CENTRE for LiveableCities SINGAPORE

Cloudburst Solutions in Copenhagen

Preamble

As cities around the world focus on mitigation measures and reducing carbon emissions to implement the Paris Declaration and meet the ambition of the UN Climate Change Conference (COP21), C40 convenes the first conference to examine adaptation measures to complement mitigation measures. This report shares lessons learnt from Copenhagen in managing stormwater challenges with cloudburst solutions.

Making Copenhagen Climate-Resilient

In July 2011, Copenhagen was hit by a devastating cloudburst, where 150mm of rainwater flooded cellars, streets, and major roads in less than three hours. This set the political impetus to change national legislation to focus on adaptation strategies. In the same year, the city unveiled the Climate Adaptation Plan that combines surface, sewer-based solutions, and strategies to retain and drain water. The combined solutions consist of a network of parks, cloudburst boulevards (or streets) to channel stormwater (Figure 1) and retention zones to delay water flow.

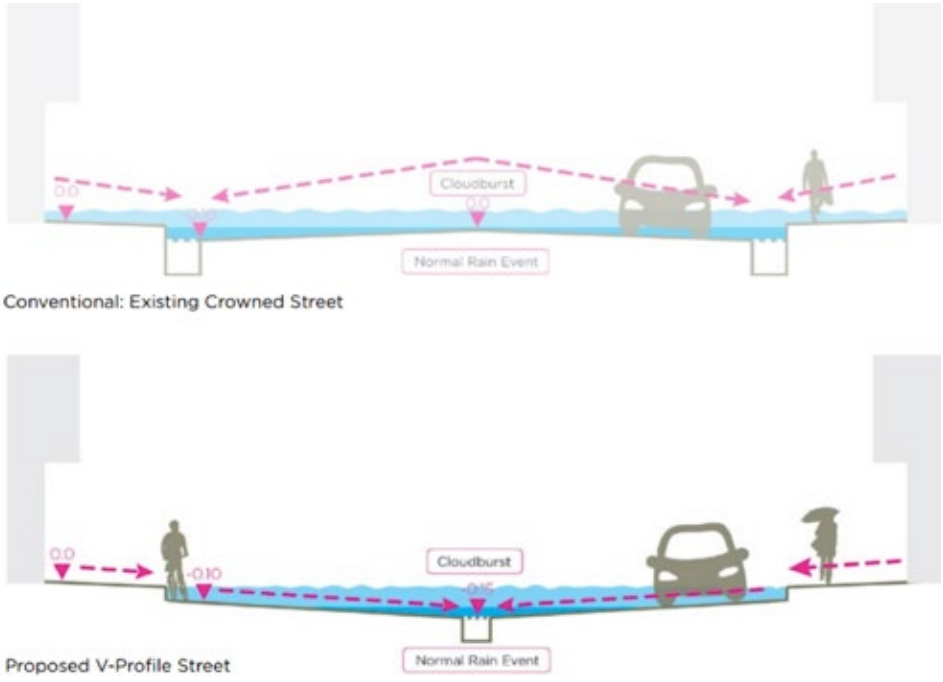

Figure 1: Cloudburst boulevards are used to channel and direct cloudburst water through unique designs such as a V-shaped profile and raised kerbs to ensure water flows in the middle of the road, away from the buildings.

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Source: "Copenhagen Cloudburst Plans," Ramboll in Brief, 20 April 2016, https://acwi.gov/climate_wkg/minutes/Copenhagen_Cloudburst_Ramboll_April_20_2016%20(4).pdf

Financing Cloudburst Solutions

In Copenhagen, water companies handled stormwater management using water fees, while the municipal government managed infrastructure expenditure. With this separation, the national legislation did not allow for the mixing of urban infrastructure with stormwater management. This meant that financing mechanisms were not available for the implementation of cloudburst solutions.

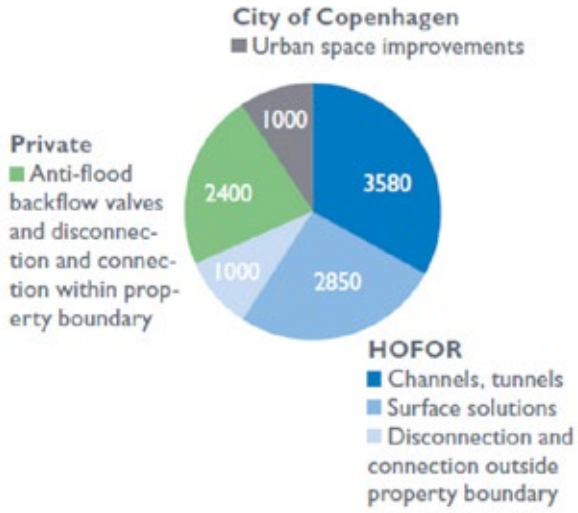

Figure 2: Construction cost estimate for the combined solution in Copenhagen (in DKK millions). Estimates is based on how much it would cost the city to establish a solution for the management of cloudbursts and stormwater in the city if it were built tomorrow.

