RETHINKING URBAN WATER FOR NEW VALUE IN CITIES

Sustainable solutions for integrated urban water management

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Version 2.1

Frontpage picture
Copenhagen harbour bath at Islands Brygge
(Phot: Kontraframe/City of Copenhagen)

About this white paper
This white paper is developed by the Rethink Water network in Denmark. The work is coordinated by the Danish Water Forum and State of Green.

The Rethink Water network consists of more than 60 technology and consulting companies, water utilities, water organisations and public authorities. It was established to support our partners internationally in developing the highest quality water solutions.

This white paper is based on the original work from previous versions 1.0 and 1.1 with Pia Klee, Danish Water Forum as editor in chief.

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Executive summary
Sustainable solutions are no longer a choice for most societies: they’re a must. Especially in our cities. We must all strive to balance the quality of people’s lives with sound economic and environmental development.

Cities are growing. Today’s urban population of 3.2 billion will rise to nearly 5 billion by 2050, by which time three out of five people will live in cities. Added to this, many cities face additional pressures of rising sea levels and extreme weather events, bringing with them the risk of flooding and/or periods with little or no water. In dry periods temperatures may rise even further, due to the urban heat island effect. This white paper sets out a wide range of examples showing how Danish water expertise is used in Denmark, and around the world, to help find the best sustainable solutions for cities.

An integrated approach to water management is the most cost-efficient way and is essential to solving the challenges of increasing urbanisation and climate change faced by many cities. However, to achieve a sustainable society, the urban planning that is required goes beyond the reach of the city authorities and the water utilities alone. What is needed is collaboration among stakeholders. Having a clear vision and common goals is the key to success.

Prioritising investments
Urban water management must include the intelligent handling of climate change and the identification of potentially attractive urban environments to be created. However, the systematic identification, analysis and evaluation of water-related risks, like flooding, or the potential contamination of drinking water, is also fundamental. Assessment of the possibilities gives a clear picture of where to invest.

Integrating water with urban development, Copenhagen, Denmark
Despite the small size of the country, Denmark’s coastline is more than 7,000 kilometres long (4,000 miles) and nowhere in Denmark is more than 50 kilometres (30 miles) from the sea. So using water in a constructive manner is an inherent part of Danish culture. Like many other waterside cities, Copenhagen, the capital of Denmark, has undergone a transformation from an industrial to a modern knowledge-based economy. Over the last decade Copenhagen has modernised and improved its old water infrastructure to provide for an expanding city and for climate change. This has been seen as an opportunity to create more value through better integration of the water system with urban development.

A clear vision is the key
To deal with water with a holistic view of the system, the quality of people’s lives, and the potential contamination of drinking water, is also fundamental. Assessment of the possibilities gives a clear picture of where to invest.

For more information
To order copies of this white paper or receive information about related publications, please contact State of Green at info@stateofgreen.com
Attracting resourceful people through coastal development, Copenhagen, Denmark

The capital of Denmark spreads along the narrow sound that lies between Denmark and Sweden. Already 80 years ago a beach park was founded here, just five kilometres away from the centre of Copenhagen. However, the state of the beach was very poor and facilities were scarce. About 10 years ago the City of Copenhagen decided to invest 25 million euros to develop a piece of “engineered nature”, the new Amager Beach Park. It has almost 2 kilometres (1.2 miles) of attractive beaches, promenades and amenities, a headland for scuba diving and a lagoon for water sports such as kite surfing. This project is an example of how water attracts resourceful residents and businesses. Property prices in Southern Copenhagen, which includes the area around Copenhagen harbour baths and Amager Beach Park, are today almost 70 percent higher than the Copenhagen average. For villas and townhouses near to Amager Beach Park prices are more than 20 percent higher than the average in southern Copenhagen. (Courtesy: Hasløv & Kjærsgaard, DHI and NIRAS)

1. Rethinking urban water solutions
2. Developing visions, common goals and integrated solutions
3. Assessing risks and opportunities
4. Integrating stormwater opportunities with urban planning
5. Controlling the risks in time
6. Developing the best solutions through stakeholder engagement

