result of mergers, this number has now been reduced to 23. We work innovatively, for example, using high-tech equipment for waste water treatment. We’re also efficient and business-minded. We’re a functional, democratic organisation which does not waste money. The remarkable thing is that we formed a separate level of government for water in the Netherlands which is chosen by the people, i.e. its residents, businesses and farmers. That makes this system unique and, because of that, water always takes precedence in decision-making.”

Hans Oosters: “That’s truly unique. When there are shortages or emergencies, you can’t afford to make the wrong choices. In many countries, you see that wrong priorities are set during an economic downturn; for example, by economising on the maintenance of dikes or systems, the risk of flooding increases. Taking a look in one of our pumping-stations, you’d think the systems were installed only yesterday. In other words, it’s a form of management that guarantees safety.”

Ingrid ter Woorst, council member of the Delfland District Water Board: “What I also consider to be a strong point of our organisation is our independence, which often allows us to take a long-term perspective. We don’t have any other interests that we continually have to balance. We raise our own taxes specifically for our own tasks. Unlike municipalities, water boards do not have to deal with other parties, such as property developers or land-users. However, we can’t do it alone. We can make all the plans we want from our Delft headquarters, but we need partners, such as national government and the municipalities which have the necessary land or funds at their disposal. For instance, in the Rotterdam area, we meet the two other water boards. We have decided to operate as a single water board, setting one clear course for the entire area. Our collaboration is very good, and our collaboration with Rotterdam also runs smoothly. The city is very result-oriented, eager to show its drive and to create.”

Hans Oosters: “I always like to tell the story of how the water boards came into being. This functional task can be traced back to the thirteenth century, when Count Floris V set up the first water boards in this region. It was a marshy region at the time and the rivers regularly burst their banks. People quickly realised that, by digging a ditch, the land would be cleared of water, but would then subside. However, by carrying out hydraulic engineering works, such as building dikes, floods become controllable. That wasn’t a private function, at all; it had to be a public function. The
Count therefore appointed administrators to supervise this. Everyone had to set to work with a shovel. The personal contribution to water safety in the form of taxes was introduced at a later stage. In exchange, people were given a say in the management of the water boards. That’s how it all began, and that’s how things still are today. What’s interesting is that this level of government is a direct result of the physical environment of the lower-lying delta.”

Ingrid ter Woorst: “A discussion that comes up from time to time is whether we should close the water boards. We can, of course, close them, but then we would lose our independence, since the funds for a sturdy dike would then come out of the same pot as those for, for example, a new hospital. You then have to choose between safety and care. What people often forget is that we can quietly live and work here, in an area below sea level. The water boards have also become increasingly cost-conscious in performing their tasks over the past few years; more attention is paid to the bottom line. However, herein also lies an opportunity: if something can’t be done for a specified amount of money, we’ll have to do things differently. That always leads to innovation.”

What is the biggest challenge facing the water boards?
Jan Geluk: “The sea level is rising and the land is subsiding. These are geological phenomena, which, in addition to climate change, have consequences for our dikes. Rivers must be able to handle higher levels of precipitation. The municipalities of Rotterdam and Dordrecht are faced with the problem of advancing water. It’s an enormous task to realise dikes in these urban areas. It is also much costlier than in rural areas. Although this is one of our core responsibilities, it also requires steps to be taken in the area of spatial planning. That is more the remit of the cities and the province. Moreover, because of the predicted low river flow levels, problems will arise with the intake of freshwater. Salt (sea) water is advancing, resulting in salination. These concerns are quite significant.”

The OECD recently concluded that water safety is very much taken for granted in the Netherlands. Everyone assumes the Netherlands is safe. What should the water boards do with this?
Ingrid ter Woorst: “That is indeed a concern since things have mostly gone well for a long time. People therefore take the work of the water boards for granted, or have no clue what is being done to keep their feet dry. We have achieved great things in Rotterdam, such as Bellamyplein and Benthemplein. But we must now take a grass-roots approach. We must try to connect with people, physically and emotionally. How can we raise awareness; that’s our real challenge for now.”

Hans Oosters: “One can indeed speak of an awareness gap. People feel that we don’t have any problems, they are not aware of the risks. Our brief is to do something about this. This means that we will constantly have to explain what is going on. That’s not really our mission, of course, but it is...”

Hans Oosters has chaired the Schieland and the Krimpenerwaard District Water Board since 1 September 2005. He also served on the board of the Association of Water Boards, responsible for water safety. Hans Oosters is also a member of the Delta Conference’s Committee for Recommendations in Times of Climate Change.