The city lobbied for a change of national legislation to finance new adaptation measures.[1] First, it is proposed that technical adaptations be financed by utilities charges or water taxes by HOFOR (the Greater Copenhagen Utility). Such adaptations include below-ground water harvesting or pipe-based infrastructure such as underground pipes and reservoirs. Meanwhile, aspects of these projects that are related to urban space improvements would be financed through the city's municipal budget (Figure 2).

With these two generic strategies as a guideline, pragmatic solutions were developed with considerable flexibility. For instance, when it was found that a surface solution is more cost-effective than a pipe-based solution, the city has the option of co-financing water management with HOFOR and sharing the water cost of cloudburst management measures with private property owners.[2]

In the case of cloudburst boulevards, making the required changes to existing roads falls within the purview of the sewage company. Therefore, legislation was changed to enable the sewerage company to acquire funds for the transportation of rainwater through the roads.[3]

Regulations were also implemented to meet the cost of climate adaptation measures. The city worked closely with HOFOR, Forsikring & Pension (an organisation for the insurance industry) and landowner associations (a third of streets are privately-owned)[4] to formalise a partnership in January 2015, with the intention to monitor flood risk and offer incentives for compliance on adaptation projects. Insurance companies helped to disseminate information on adapting houses to mitigate flooding, on the necessity of backflow installations and on dealing with decoupling of rainwater from sewage (Figure 3). This was a win-win solution; with better mitigation measures in place, insurance companies benefited from decreased insurance pay-outs for extreme weather-related infrastructural damages, while citizens gained from decreased insurance premiums for flood risk.

Case Study: Saint Kjelds – Copenhagen's First "Climate-Resilient" Neighbourhood

By 2012, Copenhagen's first climate-resilient neighbourhood, Saint Kjelds district, emerged. Saint Kjelds was chosen as a model district to pilot climate adaptation measures. By transforming 20% of the neighbourhood —formerly characterised by an abundance of hard, impervious surfaces such as asphalt — into green space, 30% of stormwater is now managed locally. With this strategy, which includes regulating privately-owned buildings to install backflow blockers, a significant amount of stormwater is prevented from entering the sewer system.[5] Insurance companies played a key role to hasten the adaptation measure by not insuring buildings that did not have backflow blockers from 2012.

At Tåsinge Square in the Saint Kjelds neighbourhood, (Figure 4), a plain grass area and parking spaces were transformed into a green oasis. Cloudburst measures include collecting rainwater from the nearby roofs in an underground reservoir and sloping the area such that rainwater collects at the bottom of the slopes, where it seeps into the ground instead of being directed to the drains.