If you goal is smart and efficient water solutions, Denmark is ready as your partner
Upgrading the city centre and early warning systems, Aarhus, Denmark: Denmark’s second largest city, Aarhus, is a waterside city, with a river connecting the city centre and port in a coherent blue structure. In 1989, the city council decided to begin opening up the river, step by step, reversing a decision taken 60 years before, when the river was covered over all the way through the city to the bay. Today the river is a very important element in the redevelopment of the city centre. An early warning system for the bathing water quality assures safe recreational use of the river, nearby Lake Brabrand and the area at Aarhus Harbour very close to the city centre. The investments have included a system for the integrated control, in real time, of the sewerage system and wastewater treatment plants. The system is based on hydraulic models that describe the transport, dilution and decay of E. Coli and it consists of four coupled parts (1) a rural catchment model calculating the rainfall run-off from the rural area, (2) sewer catchment models calculating flows, run-off, CSO’s and E. coli-transport, (3) a lake and river model calculating flow pattern and E. coli-transport and (4) a harbour model calculating flow pattern and E. coli-transport. (Courtesy: Aarhus Water and DHI)

Cities are growing. Today’s urban population of 3.2 billion will rise to nearly 5 billion by 2030, by which time three out of five people will live in cities. Added to this, many cities face additional pressures of rising sea levels and extreme weather events, bringing with them the risk of flooding and/or periods with little or no water. In dry periods temperatures may rise even further, due to the urban heat island effect. For cities to solve these new challenges, they need to invest in the water supply, in wastewater treatment, rainwater drainage and, in some cases, in coastal protection.

A classic or an integrated approach? These challenges also present the opportunity to rethink urban development and gain greater value from every cent invested. If cities replace the ‘business as usual’ approach to dealing with water with a holistic view of the situation, incorporating new blue and green structures as an integrated part of urban development, then water becomes a valuable asset. For instance, the problem of flooding in densely populated urban areas after heavy rains has typically been solved by increasing the size of the sewer and stormwater network. In contrast, Denmark has chosen an integrated approach which initially is more complex and involves a broad range of environmental, economic and social strategies (including considering drainage solutions, upstream delayed rainwater storage and, sometimes inevitably the construction of enlarged stormwater pipelines), nonetheless this integrated approach is more cost efficient seen from the overall society perspective.

New approach giving greater overall value This white paper sets out a wide range of examples showing how Danish water expertise is used around the world to deal with climate change and urban development in a sustainable way. Here it should be understood that taking the integrated approach is a journey. Just a decade ago, most cities in Denmark regarded water as something to hide and remove in sewers, not as the valuable resource it actually is. Now most Danish cities have changed their approach. Water is once again seen as an asset with an enormous potential to enhance the daily life of people living in cities. This makes large investments easier to justify to the public. Today water plays an important role in urban development and economic growth in Denmark.
2. Developing visions, common goals and integrated solutions

People’s love of water leaves its imprint on cities in so many ways – from the historic fountains and modern pools that mirror the city in their surface to the enormous variety of waterfront developments that have sprung up along harbours, rivers, lakes and canals. In many port cities, the docks now stand empty or newer facilities have been moved away from the historic centre, leaving centrally located commercial or naval docks that are no longer in use. These cities are in a state of transformation from their industrial past to becoming urban centres in a modern knowledge-based economy. This is happening just as many of them are also dealing with more extreme weather events and rising sea levels.

Boosting urban development
Swimming in Copenhagen’s harbour was out of the question for many years before the first harbour bath opened in 2002 at ‘Islands Brygge.’ Frequent overflows from the sewerage system made swimming in the water hazardous. Today, Copenhagen’s public harbour bath is one of the trendiest in Copenhagen and property values, the local business community, tourism and the quality of life for Copenhagen’s citizens have received a major boost. Waterfronts, docklands, canals and lakes help in creating exclusive areas, attracting resourceful people and businesses. This is an important consideration when new water investments are under discussion. In 2012 a study by researchers from the University of Copenhagen showed that property prices increase by an average of 10 percent if the property is within walking distance of a park or an area of urban nature. Proximity to the coast increases property prices by 15–30 percent, an increase that vanishes once the property is more than 300 meters (1,000 feet) away from the water.

The vision makes the difference
An integrated approach implies that different stakeholders have to coordinate their efforts to reach a common target. To achieve a sustainable society, the urban planning that is required goes beyond the reach of the city authorities and the water utilities alone. It requires collaboration between their consultants, contractors, equipment suppliers and the local residents. A clear vision and common goals are the keys to success. Most integrated water solutions will require a flexible attitude from stakeholders. Thus, appealing to people’s imaginations makes a huge difference in working with integrated green and blue structures:

- Imagine an urban park where nursery school children can safely go fishing; think of teenagers cycling round an urban lake having a great time; picture a retired couple enjoying the shade of the trees by a pond on a beautifully planted roundabout; and then, imagine that you wouldn’t have to imagine it anymore.

