

FESTIVAL DELL'ACQUA 2022

# COPENHAGEN AS A SPONGE CITY

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# CLIMATE ADAPTATION PLANS IN DENMARK



2nd of July 2011 Copenhagen experienced a heavy cloudburst, 150 mm of rain in one hour



The total cost of damage was estimated to exceed 1,2 bill. €



Short after the event the Parliament introduced new legislation obliging all municipalities to make climate change adaptation plans by 2013

# THE STRUCTURE OF THE PLAN

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The municipalities were obliged to conduct different analysis:



**Flooding maps** showing the estimated flooding propagation under different return periods (10, 20, 50 and 100 year) both under present circumstances and projected with a climate factor



**Mapping of values** (threatened by flooding)



**A risk map** combining the potential of flooding with potential loss of value



**Designated action areas** – where there is a great risk of flooding and a high potential loss of value

# EXAMPLES OF FLOODS MAPS

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The urban water modelling software **MIKE URBAN** was used as it covers all water networks in the city, including water distribution systems, storm water drainage systems, and sewer collection in separate and combined systems

100 year  
return  
period  
in **2010**



100 year  
return  
period  
in **2110**



# THE STRATEGY

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DECARBONIFY  
DECENTRALISE  
DIGITALISATION

# THE SOLUTION

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**With the introduction of the climate adaptation plans, it became mandatory to consider blue-green infrastructures**



**Where it is possible - manage the storm water on the surface rather than in pipes**



**Open impermeable surfaces**



**Innovative urban spaces**



**Multi purpose solutions**

# HANS TAVSENS PARK

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# NOT ONLY COPENHAGEN AARHUS

*Photo credit: Rasmus Hansen, Google Photographer*

## **A city designed around rainwater, Aarhus, Denmark**

Nye is a new suburb of Aarhus, Denmark's second largest city, where rainwater has been considered a resource right from the start of the development. Rainwater from roofs, roads and other areas is collected in open trenches and runs through small ponds before it is collected in a small lake, which in reality is a beautiful rainwater basin. In the event of a cloudburst, there is capacity in the lakes for the storage of rainwater corresponding to a 100-year rainfall event. From the lake, water is channelled into a treatment plant where it

is paramount. Therefore, the rainwater pipes are purple, to prevent them from being inadvertently connected to the drinking water system, and various backflow protections are installed. Inside the homes, the treated water is used for toilet flushing and laundry. This has reduced the need for drinking water supply by 40 percent in an area with limited groundwater resources. Nye demonstrates a completely new and holistic approach to rainwater in an urban area.

(Courtesy: Aarhus Vand, Tækker Group,

# THE GOVERNANCE

98 municipalities in Denmark serve as water authorities, responsible, for local water plans and compliance

Decentralised sector – all wastewater utilities are owned by municipalities

Utilities support municipalities in the implementation of the climate adaptation plan for 10-years storm water events for CS, and 5 years for separated systems

Climate change infrastructures for bigger events are co-financed by municipalities and utilities



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# WATER FOR SMART LIVABLE CITIES

- The presence of water increase biodiversity
- Successful integration of urban canals, rivers, lakes and harbours, have a magnetic effect on people
- Focus on full circularity and resources recovery
- Focus on efficiency and digitalisation

# EXAMPLES



## Clima ponds

To increase biodiversity, ensuring a permanent water table, climaponds handling stormwater directly from the downspouts can be established. The trench in the inlet can be designed, so the inlet flow is smooth, even throughout cloudbursts.



## Ditches

A ditch is a narrow channel dug in the ground, typically used for drainage alongside a road or the edge of a field.



## Infiltration from surface

Infiltration from surface occurs when disconnecting the downspouts and discharging the rainwater on the permeable surface.



## Linear drainage systems

Using linear drainage systems makes it possible to transport stormwater visibly just underneath the road. The linear drainage systems can carry heavy traffic. It can also be in the form of steel drain grates in a driveway or concrete drain grates alongside a motorway.



## Climate roads

Permeable asphalt is getting more common. The stormwater infiltrates through the surface and the bearing layers underneath, ensuring the water transport through all roadbox.



## Green roof and walls

Green roofs/walls are roofs covered with a multi-layer system consisting of: growth medium, drainage layer and water-proof membrane that delay runoff. The degree of delay and volume reduction increases with the thickness of the growth medium. Green roofs/walls insulate structures from heat and can provide a habitat for certain insects and birds. Retained water evaporates.



## Irish crossings

Using Irish crossings, the stormwater is able to cross a road, whenever this is needed. The trench is shaped as a pre-immersion in the asphalt itself.



## Permeable pavement

Permeable pavement provides a horizontal surface suitable for walking or driving with (heavy) traffic load but also allows rainwater to infiltrate. The infiltration capacity of the permeable pavement depends on the design and on the hydraulic capacity of the bearing layers underneath.



