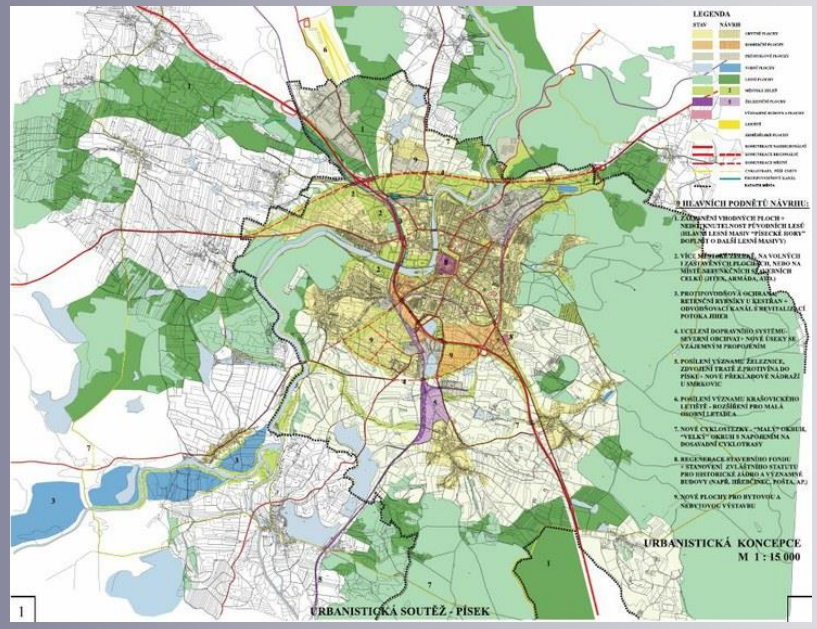
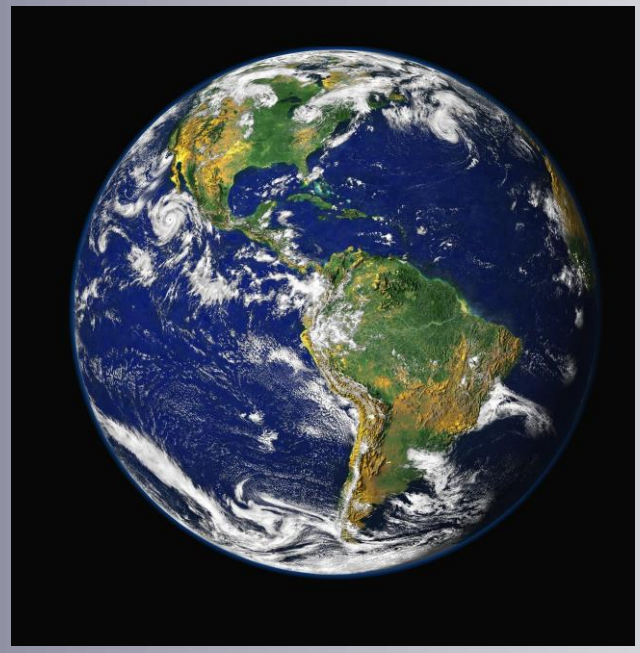
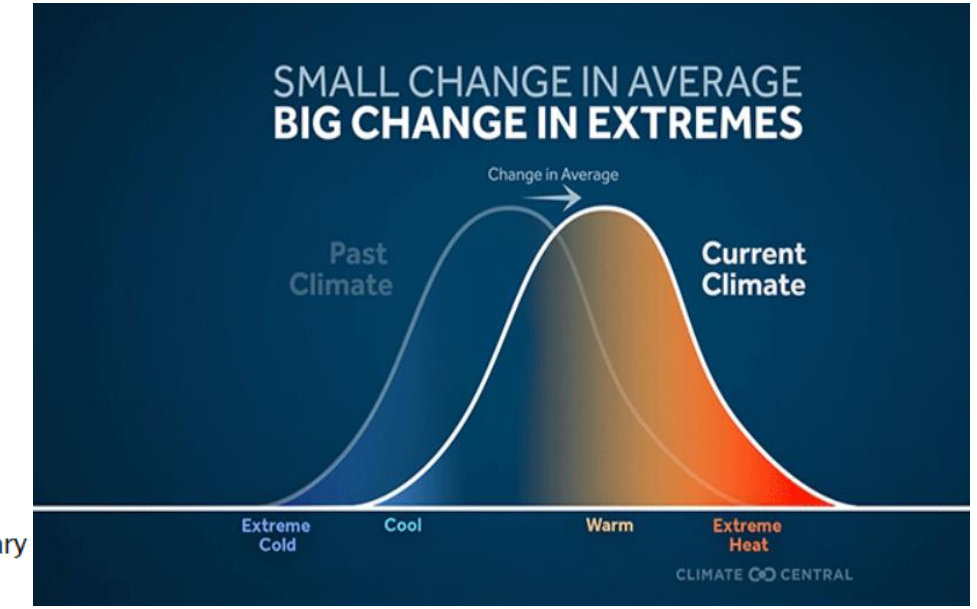
Applied Hydroinformatics II.



Climate Change



Global warming data 11.2023



Earth passed a feared global warming milestone Friday, at least briefly

Average global temperatures were more than 2 degrees Celsius above a pre-industrial benchmark on Friday, preliminary data show

By Scott Dance

November 19, 2023 at 8:01 p.m. EST

+ 2,06 celsius

Současná opatření povedou k oteplení Země o 2,9 stupně, uvádí zpráva OSN

20. listopadu 2023 16:05, aktualizováno 16:37

Nynější podoba klimatických opatření přijatých zeměmi světa by udržela oteplení Země pod hranicí tří stupňů Celsia, nejpravděpodobněji 2,9 stupně, oproti době před průmyslovou revolucí, uvádí zpráva OSN. Bezmála 200 zemí se přitom v roce 2015 v Pařížské klimatické dohodě shodlo, že globální oteplení omezí na 1,5 stupně a udrží jej výrazně pod dvěma stupni Celsia.