Benefits of an integrated approach
The integration of water solutions with urban development is a way to reintroduce water as an asset in urban living. There are a variety of tools and methods available for the development of innovative integrated water solutions. These include software to enable the visualisation of possible future scenarios that can help in convincing decision makers and stakeholders about the benefits of integrating blue and green structures. The more obvious benefits are that integration decreases the hydraulic load on wastewater treatment and reduces the number of combined sewer overflows. Integrated solutions also decrease the risk of flooding and related costs. A final argument is that infiltration of rainwater will increase groundwater regeneration, valuable to cities where groundwater is an important water resource.

Water is a prerequisite to all life, even in the city! Water creates magical and exciting locations that strengthen the cohesion and sustainability of cities. Integrating water in urban planning is a unique formula: 1 + 1 = 11

FLEMMING RAFN THOMSEN
Architect and Partner
TREDJE NATUR
New blue vision for the harbour, Copenhagen, Denmark

One of the visionary ideas for Copenhagen is to expand the number of blue and green recreational areas. Today, the harbour covers a third of the city’s total area, but still only a few areas can be used by the city’s inhabitants and even fewer are recreational areas. With the launch of Blue Visions, which presents five ideas to strengthen Copenhagen harbour’s recreational value, the City of Copenhagen wants to show politicians and inhabitants how the harbour can be developed into a more viable and healthier urban environment. The water in the harbour is so clean that you can swim and fish here, a privilege that only few major port cities in the world enjoy. One of the proposals is to create new blue spaces and a second-generation harbour bath, which with a network of floating islands is a contemporary take on Copenhagen’s tradition of artificial islands and locks. This would give people direct access to the water, where they could bathe in small heated lakes and relax between flat stones in sauna caves. (Courtesy: Tredje Natur)
3. Assessing risks and opportunities

Developing the best water solutions requires thorough data collection, data processing and evaluation of opportunities and risks. Integrated modelling and planning tools are invaluable for making the right investments.

TINA HALJÆR ANDERSEN  
Geologist  
ALECTIA

Water is attractive in urban environments and when managed wisely it offers ample opportunity for urban development. But water can also become a hazard in the event of heavy rainfall or other extreme weather. Water can damage urban structures, human health or the environment when it accumulates in large volumes and/or contains hazardous substances or harmful organisms. Thus a fundamental part of urban water management – along with identifying opportunities for developing attractive urban environments and the intelligent handling of climate change – is the thorough identification, analysis and evaluation of water-related risks like flooding and contamination of drinking water.

How to prioritise investments

Flooding is a threat in many cities around the world and it is a complex problem to solve, since it can be caused by a rise in sea levels, by more water in rivers and streams or by over-filled sewers after heavy rain – or a combination of all three. Because of the multifarious nature of the urban water cycle, risk assessments are complicated and call for a number of tools to systematically assess and address risks. Thorough assessment will clarify which of the solutions are most suitable for investment in the different areas. These assessments are based on a set of criteria regarding required investments and potential economic gains and losses – in infrastructure, buildings and property value, in agricultural or industrial production, in cultural heritage and in public health.

The experience in Denmark, and from Danish consulting and technology companies working internationally, is that timely integrated urban planning is very important as a means of addressing the increasing risk of damage from extreme weather and rising sea levels. It is, at the same time, considered an opportunity to create new urban water environments with high recreational value. By applying advanced tools combining statistical analyses, databases, spatial data (Geographical Information Systems – GIS) and deterministic modelling with economic prioritisation, it is possible to obtain a more accurate picture, so as to be able to take decisions and make the best investments.

Hydraulic models for flood protection strategy, Prague, Czech Republic

After a severe flood in 1997 the Czech government adopted a flood protection strategy. The Prague Flood Model, developed by DHI water experts, was part of the strategy. Emergency plans for Prague city centre and the suburbs were updated based on model results, the weakest points in the flood defences were identified and suggestions for improvements were assessed. Based on these analyses, the first phase of flood protections for the Old Town was designed and implemented in 2003. Just one year later, in 2002, Prague experienced its worst floods in history, and the model showed its value in guiding the response of the city authorities. They were able to close mobile barriers at the right time and place, to save lives as well as protecting the historical Old Town. The model has since been reassessed and updated regularly and has been used for the design of the complete flood protection system as well as in urban planning, including the drawing up of risk maps as required by the EU Flood Directive. Three years ago, an interactive tool, Operational Flood Maps, was introduced and has successfully been in operation since then. It is connected to eleven city water level gauges and enables the City Hall Crisis Management Department to estimate and forecast the extent of flooding.

