NOVA SCHOOL OF BUSINESS & ECONOMICS

The Skbrudsplan (Cloudburst Plan) – A Sponge City Initiative in Copenhagen

Group 14

2652-Fundamentals on Environment and Sustainability

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AGENDA

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EXECUTIVE SUMMARY

Proving the Impact: How Copenhagen's Cloudburst Plan Delivers Value

Situation

Copenhagen faces increasing extreme rainfall due to climate change. To enhance resilience, it developed the Cloudburst Management Plan based on nature-based and sponge city principles

Complication

Scaling up green infrastructure requires proof of long-term benefits across environmental, social, and economic dimensions

Question

What are the measurable sustainability impacts of Copenhagen's Cloudburst Plan?

Answer

Impact assessments show the plan delivers long-term environmental and socio-economic value, supporting climate adaptation goals

Sustainability Highlights

HOW

Environmental Impact Assessment
→ Improved water quality, reduced flooding, better land use

Life Cycle Assessment
→ Reduced emissions, efficient resource use in infrastructure

Strategic Sustainability Assessment
→ Balanced socio-economic and ecological trade-offs

KEY FINDINGS

City-Level Improvements	Global Relevance
Enhances urban resilience and climate adaptation	Reduces public infrastructure damage from floods
Promotes sustainable urban planning integration	Sets a replicable model for other global cities
Improves stakeholder engagement and awareness	Attracts international recognition and funding

PROJECT BACKGROUND

Facing the Flood: How Copenhagen Responded to Growing Rainfall Threats

The Problem

- In Copenhagen, rain and wastewater use the same small pipes
- During heavy rain, they overflow and flood streets and homes
- Climate change makes storms worse, and damages often cost more than better protection would

On July 2, 2011, a heavy rainstorm dropped **almost 100 mm in one hour**, causing **flood damage of 5–6 billion DKK**

The Solution

- After the 2011 floods, Copenhagen launched the Cloudburst Plan
- Water should flow above ground when possible, or through tunnels in dense areas
- The city is divided into 26 zones for step-by-step planning.

A **mix of green/blue ground-level** solutions **and deep tunnels** helps prevent damage and makes the city better and safer

Stake-holders

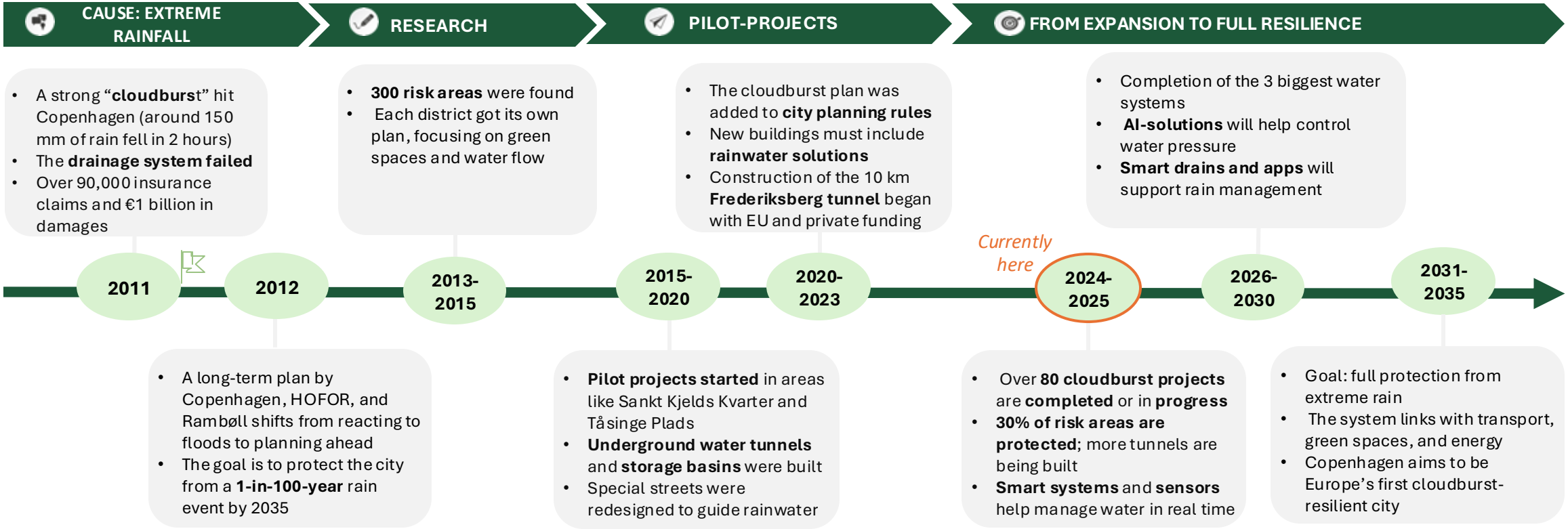
- The City of Copenhagen leads the project
- Københavns Energi builds and pays for technical parts
- Property owners protect their buildings
- Neighboring cities help with drainage
- The Environment Ministry adjusts laws to enable action