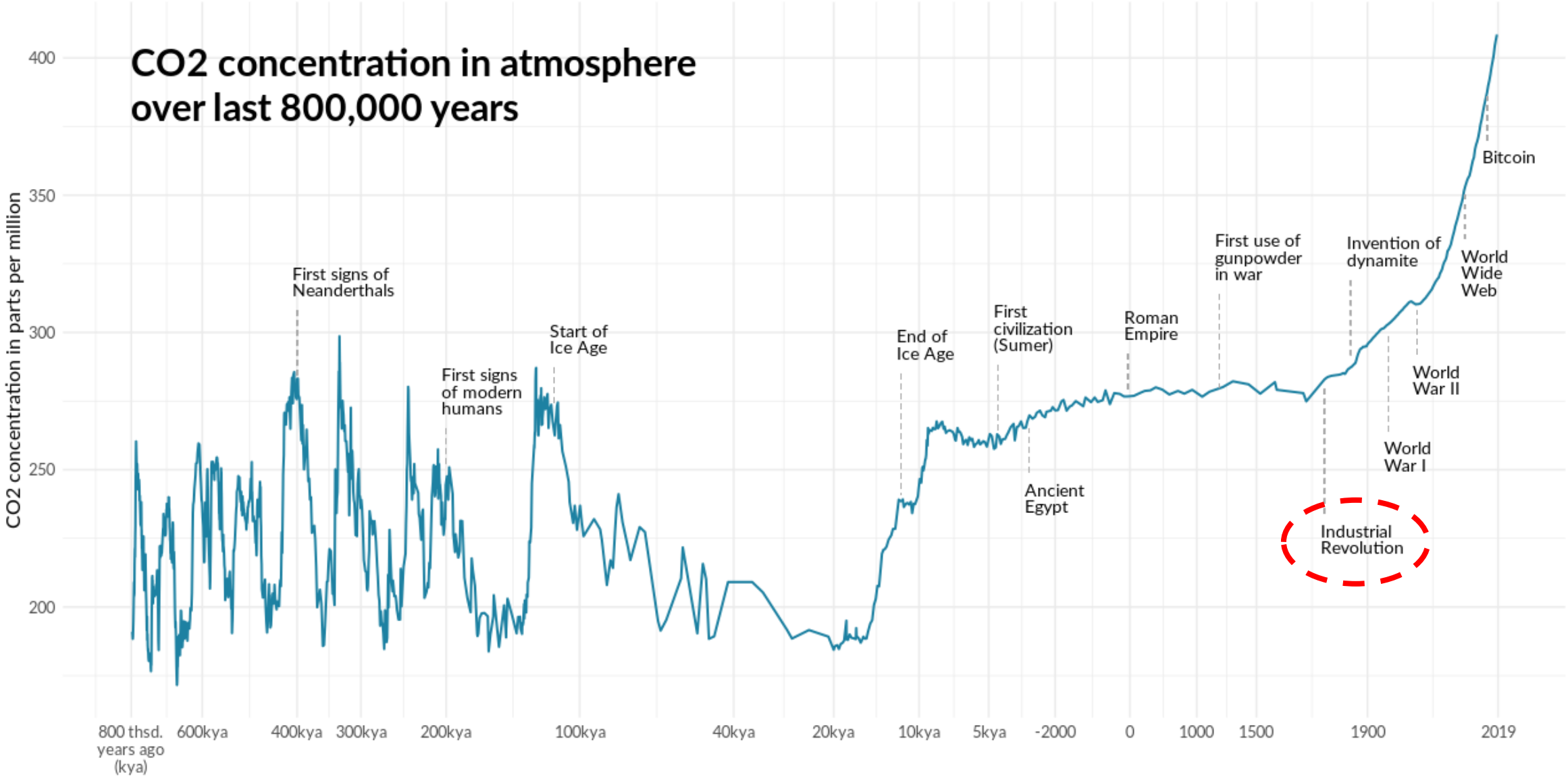
Průměrná světová teplota poprvé překonala kritickou hranici

SEZNAM ZPRÁVY

World Meteorological Organization
Environmental Services · Geneva

Year 2022 (74) World Meteorological Organization: Overview | LinkedIn

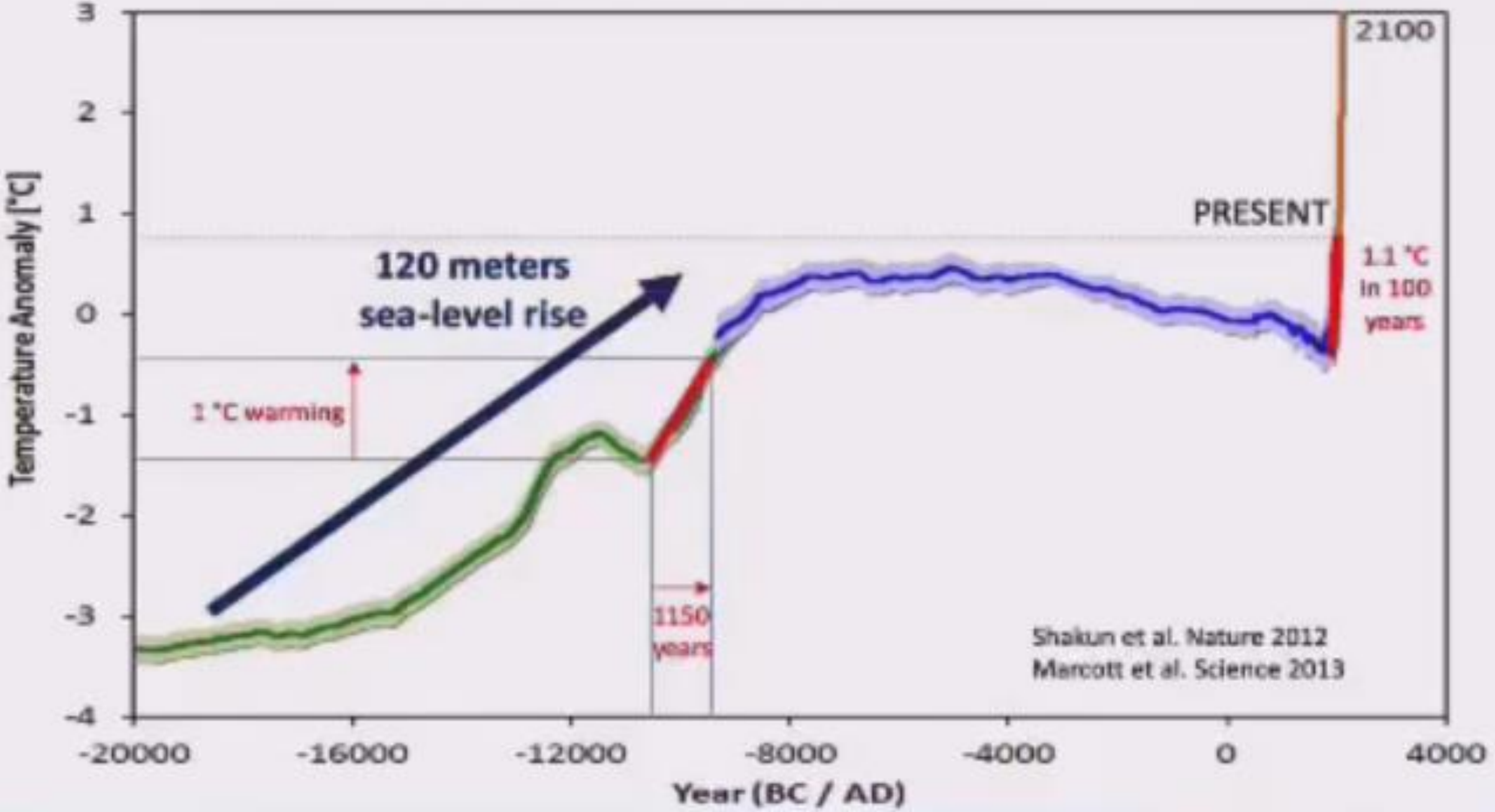
Climate change – what do we know ?