(Courtesy: DHI)

Reducing the risk of flooding, Maputo, Mozambique

Like other African countries, Mozambique faces a growing number of extreme weather events. Historically the capital Maputo lacked adequate urban planning. A lack of decision-making tools compounded the problem of recurring floods. A well proven approach, which combines hydraulic principles with GIS analyses to predict flood risks and to adapt urban areas to climate change, is helping the Ministry for the Coordination of Environmental Action and the National Institute of Disaster Management to carry out appropriate urban development plans and disaster risk reduction. Investments have been made in airborne topographical scanning, institutional analysis and flood inundation mapping to increase the capacity and preparedness for urban adaptation to climate change.

(Courtesy: COWI)

Flood risk and urban growth, Turkey

The urbanisation in Turkey is high and exceeds most other countries in Europe. Together with the increased climate impact and old existing water infrastructure, these factors calls for urban water planning and a lot of stormwater system rehabilitation and sewage extension. Recently, Ramboll has carried out several large wastewater infrastructure projects and urban development projects in Turkey among these in the cities of Istanbul, Endermli, Aksebod and Antalya.

(Courtesy: Ramboll)
Urban development, Aalborg, Denmark

Flood maps are an invaluable tool for climate change adaptation planning. If based on ultra-precise terrain data collected with airborne laser scanning techniques, they provide precise answers to where flooding may occur and how rainwater will flow on the surface after heavy rain. This combination of flood maps and advanced mathematical models was used in developing a former freight area close to the centre of Aalborg, Denmark’s fourth largest city. The vision for this area is to create an innovative green neighbourhood. Local drainage of rainwater is planned, using rain gardens, green roofs and open channels. The load on the public sewer, which is a piped part of a stream, and the amount of rainwater reaching the downstream recipient, are thereby considerably reduced. The sizing of the drainage systems has been designed after carrying out a prioritisation areas with a tendency to flood. (Courtesy: NIRAS)

Local rainwater drainage, Copenhagen, Denmark

Part of Copenhagen’s water strategy is to reduce the risk of overflows from sewers, so a target was set of handling 30 percent of rainwater locally. A model and decision tool for the use of sustainable urban drainage solutions (SUDS) was developed. Investigations at plot level have shown the potential for infiltration of water using soakaways, rain gardens, infiltration beds, green roofs and the recycling of water. For a district in northern Copenhagen the level of sustainable infiltration of water was then determined. Based on assembled data, the impact on groundwater levels has been assessed, taking into account potential sea level rises during an expected future climate scenario. (Courtesy: Alectia)

Risk and priority maps, Copenhagen, Denmark

In 2012 the City of Copenhagen was ready with a flood mitigation plan and a strategy for the greater Copenhagen area. The plan includes overview maps showing flood risk, economical risk, sensitive areas and priority areas to reduce damage in the event of heavy rainfall. (Courtesy: CDWl and Ramboll)
4. Integrating stormwater opportunities with urban planning

Stormwater initiatives can be integrated with city planning creating more liveable cities

LYKKE LEONARDSEN
Head of strategy and authority
CITY OF COPENHAGEN

If wastewater and stormwater management are integrated at an early stage with the urban planning process, benefits and synergies can be obtained, making additional costs relatively small. Waiting until town planning is completed or until crisis events occur, only leads to more complicated problems and higher costs to resolve them.

Expanding stormwater capacity

When planning for an expansion of the stormwater drainage capacity, the most cost-effective solution is often to integrate large structures like canals, lakes and storage basins into the stormwater system. When not used for stormwater, these systems can contribute in other ways, for instance, in creating green corridors that give shade and help cool the city.

Handling normal rainfall

The regular rainfall can be handled by the city water system, locally in different neighbourhoods or in individual households. It can be infiltrated for use in the water supply, if this is dependent on groundwater. It can be retained for use as secondary water when lesser water quality is sufficient, thus reducing the load on drinking water resources. Or it can be harvested for recreational purposes, which also provide environmental and economic benefits.