Jan Geluk has chaired the Hollandse Delta Water Board since 1 July 2005. He is a member of the People’s Party for Freedom and Democracy (VVD), and represented this party in the Lower House from 1998 to 2005. Jan Geluk was educated at the Agricultural College in Dordrecht. He later obtained certificates in law (including constitutional law) from the Open University. He has also worked in farming. From 1991 to 1996, he worked in Central Asia for Cebeco-Handelsraad. He was a member of the Provincial Council of Zeeland from 1987 to 1991.
nevertheless an important task. We want to play a visible role here. The water boards have already achieved a great deal, since we have come closer together and strengthened each other over the past few years. However, we should be able to tell the whole story together.”

Jan Geluk: “With regard to this awareness, we are receiving assistance from abroad. Look at the effects of a hurricane such as Katrina or Sandy. These events are constantly in the news, which gives people something to think about. But it’s true, we’re inclined to say: we’re okay. There’s a task here for cities and water boards to raise awareness. I see that the countryside differs from the city in this respect: farmers are often perfectly aware of current issues, city-dwellers less so. I would therefore also like to bring city-dwellers on board: that is a big task. Our management should be well staffed for this. Another thing that may help is that, as a water board, we have built several apps: one for water safety and one for the Blauwe Verbinding waterway between the Zuiderpark and the Oude Maas.”

**Can the water board’s age-old management model serve as an export product for climate adaptation beyond Dutch borders?**

Ingrid ter Woorst: “It is already an export product. We receive many foreign delegations. However, I don’t think we should boast about our achievements and think that others should follow our example. We should simply show what we have achieved in projects like the Benthemplein and Bellamyplein water squares. I’m convinced that when your shop window is well-stocked, this will automatically arouse curiosity and interest. On the other hand, outsiders can also make us take a good look at ourselves. Not so very long ago, a few foreign guests were surprised that we do a great deal for protected horticulture. The OECD has pointed to the quality of our water. You have to be prepared to accept this. I like to focus on what we can learn from each other.”

Jan Geluk: “We get a lot of questions from other parts of the world, some of which basically come down to whether they could create a system like ours. In South Africa, near Durban, we are setting up water boards based on the Dutch model. In this sense, our management model could definitely be considered an export product.”

Hans Oosters: “The water board is definitely an export product. This primarily concerns our in-house technical know-how: delta technology, such as constructing dikes and waste water treatment. However, the manner in which we have organised our water management is also an export product. For instance, a few years ago, we were asked to lend a hand with a polder in Semarang (on the Indonesian island of Java) that became inundated with water twice a day, while the ground was subsiding as a result of water extraction. Our work consisted of setting up the organisation: the water management was delegated to an elected executive board responsible for dikes and system maintenance. People pay taxes for this. Indonesia has adopted this model as one which may also be applied in other cities.”

Blue Corridor cleaner water and a new waterway (Hollandse Delta Water Board)
Climate adaptation increasingly important in the Rotterdam area

Regional municipalities are taking an inventory of the opportunities and problems that arise

Rotterdam is working hard to put climate adaptation into practice. The city is surrounded by fourteen other municipalities which, together with Rotterdam, form the Rotterdam metropolitan area with a population of 1.2 million people. How does the region deal with climate adaptation? The extent to which the regional municipalities are negatively affected by climate change - and the extent to which this creates opportunities - differs from municipality to municipality. It is therefore important that these municipalities take an inventory of the prevailing issues within their boundaries. They will then be able to develop their own policy for facing the future and seizing opportunities.
In the Rotterdam area, municipalities are becoming more aware of climate change and its effects within their city limits. “People realise that the water in their gardens is not drained off as quickly as before, and they put two and two together: they observed that there is a greater incidence of peak downpours and subsidence,” says Andy van Rossem, who works for the city of Barendrecht. “The question we should then ask ourselves is: can we solve this problem by laying more drainage pipelines or do we need to take more structural measures? Colleagues are also increasingly aware that something is going on.”

The same process is taking place in Schiedam, which is located on the banks of the Nieuwe Waterweg, the river between the River Meuse and the North Sea. Saskia van Walwijk, planner with the municipality of Schiedam: “These problems are being addressed, but not from an angle of climate adaptation or sustainability. We have come across problems with foundation and subsidence in a number of residential districts. These issues are linked to climate adaptation of course, but we did not put them in that context.”