Time is warped using sqrt scale before 1900 for readability. Graphic: Gregor Aisch, vis4.net

Source: NOAA (1959-today), NASA (1850-1958), Monnin et al., Petit et al., Siegenthaler et al., Luethi et al. (800kya-1850)

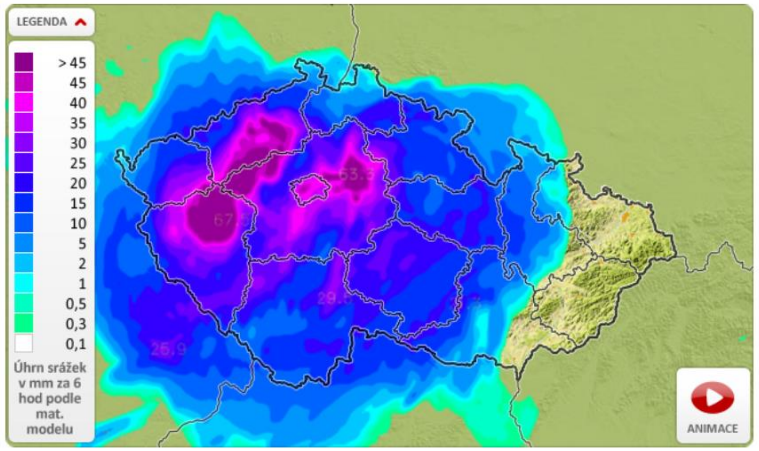
GLOBAL TEMPERATURE SINCE THE LAST ICE AGE

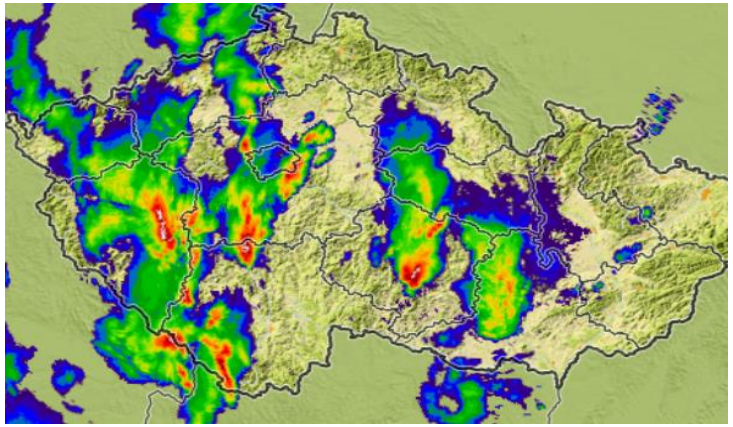


Extreme cloudbursts

A picture is worth a thousand words. This is why #weather monitoring must be smart, granular and in real time: 100mm of rain in 1,5 hours on Torino city center, not a single drop few streets away. #weatherCAM #monitor ...see more

Předpověď počasí - srážky, zítra v noci





Cludburst intensity increase

Hongkong 8.9.2023

VIDEO: Voda se prohnala ulicemi. Na Hongkong dopadl nejsilnější déšť za 140 let

Hongkongská observatoř zaznamenala za hodinu do půlnoci na pátek místního času (18.00 SELČ ve čtvrtek) 158 milimetrů srážek.

Španělsko 4.9.2023

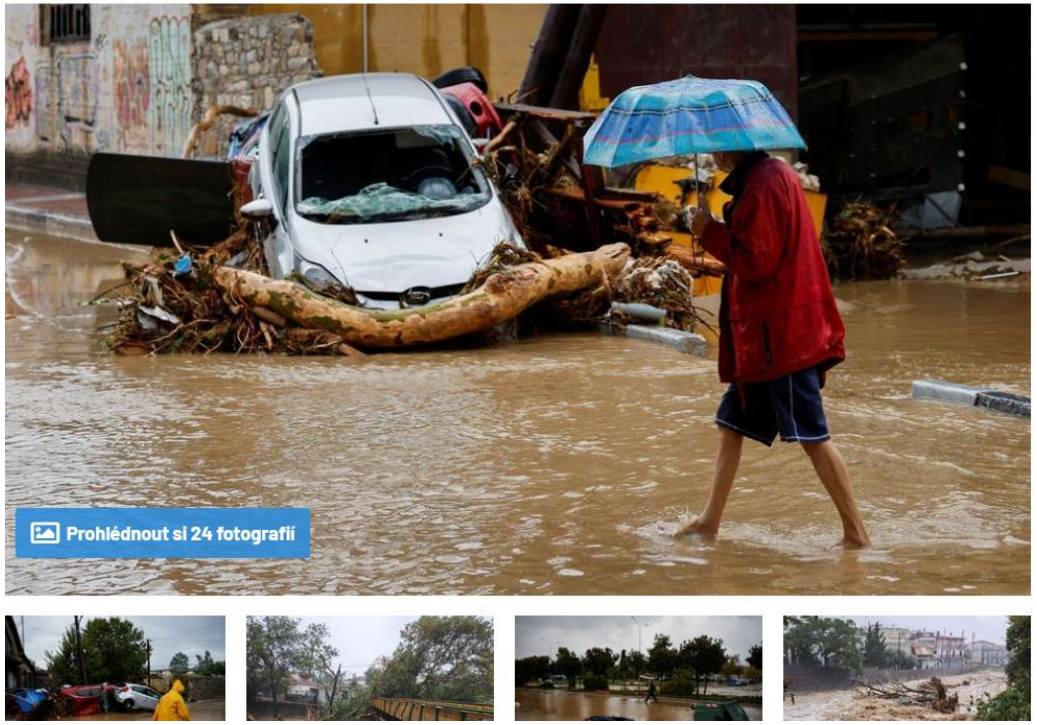
Z ulic se staly ničivé potoky. Přívalové deště ve Španělsku za sebou zanechaly tři mrtvé