Climate adaptation strategy, Copenhagen, Denmark

A very detailed climate adaptation plan for Copenhagen is now complete. It contains detailed dynamic analysis of flood risk from high sea levels and heavy rainfall. The proposals it contains — for integration with urban planning in existing and new urban areas — are for dams, dikes, sluices, canals, circulation and similar systems for protection against flooding. The plan includes economic analysis of the consequences of flooding and if possible interventions based on sophisticated statistical and economic methods. The purpose is to identify the most appropriate interventions and timing for measures to avoid or reduce damage to infrastructure, water supply, sanitation and buildings. It also contains a summarised risk over a hundred year period for the optimised framework of action based on cost-benefit. The software MIKE Flood was used for dynamic modelling of the whole city and advanced GIS applications used for illustration, impact assessments and risk assessments. (Courtesy: City of Copenhagen and COWI)

We need to rethink our urban design and spatial structures. In Northern Europe 30 percent of all built-up and paved areas are at risk from flooding

SONIA SORENSEN
Senior Project Manager
RAMBOLL

Cost benefit analysis helps prioritise. A cost benefit analysis will help identify the most feasible risk level for stormwater protection. This is a calculation of the financial effects of taking no action compared with making the city climate resilient to different levels of security. The economic risk is estimated based on the likelihood of an incident versus the cost involved in reducing the risk to a certain level. A cost benefit analysis also includes an overview of the economic effects on different stakeholders, break even points for different safety levels and the most feasible point at which to make the investment.

Bishan - Ang Mo Kio Park, Singapore

Integrating stormwater opportunities with urban planning is highly relevant in tropic and sub-tropic regions. A good example is the rehabilitation of the Kallang River within Bishan - Ang Mo Kio Park in Singapore, where an existing concrete stormwater canal was changed into an attractive and accessible natural river ecosystem, still securing the flood protection. The inaccessible canal was transformed into a liveable city waterscape for the joy of the local residents. (Courtesy: Atelier Dreiseitl / RamBoll)

Local rainwater drainage, Copenhagen, Denmark

In an urban area of Copenhagen, canals and lakes form the central feature with the layout of the channels and their edges defining different spaces within the environment. The huge development in the area is thus solved with the canals receiving run-off rainwater to offset the load on the existing drainage systems. The more polluted rainwater from roads and car parks is handled separately in the system to protect the quality of water.

Analyses to locate weak points

Many powerful analytical tools have been developed by Danish companies, including those which support an integrated approach. An initial screening can be performed with relatively little data while a very detailed analysis of the hydraulic performance of the entire integrated water system requires models of the soil conditions, sewerage networks, canals, retention basins, surface conditions, elevation, etc. The detailed analysis is then combined with modelling of the full dynamic hydraulic performance of different measures. This makes it possible to find the weak points.

Finding the right solutions

Identifying the best integrated solutions requires experience with stormwater handling and utilisation. Verifications can be done to the desired level of documentation for technical feasibility and economic feasibility with the use of the right data and decision support tools. In Copenhagen, the most feasible solution was found to be a combined approach with principal drains relieved by local drainage in combination with parks, green corridors, canals, roads and tunnels which store or transport water. Most structures provide additional functions for purposes like recreation or public transport.

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Stormwater solutions, Fornebu, Norway The former Fornebu International Airport in Norway closed in 1998 and has been transformed into a green and active residential area and public park with water as an important visual element throughout. The Nansen Park, a new section of the Fornebu Park, was completed in 2008 and includes solutions for managing stormwater, green structures with gutters, cleaning ponds, retention basins and an outlet to the sea. (Courtesy: COWI)

Interdisciplinary planning, Hvidovre, Denmark Climate change involves more than heavy rainfalls and rising sea levels. From an urban perspective a variety of areas will be affected. In Hvidovre, a suburb of Copenhagen, the need for a coordinated climate adaptation effort is being taken seriously. In recent years several episodes of flooding have occurred after heavy rains and the city’s water supply has been seen to be vulnerable to flooding. The solution has been to develop individual plans for the water sector, climate adaptation, water supply and wastewater simultaneously. This has demanded a professional and interdisciplinary approach, and close cooperation between the municipality and the water utility. (Courtesy: Ramboll)

In 1854, in London, England, John Snow identified contaminated water from a pump in Broad Street as the means of transmitting cholera. He persuaded the local authorities to remove the pump handle to prevent further transmission of the disease. That same year, Robert Koch proved that sand filtration of drinking water reduced the risk of cholera infection. Snow and Koch are in many ways the forefathers of urban water management as they identified water related risks, and designed and implemented interventions as well as the means of monitoring their effect. Today we know much more about the hazards and risks related to water, not only the risks of becoming ill but also the risks of flooding and environmental damage.