# EXAMPLES



## Rain gardens

A rain garden is a depression in the terrain designed to receive, store and filter runoff from roofs or surfaces and is also designed as a specially planted area with selected plants that can cope with dry and with wet conditions.



## Soakaway or infiltration trench

A soakaway (dry well, infiltration well) is a pit in the ground, stabilised with a porous material. Wrapped in geotextile and covered with topsoil and vegetation. An infiltration trench is a soakaway shaped geometrically like a trench, for example, 60 cm wide, 1 m deep and several metres long.



## Swales

A swale is a rain garden placed in the side of a road, with a soakaway underneath. Typically, the swale also serves as a traffic harassment.



## Trenches

Trenches are used for transporting water above ground in places where open trenches do not inconvenience road users. Trenches can be a recreational element in an urban landscape.



## Underdrains

An overlooked NbS is underdrains. Combined with all other NbS elements, underdrains contribute to distribute the stormwater into - or out from - the NbS, optimising infiltration rate from the NbS or securing a far bigger infiltration area.

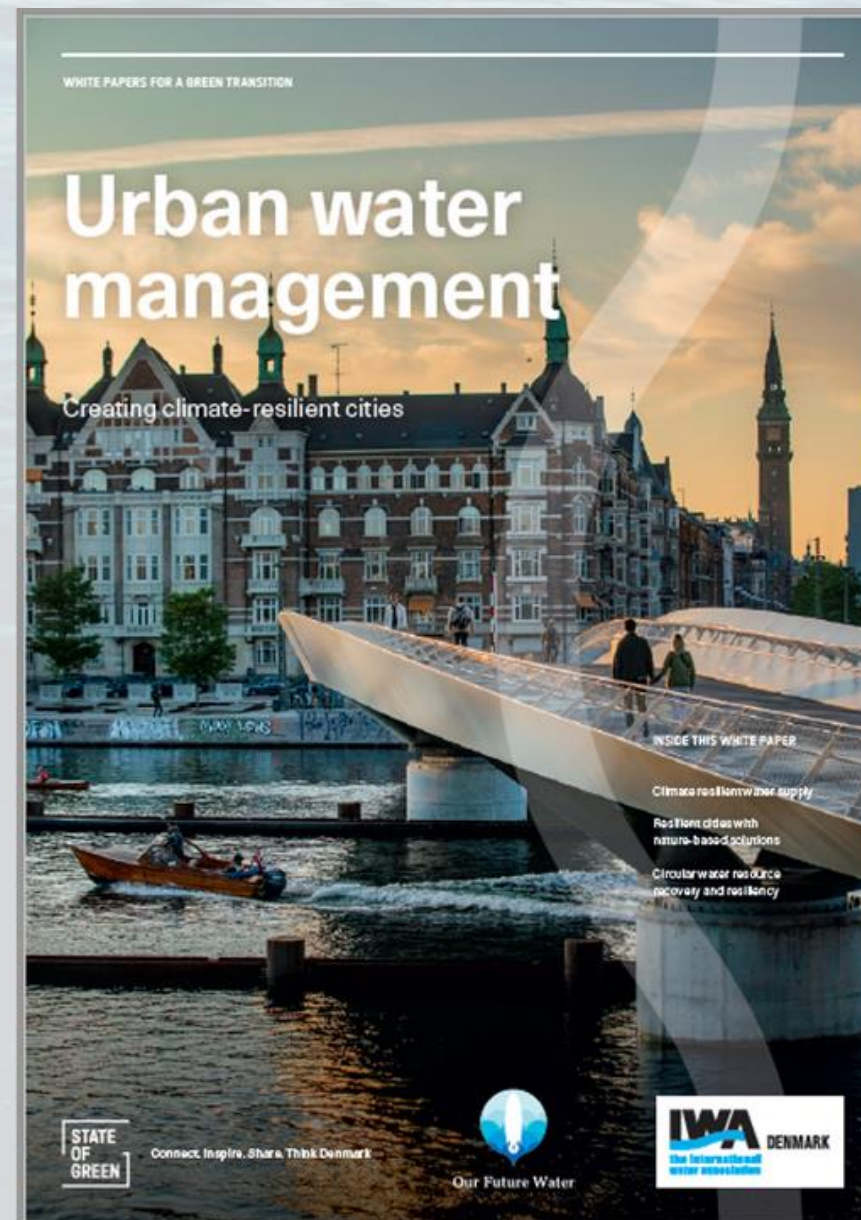


## Mix of NbS

All the above mentioned NbS can be combined in many different ways. Permeable pavements, linear drainage systems, raingardens, underdrains are all pieces of a larger puzzle, all contributing to the water infrastructure of climate adaptation.



# LEARN MORE



# THANK YOU!

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un evento promosso  
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