4. září 2023 22:01

V souvislosti s bouřemi a přívalovými dešti zemřeli ve Španělsku tři lidé, další tři se pohřešují. V pondělí o tom informoval server veřejnoprávní stanice RTVE. Silné srážky také způsobily rozsáhlé výpadky v železniční dopravě a významné škody na majetku.

Řecko 6.9.2023

Po požárech přišly deště. V Řecku zabíjely povodně, za den napršelo až půl metru vody



Rekordní deště zaplavily během úterý Řecko. V zemi, která v létě čelila sérii silných požárů, spadlo nejvíce srážek minimálně od roku 2006. V obci Zagora na východě země napršelo podle deníku Kathimerini za jediný den přes půl metru vody. V Athénách to obvykle bývá jen 40 centimetrů za rok. Lijáky zasáhly i část sousedního Bulharska a Turecka, vyžádaly si nejméně devět obětí.

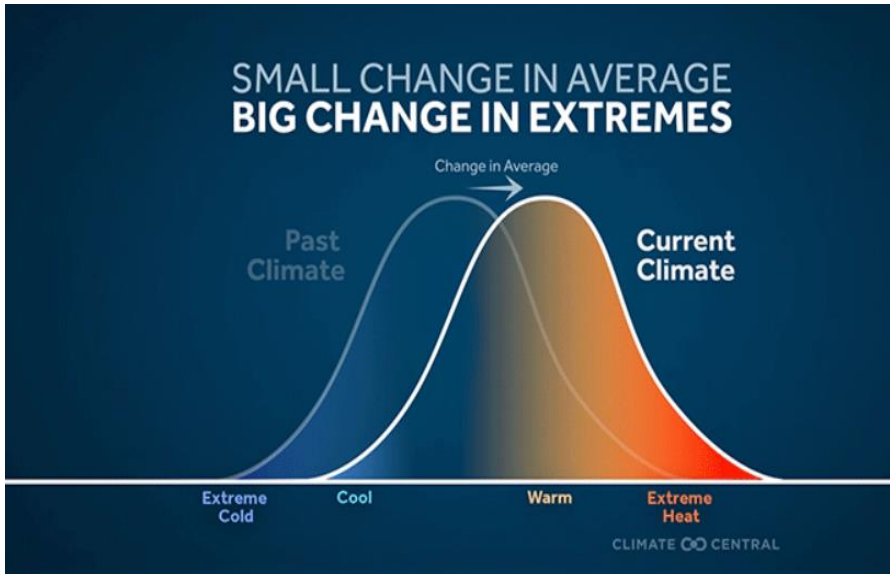
Introduction – Climate Change

Climate change impacts (Europe)

- Warming for 2 (4 degrees) since preindustrial time
- Evaporation increase (7% for 1 degree)
- Exhaustion of ground water resources
- Shortages of water supply and irrigation services
- Forest fires
- Hurricanes / tornados
- **Heavy storm and cloudbursts (resulting in flash floods)**

Pressure on society

- Heat mortality
- Agricultural production losses
- Drinking water stress
- Economical losses
- Lost of lifes

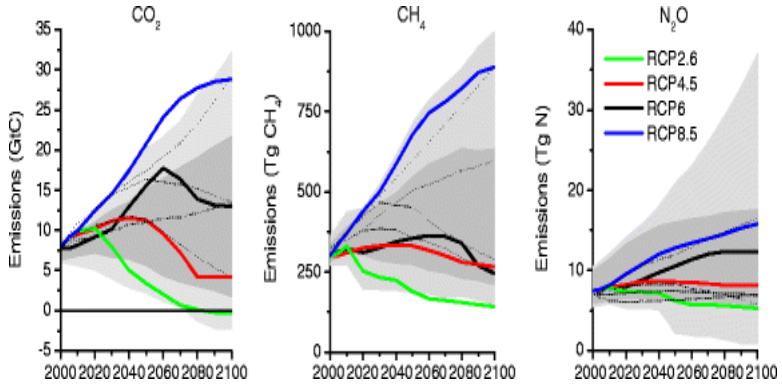


The situation will worsen in future according to Climate models

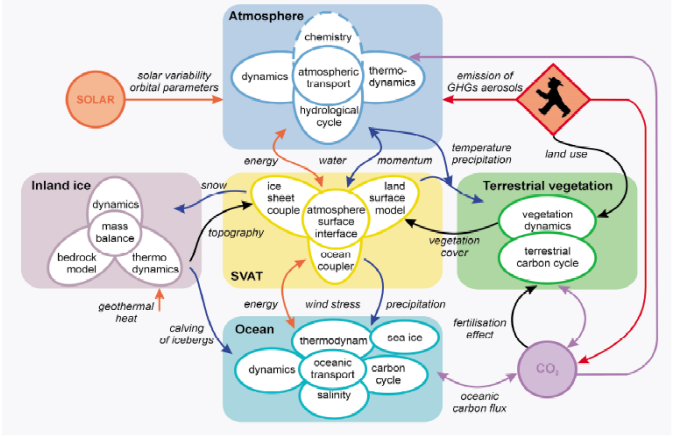
Climate Change Impact on Precipitation Extremes

Climate Factor

Climate scenarios (RCP)



Climate models (RCM, GCM)



Climate Factor (dimensionless coefficient of the intensity increase)