Tools for preventative action In Denmark, the water sector has a long tradition of managing risk in the urban water cycle using advanced, knowledge-based tools such as models, sensors, data management systems and decision-support systems. When integrated with information and communication systems, these tools offer the means for preventive and corrective actions and ensure due diligence in urban water management.

Sensors as input providers Models are used to gauge the effects of interventions, while sensors monitor operational parameters or directly detect hazards. Combined with process knowledge, the sensors provide the necessary data for optimisation and monitoring of the water and wastewater treatment process. Furthermore, sensors provide input to online models of sewerage systems, water distribution networks, etc. and so on, for intelligent management, early warning systems and decision support systems.

Health issues must be at the top of the agenda in managing urban water challenges. Plans for preventative measures must be in place.

CLAUS JØRGENSEN Senior Scientist and Head of the WHO Collaborating Centre for Water and Health DHI

Prepared for extreme weather with intelligent handling, Copenhagen, Denmark Intelligent wastewater handling enables the treatment of a greater volume of wastewater using existing infrastructure, leading to fewer overflows and reduced pollution. A cost-effective system, the first of its kind, is now providing seamless co-ordination between sewerage systems and wastewater treatment plants at the Lynetten wastewater treatment plant. The plant services 765,000 residents of Copenhagen and annually processes 80-110 billion cubic metres of wastewater (20,000 to 30,000 billion US gallons). (Courtesy: BIOFOS and Ramboll)

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Water related legislation on drinking water, wastewater and bathing water aim to reduce these risks by setting standards and demanding monitoring. Water utilities work hard to establish barriers and control measures to reduce the risks to an acceptable level, while still serving the needs of the urban population.

5. Controlling the risks in time

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Calculations and visualisations with advanced software technology, Bangkok, Thailand In 2011, huge floods submerged large parts of Thailand and the capital Bangkok with serious economic consequences. The government of Thailand has teamed up with Danish water experts with the goal of saving lives, protecting infrastructure and flood-prone cities. The expected flow of water in the case of extreme flooding has been calculated and mapped, and software technology is now in place to advise on how torrential rain can be distributed to reservoirs, extensive river systems and individual areas selected for flood control. Planning and early warning systems will be established to limit and control future floods as it is too late to try to prevent flooding once rain is falling heavily. A strategy and a number of measures for dealing with critical flood situations must be in place due time in advance. (Courtesy: DHI)

Monitoring water quality at beaches Taking a swim can present a serious threat to health when short-term pollution is caused by sewage overflow. To protect bathers EU legislation requires that water quality is monitored for the indicators of faecal pollution, E. coli and Enterococci. To overcome the shortcomings of traditional control systems, an online bathing water forecast system has been developed in Denmark and has been in operation since 2002. The system provides water managers, as well as beach guests, with a continuous evaluation of current bathing water quality as well as a forecast for the coming days. This online predictive tool makes it possible for water managers to follow the developments in water quality and reliably assess the need for short term action, such as temporary closure of the beach, or long term action, such as reduction of sewer overflows. The system uses sensors for the detection of sewer overflows and hydrodynamic modelling and estimation of the concentration of E. coli and Enterococci. The model can also be used to determine the risk of infection and to evaluate scenarios. This is useful for water managers analysing the cost-effectiveness of planned actions. (Courtesy: DHI)

Handbook A handbook on the design of flood control solutions has been developed by Grundfos to assist application engineers, design's, planners and users of sewage and stormwater systems to incorporate axial- and mixed-flow pumps.

Flood protection with advanced pumping solutions. Saint Petersburg, Russia. Saint Petersburg Flood Prevention Facility Complex is the principal line of defence in protecting the beautiful Russian city against flooding. The complex involves dams and related hydraulic structures extending over 25.4 kilometres (15.8 miles) and comprises two navigation canals, six water gates, eleven protective dams and a six-lane highway with a tunnel, bridges and road interchanges passing over the protective dams. When a flood threatens, the dock chambers fill with water, the floating gates rise to the surface and are moved to the middle of the navigable canal reducing the impact of the storm surge on the Neva Bay water area. When the flood danger recedes, the floating gates are let back into the docks and the water is pumped out. The drawing of the dock chambers is executed by advanced pumping equipment installed at each of the pump stations at the Northern and Southern sides of the navigable canal. All the pumps feature a special design and the pump stations are located in cost-internal reinforced concrete framing below the water line. (Courtesy: Grundfos)
Stormwater solutions with multiple purposes, Roskilde, Denmark