Collaboration and shared financing are essential, as the damage from events like 2011 **costs more than the entire plan itself**

The Cloudburst Management Plan is a bold and forward looking strategy that brings together smart urban design, close cooperation between key stakeholders, and long term investment with one clear goal: to make Copenhagen safer, greener, and better prepared for future extreme rainfall events

PROJECT TIMELINE

From Disaster to Resilience: Copenhagen's Long-Term Path to Flood Protection



This timeline shows how one extreme rainfall event in Copenhagen led to a long and coordinated process of research, planning, and investment. Over time, this has helped transform the city into a safer, more climate-resilient, and better-prepared place for the future

EIA– IMPACT ON WATER

Rethinking Rain: How Nature-Based Solutions Reshape Urban Water Management

Contributing Factors	Impact on Water
1 Bioswales 2 Retention basins 3 Vegetated infiltration areas	**Improvement of Water Quality** Rainwater is naturally filtered, with pollutants removed before reaching groundwater or rivers
1 Green roofs 2 Stormwater parks (e.g., Enghaveparken) 3 Redesigned streets as water channels	**Reduction of Urban Flooding** Rainwater is slowed and stored during storms, helping to prevent sewer overload and flooding
1 Infiltration basins 2 Tree trenches 3 Disconnection of roof downpipes 4 Permevable Pavements	**Support for Groundwater Recharge** Rainwater seeps into the soil, recharging groundwater and helping plants survive dry periods
1 Rain gardens 2 Vegetated swales 3 Native planting 4 Multifunctional green spaces	**Strengthening of Urban Biodiversity** Urban nature areas support wildlife, improve biodiversity, and reconnect fragmented habitats

Green & Blue Solutions

- Green solutions: refer to vegetated, nature-based systems that manage rainwater by mimicking natural processes
- Blue solutions focus on the management of visible or surface water and include

Construction Phase

Downsides

Infrastructure disruption: Roads and public areas may need to be dug up or closed during construction

Soil erosion: Loose soil can wash into drains and harm water quality

Measurement

Water Quality Monitoring: Water quality is assessed by testing runoff for pollutants

Runoff Volume Tracking: Compare runoff before and after interventions

Various nature-based measures introduced by the Cloudburst Management Plan collectively influence urban water systems by improving quality, reducing flooding and supporting ecological balance

EIA– IMPACT ON EARTH

Rethinking Urban Space: How Nature-Based Strategies Reshape Land Use and Ecosystems

Four important impacts on Earth

Land use transformation
Urban spaces serve multiple functions:
• Parks and streets act as flood zones during heavy rain
• 300+ sites now combine social and environmental use

Boosted Urban Biodiversity
Native plantings and green zones support habitats for animals
• Rain gardens and bioswales attract birds and insects
• Green corridors reconnect fragmented ecosystems

Improved Soil Health
Permeable surfaces improve infiltration and reduce erosion
• Porous pavements and green roofs support water absorption
• Less surface runoff helps stabilize urban soils