CF 2050						
N	2	5	10	20	50	100
T						
10	1.13	1.16	1.17	1.17	1.18	1.18
15	1.11	1.13	1.14	1.15	1.16	1.16
30	1.09	1.11	1.12	1.13	1.14	1.14
60	1.08	1.1	1.11	1.11	1.12	1.12
90	1.07	1.09	1.1	1.11	1.11	1.11
CF 2080						
N	2	5	10	20	50	100
T						
10	1.24	1.28	1.3	1.31	1.32	1.33
15	1.2	1.24	1.26	1.27	1.29	1.3
30	1.16	1.2	1.22	1.24	1.25	1.26
60	1.13	1.17	1.19	1.2	1.21	1.22
90	1.12	1.16	1.18	1.19	1.2	1.2
CF 2100						
N	2	5	10	20	50	100
T						
10	1.3	1.36	1.38	1.4	1.42	1.43
15	1.25	1.31	1.34	1.35	1.37	1.38
30	1.2	1.26	1.29	1.31	1.32	1.33
60	1.17	1.22	1.24	1.26	1.27	1.28
90	1.16	1.21	1.23	1.24	1.25	1.26

2050 → +15%

2080 → +20%

2100 → +30%

AQUA PROCON

Extreme Rainfalls (clourbursts)

Ordinary
< N05
65-80%

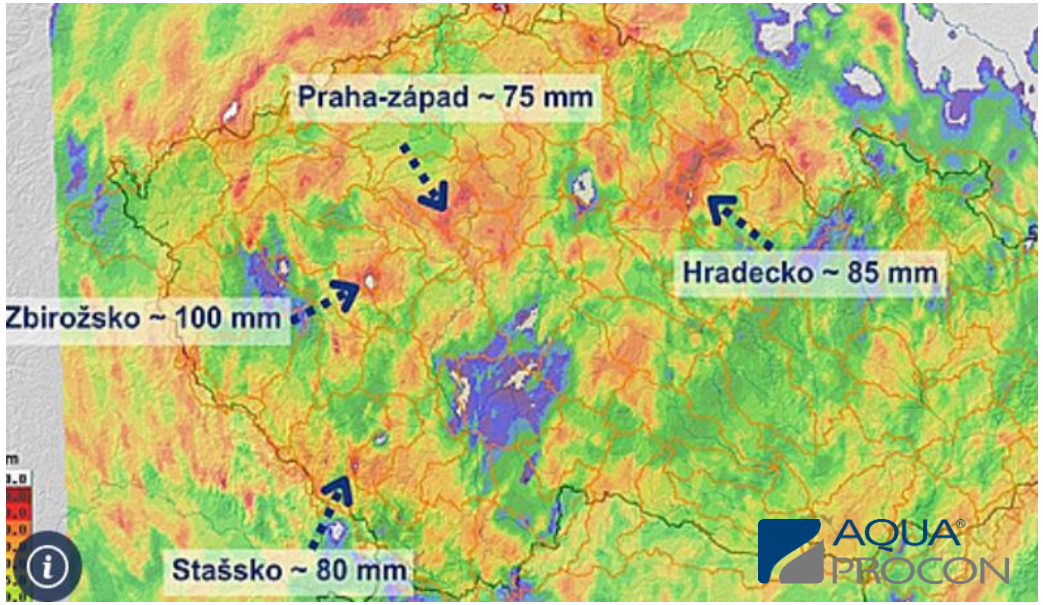
Strong
N05 < N20
20-30%

Extreme
> N20
1-5%

A picture is worth a thousand words. This is why #weather monitoring must be smart, granular and in real time: 100mm of rain in 1,5 hours on Torino city center, not a single drop few streets away. #weatherCAM #monitor ...see more

Extreme rainfall:

- > 60 mm
- 30 to 60 (120) minutes
- intensity more than 250 l/s/ha



Clourburst induced Flash Floods

Valencia: November 30.10-3.11. 2024




Czechia: September 13-16, 2024





City Adaptation to Extreme Rainfalls

Stormwater management (SWM)

approaches and application

DEŠTĚ	běžné	silné	extrémní
ČETNOST VÝSKYTU	1x za 5 a méně let	1x za 5-50 let	1x za 50 a více let
PODÍL NA ÚHRNU	65 – 80 %	19 – 34 %	1 – 5 %
CÍL	napodobit přirozené odtokové podmínky	ochrana před zaplavením snížení vlivu na PV	ochrana obyvatel a kritické infrastruktury
PROSTŘEDKY	výpar, vsak, zálivka, MZI	stoková síť, dočasné retenční prostory	nouzové cesty odtoku (např. ulice)

konjklec

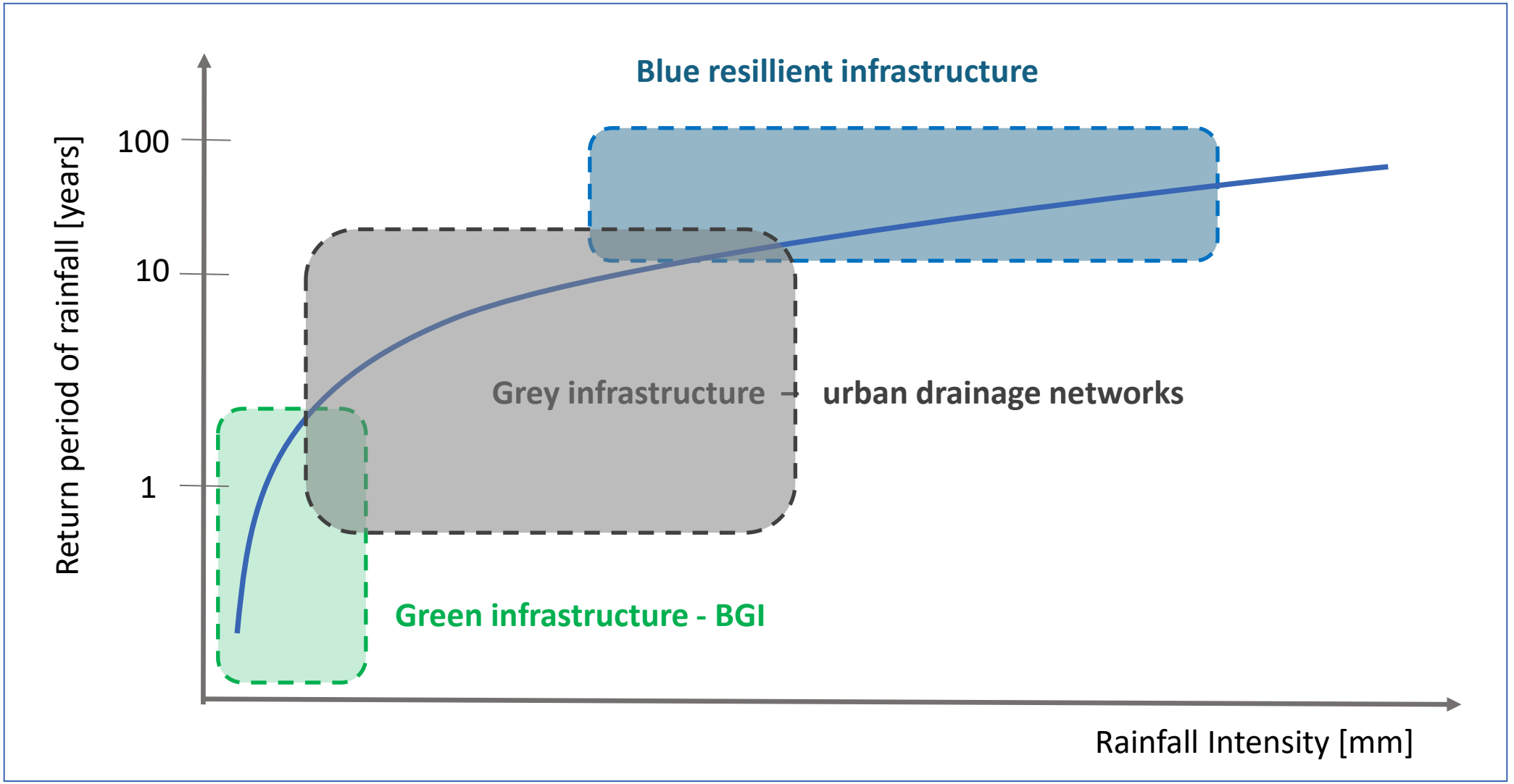
- **Standard SWM**
  - City outskirts
  - Primarily used for new developments
  - Handling the precipitation up to N=5-10 years