Good collaboration between many parties is necessary to find unconventional solutions. This approach lead to a new stormwater storage solution in the city of Roskilde. The storage tank serves a double purpose as a recreational facility for skaters. Close cooperation was successfully achieved between all the stakeholders, consultants and subcontractors to get the unit to function optimally for different purposes and at the same time comply with the technical specifications. (Courtesy: Nordarch, City of Roskilde and COWI)

6. Developing the best solutions through stakeholder engagement

Cities get the most cost-effective solutions and better overall value when the authorities, citizens, urban planners, architects and water experts all work together with common goals

JACOB LARSEN
Director
ORBICON

In many countries it is common practice that proposals for public investment go through a consultation by experts, lawyers, organisations and the public before they are implemented, in order to avoid unforeseen situations. For more than a century public hearings have been an important tradition in Denmark, both for small and large scale public projects. What may be more unique is the Danish tradition of inviting the most important stakeholders directly into the development process. By taking different perspectives and agendas into account, it is possible to achieve more satisfying and cost-effective solutions.

Stakeholder involvement is manageable

To achieve the smoothest flow in the initial design phase and subsequent construction, the process must be managed in a structured way and designers and engineers must be open to the opinions of others. For the best outcomes in integrating stakeholder opinions into urban planning projects, urban planners must take responsibility for identifying suggestions and factors that are worth considering for both public and private stakeholders. They should present them in an understandable manner and create the right space for close dialogue. The negotiations that follow the presentation should be managed into specific topic tracks, to ensure not to lose sight of the goal, while including those who have interests and ideas for the projects. Experience with public process management is vital.

Flood protection for high sea levels, Aarhus, Denmark

As described earlier in this white paper, the Aarhus River has been reopened step by step over two decades. This action reverses a decision taken 60 years ago, which was to seal the river in a concrete culvert from upstream of the city to the bay. A new urban waterfront will become reality when the last part of the river is reopened in 2014. This final phase is a comprehensive climate adaptation project giving the city an extensive lock system, and one of Denmark’s largest pumping stations. It will protect Aarhus city centre against flooding from rising sea levels and in situations of excessive rainfall.

The design of the lock and pump system is based on comprehensive water modelling expertise. (Courtesy: ALECTIA, Schmidt Hammer Lassen Architects, Architect Kristine Jensen)

Engaging the citizen in the process of climate adaptation, Middelfart, Denmark

Two major floods convinced Middelfart, a historic market town in central Denmark, to develop a climate adaptation plan which, among other elements, includes the local retention of huge amounts of water. As public roads, private properties and gardens would be affected, the challenge was to get the public authorities and homeowners volunteering to work for a common cause, together to rethink the distribution of water. Sharing the common goal to improve recreational facilities while reducing the risk of flood damage spurred a visionary project in which the authorities, the water utility, consultants and citizens worked together. They created the input for technical, aesthetic and locally based solutions for improved drainage of rainwater in a 450,000 square metres area (five millions square feet). An innovative process ensured that stakeholders, authorities and citizens were already involved in the preliminary project, which created the platform for an architectural competition. (Courtesy: Orbicon)
Multiple benefits from climate change adaptation, Sillebro River Valley, Frederikssund, Denmark

Heavy rainfalls earlier led to severe flooding in the city of Frederikssund. The increased volume of rainfall is now used positively in the river valley in open ponds and wetlands, providing both recreational value to the citizens and improved and new habitats for flora and fauna. New ponds purify rainwater before it runs to the restored river, allowing trout and other wild fauna better living conditions. This holistic project is a unique collaboration between Frederikssund Water Utility Company and Frederikssund Municipality creating win-win solutions for everyone involved. The water utility company saved up to 50 percent of the construction costs used for traditional urban retention basins. The holistic approach used to make the project possible, involves a strong focus on stakeholder involvement, alternative financing mechanisms and the fulfilment of environmental legislation demands. In the Frederikssund case, climate change adaptation became a strong driver of local sustainable and cost-effective development. (Courtesy: NIRAS)

Local rainwater drainage integrated with urban development, Usserød River, Kokkedal, Denmark

Rainwater handling can be used positively to create more interaction between the inhabitants of a city as well as more attractive areas and a safer environment. After implementing the first phase of its climate adaptation strategy, the city of Kokkedal moved into a second phase, where local management of rainwater became an integral part of urban development. In 2013, the city implemented a climate change adaptation project. The ideas and plans were developed and carried out by landscape architects in collaboration with an architect and a consulting engineering company. The city council saw the project as an opportunity to regenerate the entire city and create a new beginning, making the place more liveable and safer than it was before. The vision is an attractive town centre with new paths and active places where citizens can meet for water games, skating, football, golf and much more. The project area includes a park, nursing homes, a sports centre, a shopping centre and five residential areas. Approximately 3,000 people live in the project area and local residents were involved in the completion of the first stage of the project. (Courtesy: Schenker, BIG and Ramboll)

In climate adaptation it is important to use a holistic and interdisciplinary methodology. It sounds easy, but it is not! Skills relating to the entire water cycle must be covered by the working team.