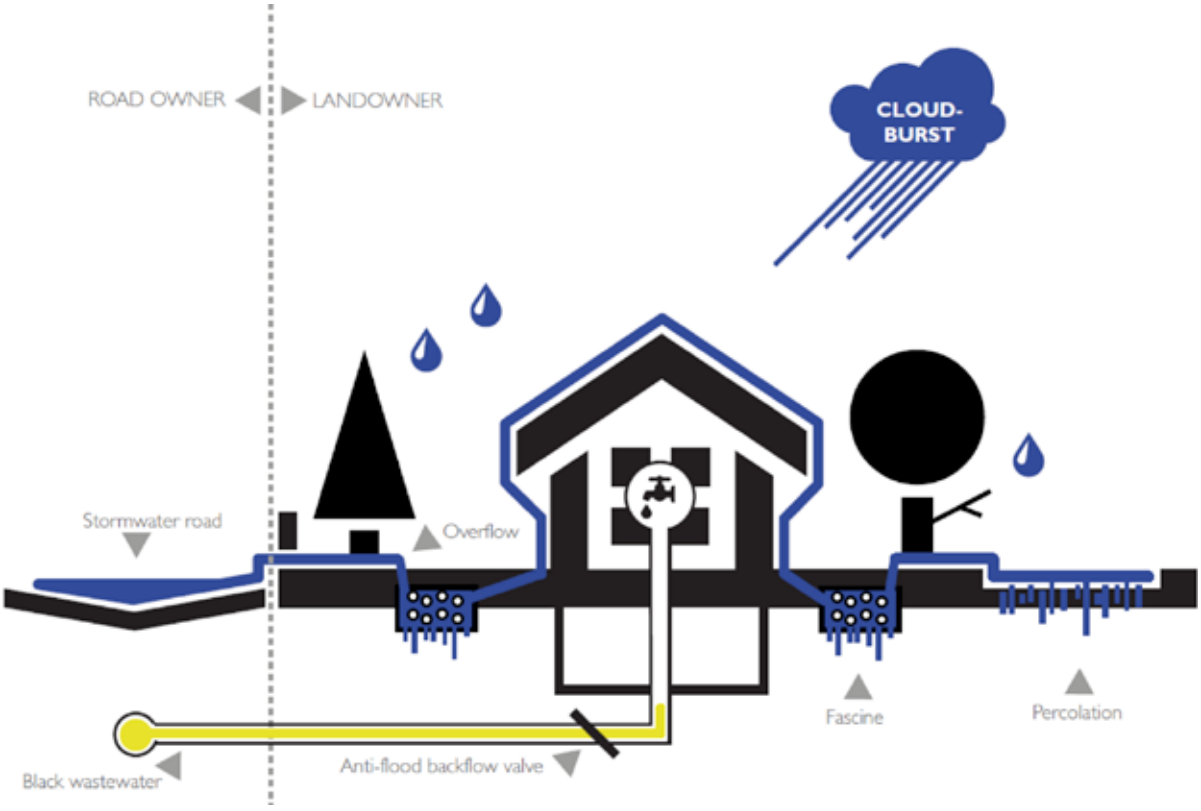

Figure 3: Schematic diagram of cloudburst management in a building – when normal systems for stormwater management become full and excess stormwater is conveyed to public solutions e.g. pavement and anti-flood backflow valves are installed to prevent backflow of wastewater into the house in the event of high pressure in the sewer.

Reflections and Concluding Remarks

In Singapore, the intensity of rainfall is sometimes higher than Copenhagen during the monsoon periods. For example, rainfall of 63.4mm in 30 minutes was recorded in Toa Payoh in December 2015. Presently, Singapore relies on strategies that localise the management of stormwater; flash floods mostly occur in a small locality and subside within an hour.[6]

Figure 4: Tåsinge Plads: Water from the street flows into flowerbeds during heavy rains, while sculptures collect water to nourish plants, creating capacity in the drains to prevent flooding and damage.

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Source: Athlyn Cathcart-Keays, "Why Copenhagen is building parks that can turn into ponds," Citiscope, 21 January 2016, http://citiscope.org/story/2016/why-copenhagen-building-parks-can-turn-ponds

As the city-state faces new challenges in a climate-challenged future, we can expect an increase in intensity and frequency of heavy rainfall events. Adopting blue-green elements in the urban fabric should become more commonplace through programmes such as ABC Waters, which has elements similar to Copenhagen's cloudburst measures. One way to improve our water resilience could be to consider Copenhagen's redesign of streets to channel water, and the funding of these cloudburst boulevards based on multifunctional designs (i.e., stormwater management and urban space improvements).

Footnotes:

[1] Connecting Delta Cities (CDC) Resilient Cities and Climate Adaptation Strategies (Rotterdam., 2013) page164.

[2] City of Copenhagen Cloudburst management pays off: economics of cloudburst and stormwater management in Copenhagen (Copenhagen, 2014), page 16.

[3] City of Copenhagen Cloudburst management pays off: economics of cloudburst and stormwater management in Copenhagen (Copenhagen, 2014), page 15.

[4] Mayors Adapt, Twinning Visit Report: Copenhagen: 25–28 April 2016, http://www.pilsetumerupakts.eu/IMG/pdf/Twinning_report_Copenhagen.pdf

[5] Water Environment Federation, "Copehagen neighbourhood redesigned with climate in mind," 25 February 2015, http://stormwater.wef.org/2015/02/copenhagen-neighborhood-redesigned-climate-mind/

[6] Meteorological Service Singapore, Annual Climate Assessment Report 2015, http://www.weather.gov.sg/wp-content/uploads/2016/03/Annual-Climate-Assessment-Report-2015.pdf

About the Writer

WRITER

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CLC researcher Michelle Chng represented Singapore at the C40 Climate Change (Adaptation & Water Initiative) Conference in Dubai in January 2017 that convened three networks (Connecting Delta Cities, Cool Cities and Climate Change Risk Assessment), to support C40 cities in meeting their goals in the area of climate change adaptation-planning and water management.

About CLC

The Centre for Liveable Cities was set up in 2008 by the Ministry of National Development and the Ministry of the Environment and Water Resources, based on a strategic blueprint developed by Singapore's Inter-Ministerial Committee on Sustainable Development. Guided by its mission to distil, create and share knowledge on liveable and sustainable cities, the Centre's work spans four main areas - Research, Capability Development, Knowledge Platforms and Advisory. The CLC Lecture Series is a platform for urban experts to share their knowledge with other practitioners. For more information, please visit us at http://www.clc.gov.sg