- **Non-standard SWM**
  - Management of runoff waters from extreme rainfalls N=50-100 years
  - Climate Change impact
  - Used for the city centres
  - Integrated with the urbanistic, landscape, transportation activities (multifunctional use)

Rainfalls x Extreme cloudbursts

- **2 years rain** – design rain (design capacity for drainage networks)
- **10-15 years rain** – assessment rainfall (operational capacity of drainage systems)
- **50-100 years rain** – extreme rain (drainage cannot cope with such rain)

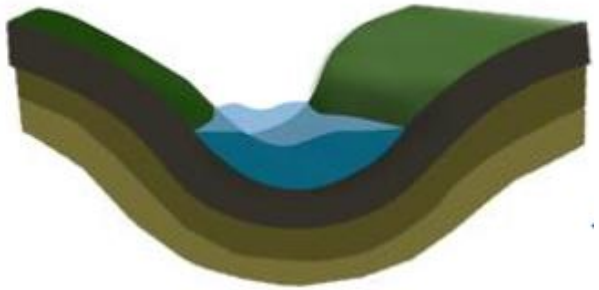
Handling the runoff Water



Urban Drainage Services Under Climate Change

City Adaptation Principles

+



Optimisation of drainage network performance

&

new drainage infrastructure on surface

Multifunctional usage

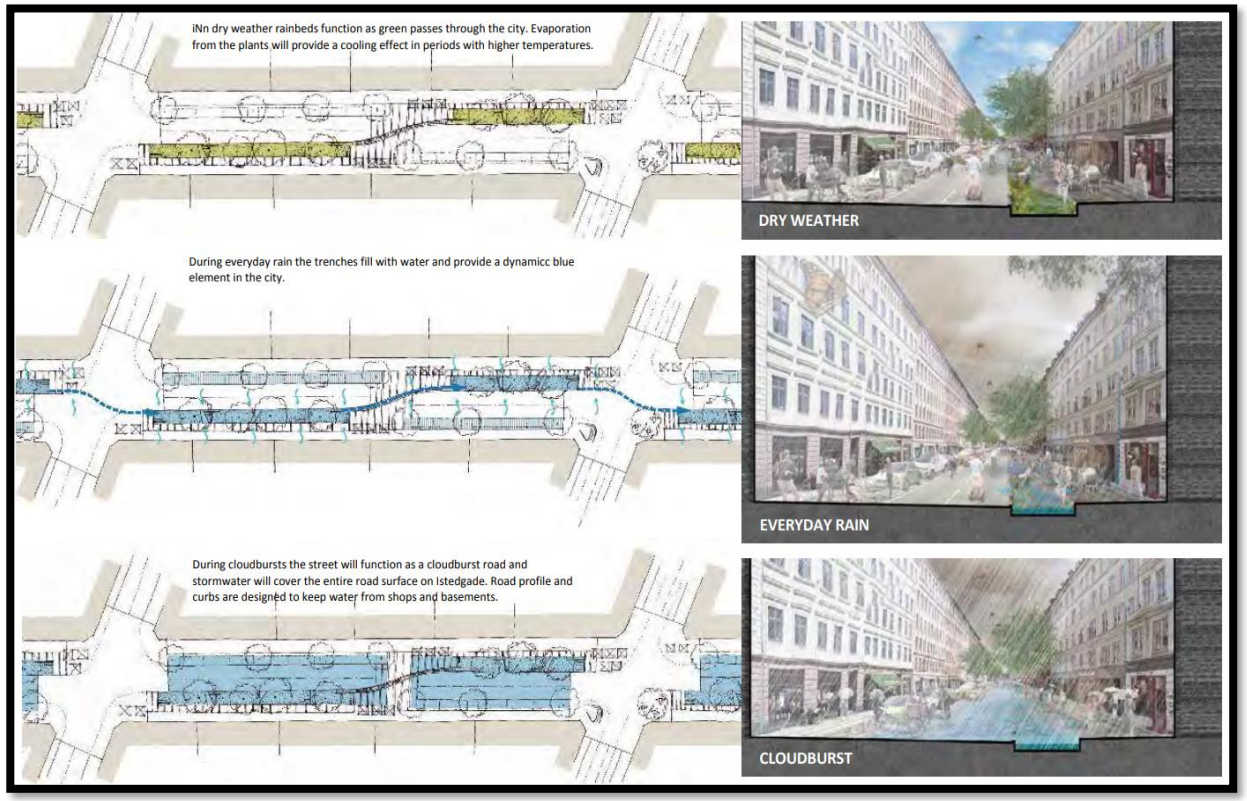
- New places for free time activitites
- Multifunctional blue-grey infrastructure
- Increas of recreational value, biodiversity and local mikro-climate

AQUA PROCON

Urban Drainage Services Under Climate Change

City Adaptation Measures

- **Cloudburst road** represents the option for drainage of runoff waters on the surface in case of extreme heavy rainfalls.
- Drainage is redirected to streets designed to cary water runoff while protecting local infrastructure and property.