**Public spaces**

“Flooding is a problem in many municipalities around Rotterdam,” says Lissy Nijhuis, who coordinates the collaboration between the regional municipalities from the Rotterdam metropolitan area in the field of climate adaptation. “Many municipalities state they do have someone dealing with water, but the question is whether that will ultimately be sufficient. You could also see it as an opportunity, by including the issue of flooding in the layout of public space or the way in which paving works are carried out.”

The Rotterdam metropolitan area, the coordinating body of the Greater Rotterdam region (covering fifteen municipalities), thinks it is extremely important to put climate adaptation high on the agenda. That is why the Rotterdam metropolitan area is already stimulating municipalities to identify potential climate problems and opportunities promptly and to know what can be done about them. In this way, the region can retain its economic strength and appeal for its residents.

To this end, a policy document entitled “Building blocks for adaptation strategies in the region Rotterdam” was issued towards the end of 2013. The key message of this document is that the problems are largely the same for the entire region. However, because solutions are always location-specific, every municipality has to develop its own policy. Collaboration is essential here. Lissy Nijhuis: “When you collaborate, you can not only share costs and responsibilities, but also exchange experiences and learn from each other.”

**Stress test**

A principal point in the policy document is that the municipalities should carry out a stress test, to identify and list the threats and opportunities that arise within their city limits. Barendrecht will carry out such a test in the autumn of 2014, Schiedam’s test has already begun. Saskia van Walwijk: “Many different disciplines are involved in this test. It is not an easy time for municipal organisations; they have to downsize and set priorities. It concerns abstract developments in the long term, and we only know in part which solutions are effective. But we will continue the test nonetheless. It’s largely a matter of collecting information, listing and finding solutions that are effective in several respects. Take the risk of heat stress, for example. The current opinion is that it’s good to “cool” the city by creating more green spaces. Right now, we can’t be sure that will be sufficient or if we are doing it at the right time. More green spaces will have a positive effect on the living conditions in Schiedam. More greencover will make the city look better and make it a more pleasant place to live. It cuts both ways.”

Collaboration is an essential concept in the regional municipalities. This includes collaboration with the Rotterdam metropolitan area and the city of Rotterdam - where a great deal of knowledge about climate change and adaptation is
The most important piece of advice to the municipalities of the Rotterdam metropolitan area stated in the “Building blocks for adaptation strategies in the Rotterdam region” policy document is: “set to work”. The municipalities concerned can do so by analysing the opportunities and problems by means of an “awareness and stress test”. In this way, they will be able to form an impression of what is required within their boundaries, or what expertise is lacking to clarify the picture. The next recommendation is to set a goal: in this way, the municipalities will make clear what course they wish to take and where they would like to end up in the longer term.

The third step in this approach is to select and implement the measures required in the area of climate adaptation. Collaboration with other parties is very important here and may lead to innovative solutions and new opportunities. The fourth recommendation is to integrate the work on climate adaptation into regular activities. The fifth recommendation comes down to carefully monitoring progress and the results achieved. This is the only way to determine if the climate-adaptive measures are actually effective in the longer term.

The Rotterdam metropolitan area is large, encompassing municipalities whose circumstances vary widely. What is good for the suburban city of Barendrecht, may not work for rural and coastal Oostvoorne. This requires tailor-made solutions: every municipality will have to develop its own adaptation policy. At the same time, municipalities should not lose sight of the bigger picture, Lissy Nijhuis stresses: “Because we form one big delta, we should be aware of our common interests. The trick is to ensure that everyone assumes his own responsibility in this.” The building blocks policy document should provide help: every municipality can select the building blocks that apply to it and set to work.

Combining knowledge, that is where the opportunities lie for creating a climate-proof region. Saskia van Walwijk: “For instance, we could also devise adaptation strategies that can be applied to different places, i.e. not only to Schiedam, but also to Vlaardingen and Maassluis, or to municipalities, such as Barendrecht, Ridderkerk and Albrandswaard. It would be nice to have a joint adaptation strategy for the entire Rotterdam metropolitan area and create a knock-on effect, whereby all municipalities take part and we come up with area-specific solutions. That will enhance the identity of the Rotterdam metropolitan area and the individual municipalities.”
Rockefeller Foundation selects Rotterdam

Rotterdam is one of the first 33 cities selected by the Rockefeller Foundation for the 100 Resilient Cities programme. With this programme, the philanthropical organisation’s mission is to support cities around the world in order to make them resilient: to be prepared for climate change, to be resilient and flexible in case disaster strikes and to be able to learn from change.