Jens Brøndt Bering
Business Unit Director
NIRAS
Citizen-driven problem solving, Odense, Denmark. A new recreational area is the result of innovative cooperation between landowners in the city of Odense and Odense Water, solving the problems of flooded basements after heavy rain. Since 2005, the area had been seriously affected three times by stormwater that neither sewers, storm sewers nor flood retention basins could prevent. The local residents came up with the idea that Odense Water might buy some of the flooded properties to extend an existing flood retention basin. This was by far the cheapest solution and meant that residents could lay their fears to rest. (Courtesy: VCS Denmark)

A long tradition of sustainable water management

As awareness about sustainable water practices has increased, Denmark has spent the past decades building expertise within water efficiency and water management. Today, our tap water is as pure as the finest spring water, water loss in our pipelines has been reduced to less than 8 percent, wastewater is treated efficiently with a strong focus on energy and resource recovery and the water in our capital’s harbour is clean enough to swim in.

The knowledge we have about water resources, security and efficiency is no coincidence. Successive governments have addressed our country’s limited natural resources and water management, urban drainage, water supply, wastewater treatment as well as governance and ensuring public awareness and support for water policies.

Denmark is prepared to take responsibility in solving the world’s major water challenges and has ambitious plans for its water sector. A water vision for 2025 has been created through dialogue between the Danish water sector and the Ministry of Environment and Food with the intention of developing Denmark’s position as a water hub for intelligent and efficient water solutions. The aim is to create solutions which will increase access to clean water and sanitation, promote efficient use of water resources, improve the competitiveness of water consuming industries, lead to a cleaner global environment and protect cities from floods and storm surges.

As a country, we see great opportunity for mutual benefit in the transfer of knowledge and we aim at turning global water challenges into opportunities for sustainable growth.

Explore water solutions online or experience them live in Denmark

We invite you to explore the newest Danish water solutions, policies and news online at www.stateofgreen.com/water. You can also visit Denmark on a State of Green Water Tour where you can experience innovative water solutions first-hand and take advantage of the lessons learned by leading Danish companies and utilities.

For more information about State of Green Water Tours, please visit: www.stateofgreen.com/tours

Water is an increasingly scarce resource in most parts of the world and we need to rethink how we use it. Denmark holds a long tradition of integrated water management and is committed to take responsibility and contribute to solving the major global water challenges.

A shared water vision for the future

The close collaboration between multiple stakeholders has put Denmark at the forefront of research, technology development, know-how and best-practice in integrated water management, urban drainage, water supply, wastewater treatment as well as governance and ensuring public awareness and support for water policies.

Denmark is ready as your partner in finding solutions to the major water challenges the world faces.

ESBEN LUNDE LARSEN, Minister for the Environment and Food, DENMARK

Energy efficiency and integrating water for a liveable city, Nanning, China

Sustainable urban development plans for the Nanjing High Tech Zone on the west bank of the Yangtze River in China were designed to make the semi-developed area greener and more attractive for both businesses and citizens. The concept was to rethink and升级 urban planning in the area to shift the development in a more sustainable and innovative direction, while at the same time safeguarding the growth of the city and ensuring its climatic resilience. Solutions that would improve existing town plans, reduce energy consumption and create a greener and more healthy environment were developed in cooperation with Danish experts. As a result, the water infrastructure of the city was transformed from an ugly, technical-looking structure to being an integrated part of city life. The newly developed structures are used as green areas, recreational spaces, transport corridors for soft traffic, rest places, wetlands for water treatment and so on. At the same time the capacity of the water transportation and storage systems has been increased making the city more climate resilient. (Courtesy: COWI)

“Danish water companies, utilities and organisations have shown that by working together, it is possible to create more innovative solutions which lead to added value for both their customers and society as a whole. This is a great example of how Denmark contributes to finding solutions to the major water challenges the world faces”
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