Selected Interantional Projects

Typical cloudburst solutions

Copenhagen: cloudburst adaptation plan

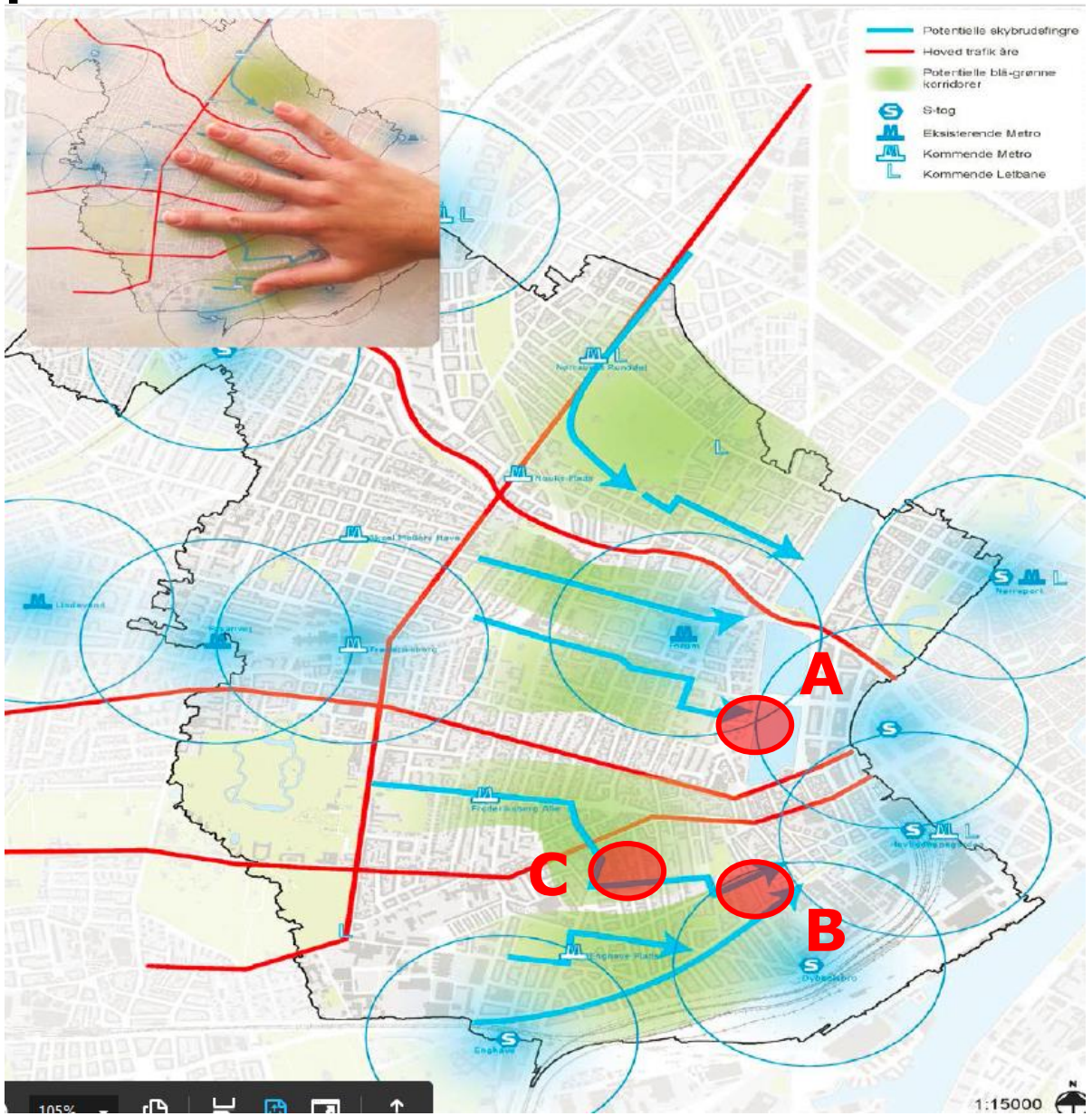
02 July 2011: > 150mm
RAIN fell in 2 HOURS.

<u>3 extreme rainfalls during 2010-2011</u> (15.8.2010, 2.7.2011, 15.8.2011)