Spatial Trade-Offs
Green infrastructure reduces land for housing/commercial use
• Limited space in dense areas leads to land-use conflicts
• Gentrification risk in upgraded, greened neighborhoods

Construction Phase

Downsides:

Soil Disruption: Machinery can compact or erode soil, reducing infiltration
Vegetation Loss: Trees and greenery may be cleared during works
Landscape Alteration: Reshaping terrain for infiltration zones or basins changes the natural topography and soil structure

Measurements:

Soil Tests: Check how well water soaks into the soil
Plant Monitoring: Track growth of new vegetation
Biodiversity Checks: Count species to assess habitat recovery

Together, these nature-based transformations reshape the urban landscape, improve soil and biodiversity, but require careful planning and long-term monitoring to manage trade-offs and construction impacts

EIA– IMPACT ON AIR

Skybrudsplan cuts air pollution with green space and fewer cars

Direct Effects

Urban greenery – such as trees, green roofs, and parks – helps clean the air by **filtering fine dust ($PM_{2.5}$)** and **binding nitrogen dioxide (NO_2)**. This leads to **better air quality**, especially in densely built-up areas.

Open water surfaces – like retention areas and canals – **cool the air through evaporation**, which helps to **lower temperatures** and **reduce ozone formation** on hot days.

CO_2 storage: Plants take in CO_2 and store it in their leaves, roots, and soil. This helps Copenhagen reach its goal of becoming CO_2 neutral

Urban greenery cleans the air and cools the city

Indirect Effects

Traffic calming & active mobility: More bike lanes and walkways mean fewer cars, which leads to **less NO_x, CO_2, and fine dust ($PM_{2.5}$)** in the air.

Cooler microclimates: Green areas reduce city heat, which leads to **less ozone** and **lower energy use** (e.g. for air conditioning).

Behavior change: Over time, people use cars less – leading to **long-term improvements in air quality**.

Human-friendly cities lead to healthier environments.

Construction Phase

Fine dust & diesel: Construction sites produce **$PM_{2.5}$, NO_2, and CO_2** from excavators, trucks, and earthworks.

Health risk: The WHO says that fine dust and diesel smoke are bad for your health and can even cause cancer.

Countermeasures: Particle filters, dust control sprays, and low-emission construction machines help reduce pollution.

Short-term impact – but technically manageable.

SDG contribution

- 3 GOOD HEALTH AND WELL-BEING: Reduced air pollutants → fewer respiratory and cardiovascular diseases
- 11 SUSTAINABLE CITIES AND COMMUNITIES: Cleaner, greener, more livable urban neighborhoods
- 13 CLIMATE ACTION: CO_2 sequestration, reduced ozone formation, climate-resilient urban planning

The Skybrudsplan does more than manage stormwater – it also contributes to cleaner air by promoting urban greenery, reducing car traffic, and cooling the city. By connecting climate adaptation with public health, urban livability, and the Sustainable Development Goals (SDGs), it shows how environmental planning can deliver multiple long-term benefits for people and the planet

EIA– SOCIO-ECONOMIC IMPACT

The Cloudburst Plan as a Catalyst for Equity and Innovation

Category	Benefit	Challenge
Economic Resilience	• **Avoids** over **DKK 16 billion in potential flood damages** through proactive adaptation • More cost-effective than traditional sewer systems	• Requires around DKK 11-12 billion in upfront investment and has a **long payback horizon**
Jobs and Innovation	• **Creates 13,000–15,000+ jobs** in construction, design & maintenance • **Builds local expertise** in blue-green infrastructure	• **Risk that benefits concentrate** in already **skilled sectors**, so an inclusive access to training is needed
Housing and Real Estate	• Property values increasing near upgraded areas leads to **more tax revenue for Copenhagen**	• **Green gentrification risk**: low-income households could be displaced if rents rise • Requires **affordable housing policies** to ensure inclusive outcomes
Public Space and Urban Quality	• **Converts grey spaces into parks**, plazas & green boulevards • **Improves mental health**, recreation and social cohesion	• **Construction causes short-term disruption**: noise, dust, traffic issues, access barriers
Social Accessibility	• Strong emphasis on **co-creation with citizens**; broad public support • Prioritizes **projects by flood risk**, not income → **citywide distribution**	• **Fairness and inclusion** are not as strong as the technical parts, so they **might need more attention**

