

CITY OF COPENHAGEN

CLOUDBURST MANAGEMENT PLAN

Copenhagen, Denmark

PREPARING FOR **EXTREME RAINFALL**



CLIMATE CHANGE **CHALLENGES**



CLIMATE-READY **DESIGN**



With costly intense precipitation events known as “cloudbursts” already stressing city infrastructure, the City of Copenhagen in Denmark saw an opportunity to develop an innovative, adaptive city-wide solution for managing stormwater and reducing flooding risks. Copenhagen’s Cloudburst Management Plan, which is a component of the city’s Climate Adaptation Plan, focuses on solutions that combine large-scale, blue-green infrastructure projects that manage stormwater at the surface with underground drainage tunnels where needed.

A cloudburst in July 2011 produced over 6 inches (150 mm) of rainfall across the city in two hours, and caused ~\$1 billion USD in damage. Local climate change projections indicate that the intensity of heavy downpours is expected to rise by 20-50% in the future under moderate to high greenhouse gas emissions. These changes will overwhelm the existing sewer system, be increasingly costly, and make it challenging for Copenhagen to meet its level of service objectives. Motivated to act and reduce risks, the City decided to develop a Cloudburst Management Plan.

The City of Copenhagen viewed the Cloudburst Management Plan as an opportunity to reduce flood risks, create value, and innovate through the design and implementation of blue-green infrastructure. The current cost risk of doing nothing to address cloudburst impacts in Copenhagen is estimated to be ~\$60 million USD annually and will rise to ~\$160 million by 2100. The Plan aims to provide a level of service that is cost effective and can be maintained throughout the city during cloudburst events. Copenhagen determined that protecting against the 100-year event would provide the largest socio-economic gains. The Plan used global climate model output to determine rainfall intensities associated with a 100-year event in 2100. An acceptable level of flooding was then defined as an average of 3.9 inches (10cm) of floodwaters above ground level during a 100-year event. This level of service informs project planning and design.

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SPOTLIGHT ON THE SCIENCE

Having already experienced severe impacts from cloudburst events, the City of Copenhagen wanted to develop a climate-smart plan that outlines comprehensive, feasible solutions to protect the City and residents from rainfall intensities associated with current and future conditions. The Danish Meteorological Institute (DMI) evaluated future rainfall intensities for the City using global climate model output for a moderate-to-high greenhouse gas emissions scenario (A2) from the Intergovernmental Panel on Climate Change (IPCC). The projections indicate that the intensity of heavy downpours is expected to rise by 20-50% by 2100, with the intensity of the 10-year event increasing 30% and the 100-year event increasing by 40%.

Using these projections, the City determined a level of service associated with a 100-year flood event in 2100 with the acceptable flood level being an average of 3.9 inches (10cm) above ground level. Based on experiences gained during development of the Copenhagen Cloudburst Management Plan, Ramboll, a project consultant, outlined an adaptable 6-step process known as the 'Copenhagen Formula' that includes steps for data acquisition and assessment, modeling and mapping, cost of doing nothing analyses, design and visualization, stakeholder engagement, design iteration, and economic assessment.

THE ROLE OF STAKEHOLDERS

The City of Copenhagen developed the Cloudburst Management Plan in coordination with HOFOR (Greater Copenhagen Utility), the City of Frederiksberg, and the Frederiksberg utility company. The development of the Plan also involved consultants and stakeholder engagement with a variety of subject matter experts, including engineers, landscape architects, planners, scientists, economists, and communication specialists. Implementation of the Plan is on a 20-year timeline and areas of the city are prioritized based on where risks are highest, measures are easy to implement, there is ongoing urban development, and where there are opportunities for multiple benefits.



KEY TAKE-AWAYS

With cloudburst events already causing extensive damage across Copenhagen, it was clear that action was needed to reduce risks and build resilience to future extreme rainfall. The City of Copenhagen used this opportunity to bring together a team of experts and stakeholders to develop the Cloudburst Management Plan. Using climate change projections to define a consistent 'level of service' helped to support implementation of the Plan. Additionally, identifying opportunities for both environmental and socio-economic benefits of Plan implementation has been an important resource and has helped the City garner support and financing to support the 20-year Plan implementation timeline.



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