Rotterdam and the Rockefeller Foundation made initial contact in May 2013 when mayor Aboutaleb was in New York at the invitation of then mayor Michael Bloomberg and former president Bill Clinton to talk about urban climate adaptation. Judith Rodin, president of the Rockefeller Foundation, also attended this meeting. This organisation, founded in 1913 by the rich oil magnate John D. Rockefeller, celebrated its centenary in May 2013. On the occasion of reaching this milestone, Judith Rodin expressed the intention of the Rockefeller Foundation, during the centenary celebration, to support one hundred cities in their stride to achieve effective climate adaptation and to become resilient in the face of other “shocks” and “stresses.” The Rockefeller Foundation had made $100m available for this purpose.

For Rotterdam, this was the go-ahead for applying to the Rockefeller Foundation for such support. In December 2013, it was announced which of the over 400 applicants had been selected. Rotterdam formed part of the initial group of 33 cities that were admitted to the 100 Resilient Cities network. “That was one to remember,” says Arnoud.
Molenaar, who attended the award ceremony. As the Rotterdam Climate Proof Programme Manager, he had been responsible for the application. “This was coupled with praise for the Netherlands, land of water, and praise for the delta city of Rotterdam and how we are involved in climate adaptation. You feel rather proud at such a moment, especially when you learn that your city was among the first 33 out of a total of 400 applicants, and which included only five European cities.”

Cybersecurity
According to Arnoud Molenaar, participation in the Rockefeller Foundation programme is a logical step in a process: “We started in Rotterdam with water and water management. This has since been stretched to include climate adaptation. The 100 Resilient Cities programme will enable us to extend the scope to include other policy areas. Although contracts with the Americans have yet to be signed, we have already started to identify and list the vulnerabilities of our city and the opportunities we have to become more resilient. Making the city resilient also involves cybersecurity, energy security and socio-economic resilience. You can discuss water safety as much as you like, but you won’t be able to do anything if the city’s ICT infrastructure is not up to par when disaster strikes, or flooding causes a power outage and the city’s 1,000 pumping-stations grind to a halt.”

Rotterdam’s application highlighted three areas which the city wished to focus on when implementing the Rockefeller Foundation programme. This concerned further deepening the scope of the Rotterdam Adaptation Strategy (RAS). Molenaar: “There are still a few relevant knowledge gaps to be filled, and we would like to find out how we can apply the adaptation strategy throughout the city.” Extension to other policy areas (e.g. ICT and socio-economic issues) is the second focus area. “And the third concerns gathering, storing and sharing knowledge and learning from what other cities taking part in the programme are doing.”

Source of information
That is one of the objectives which the Rockefeller Foundation set for the programme: the selected cities will form part of a unique network in which they will be able to share knowledge. The cities will be able to make use of a knowledge platform, which can eventually serve as a common source of information to help foster resiliency. The cities also have to set out a strategy for achieving their intended resiliency. Finally, each selected city will appoint a Chief Resilience Officer (CRO) who will direct and monitor the process.

The first step to determine a strategy for Rotterdam was taken in the spring of 2014. This strategy will be worked out in greater detail in the course of the year. Meanwhile, Rotterdam regards its selection by the Rockefeller Foundation as a real boost. Arnoud Molenaar: “It strengthens Rotterdam’s front-runner position as a model city as far as climate adaptation is concerned, it strengthens its image as an innovative delta city and it creates opportunities for widening and deepening the scope even further. That’s a win-win situation.”

Climate resilience: ‘adaptation to the times’
Being resilient also means ‘adapting to the times’, including a new economic situation. We need new financial arrangements, as the options for joining in on large-scale construction and renovation projects decrease. Adaptation measures need to be included with urban maintenance schedules.

We have started scaling projects upwards, from object level (green roofs and water squares) to district level (with pilots in the Zomerhof district and on Noordereiland) and city level. Adaptation requires a grass-roots approach, deploying small-scale solutions on a very large scale.

This approach should leave as much room as possible for ecological solutions, suiting the Rotterdam ambition to greenify and increase resiliency. The new, district-oriented approach to adaptation involves collaboration with many stakeholders, some new to the game. Housing associations, utilities and residents will be emphatically invited to participate in the implementation of the Rotterdam Climate Change Adaptation Strategy. Self-reliance en self-organisation, ‘community resilience’ in short, will become increasingly important when it comes to adaptation.
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 in 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!