The Skybrudsplan proves that climate adaptation can deliver economic value, public benefits, and urban transformation — but only if social equity and inclusion are built into every step

TOOLS APPLICATION

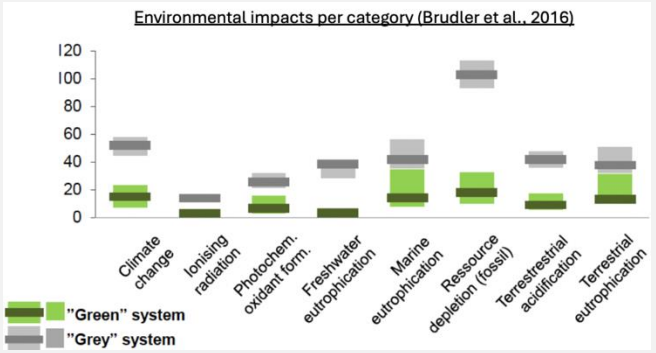
Applying Assessment Tools for Sustainable Urban Planning

Environmental Impact Assessment

- **No formal EIA** conducted under EU Directive 2014/52/EU
- Environmental impacts addressed through integrated planning
- Includes blue-green infrastructure (e.g. rain gardens, retention basins)
- Continuous monitoring enables adaptive management
- **Environmental risks identified and managed** without formal EIA procedure
- A formal EIA might be recommended to enhance environmental accountability

Life Cycle Assessment

- Assesses environmental impacts of **green vs. grey infrastructure**
- Shows **lower impacts for green solutions** overall
- Material production is key contributor to impacts
- Extreme rain events → higher impacts in green systems



Strategic Sustainability Assessment

- Aligns the project with UN Sustainable Development Goals (SDGs)
- **Key SDGs:**

- Assesses broader sustainability contributions beyond the environment
- Supports long-term, integrated urban planning and decision-making

The Cloudburst Plan integrates principles from EIA, LCA, and SSA to assess environmental and sustainability impacts: While no formal EIA or SSA was conducted, key environmental risks, lifecycle effects, and contributions to UN SDGs were addressed through integrated planning, monitoring, and sustainable design choices.

RECOMMENDATIONS

Recommendations for a resilient, green, and inclusive Cloudburst Plan

Water

Enhancing Water Management through Distributed Blue-Green Infrastructure

- Promote **rain gardens, bioswales, permeable pavements** to manage stormwater locally and reduce sewer overload.
- Establish a **maintenance and monitoring plan** to ensure long-term function and accountability.
- Provide financial incentives (e.g. subsidies, tax breaks) to encourage **private green infrastructure.**

Earth

Securing Soil Health and Biodiversity through Ecological Corridors

- Create **ecological corridors** to connect green spaces and support biodiversity along cloudburst routes.
- Use native, drought-tolerant plants to enhance resilience and reduce maintenance.
- Apply **soil restoration measur**es to improve infiltration and prevent compaction.

Air

Integrating Urban Vegetation for Air Quality and Heat Mitigation

- Plant **more trees** along cloudburst boulevards to filter air pollutants (PM2.5, NOx, CO_2).
- Install **green roofs and walls** to improve air quality and provide insulation.
- Focus greening efforts on **polluted, flood-prone areas** for maximum impact.

Socio-Economic

Strengthening Socio-Economic Equity through Inclusive Implementation

- **Prioritize vulnerable communities** to avoid green gentrification and ensure equitable benefits.
- Support **affordable housing** policies to prevent displacement near upgraded areas.
- **Expand training and green job opportunities** to build local skills and distribute economic gains.

These recommendations propose decentralized blue-green infrastructure, ecological corridors, urban vegetation, and inclusive implementation to enhance flood resilience, biodiversity, air quality, and social equity.


THANK YOU!

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