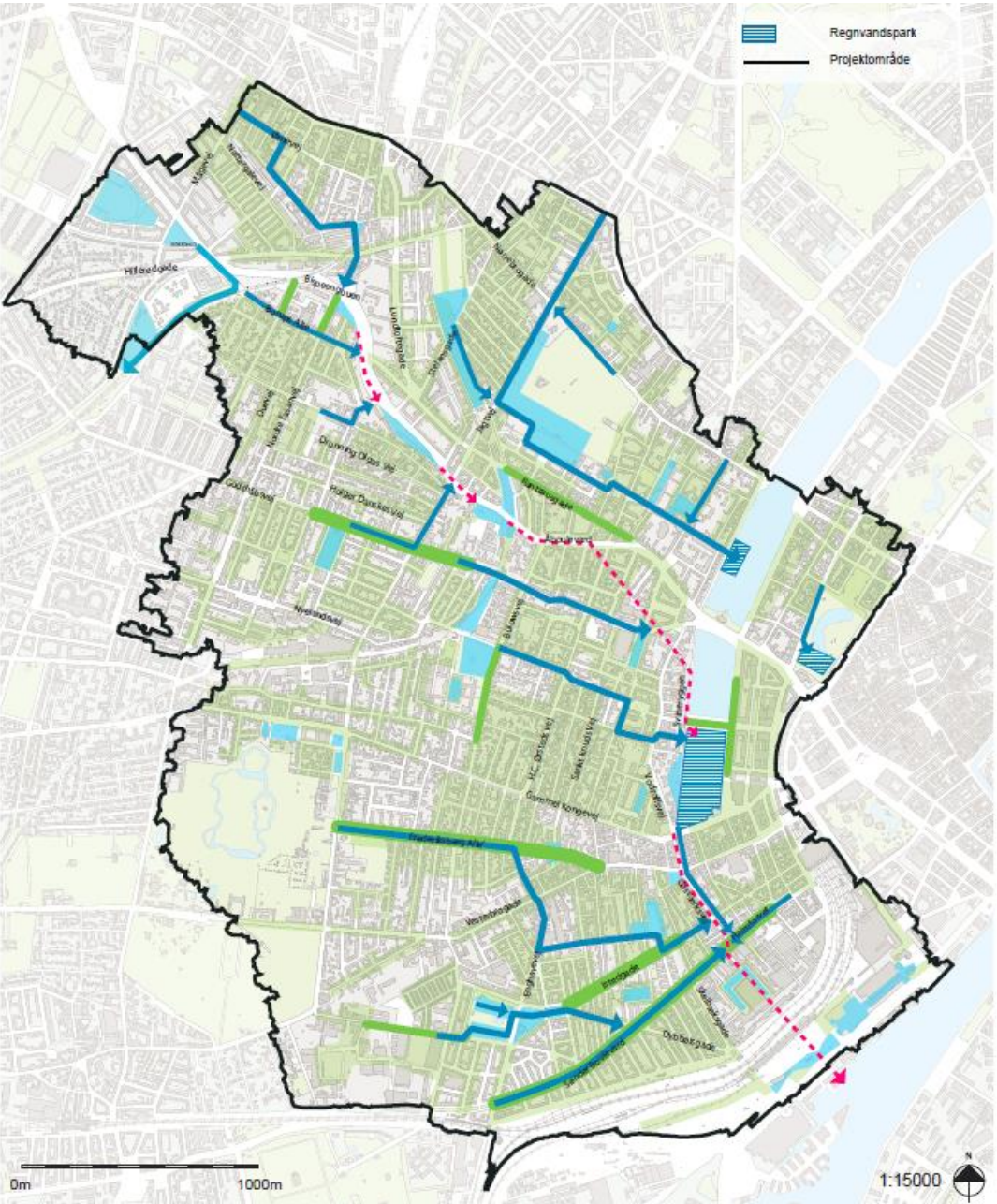
- 30-90 mm in 24 hours
- Direct loss **800 mio.EUR (22 mld. Kc)**
- Indirect and social loss **600 mio.EUR (16 mld.Kc)**
- Total loss - **1,4 mld. EUR (38 mld Kč)**

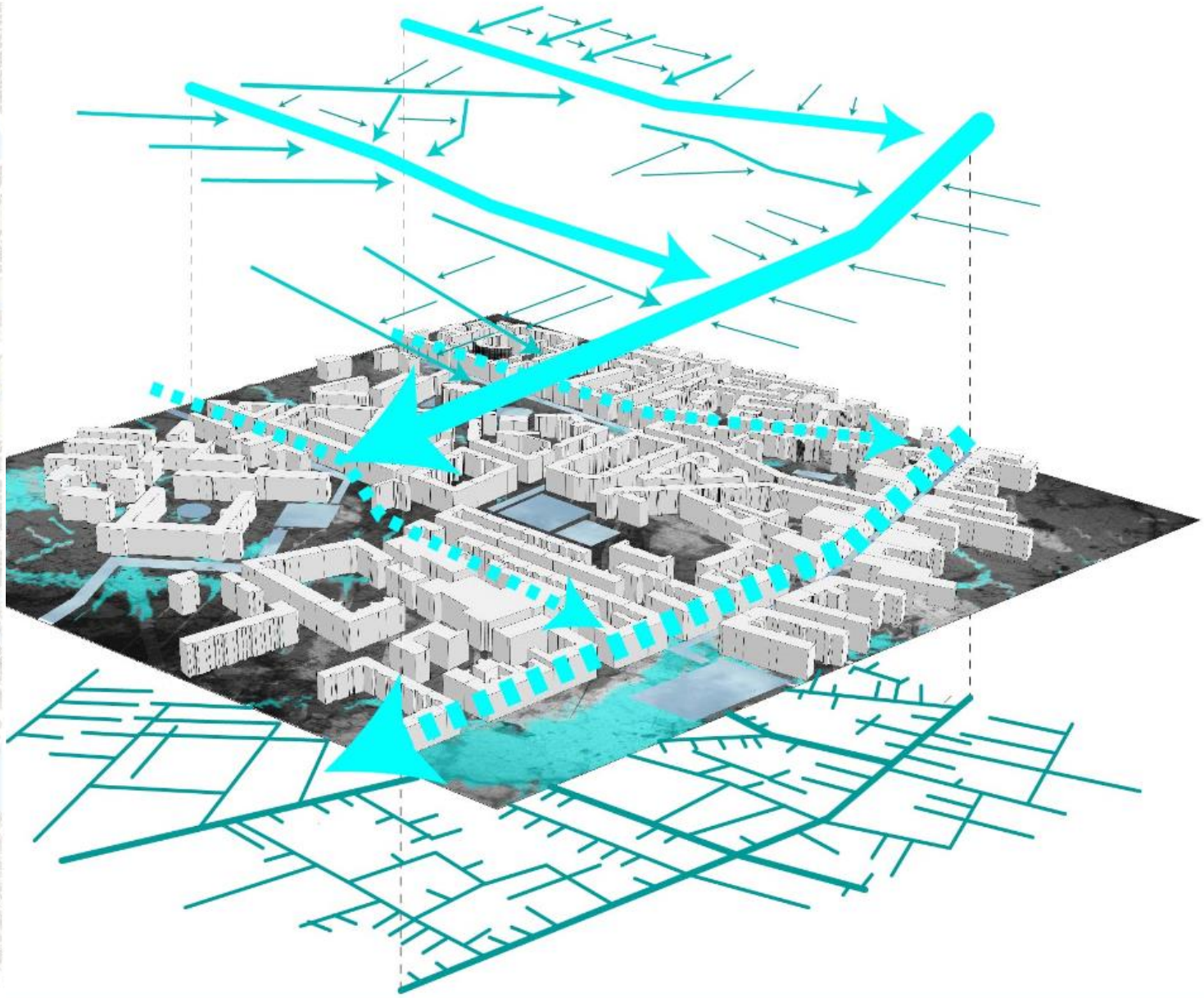
Climate change adaptation

- **Extreme cloudburst rainfall** analysis
- Combined with **sea level rise**
- Effect on **microclimate (hot islands)**
- Effect on **comfort of life** (*biodiversity, synergy with urban transport, safety, accessibility, free time activities, etc.*)
- Solution primarily for **city (intravilan) center**
- Use of **green and blue infrastructure**
- **Disconnection of storm water**



Cloudburst city adaptation plan

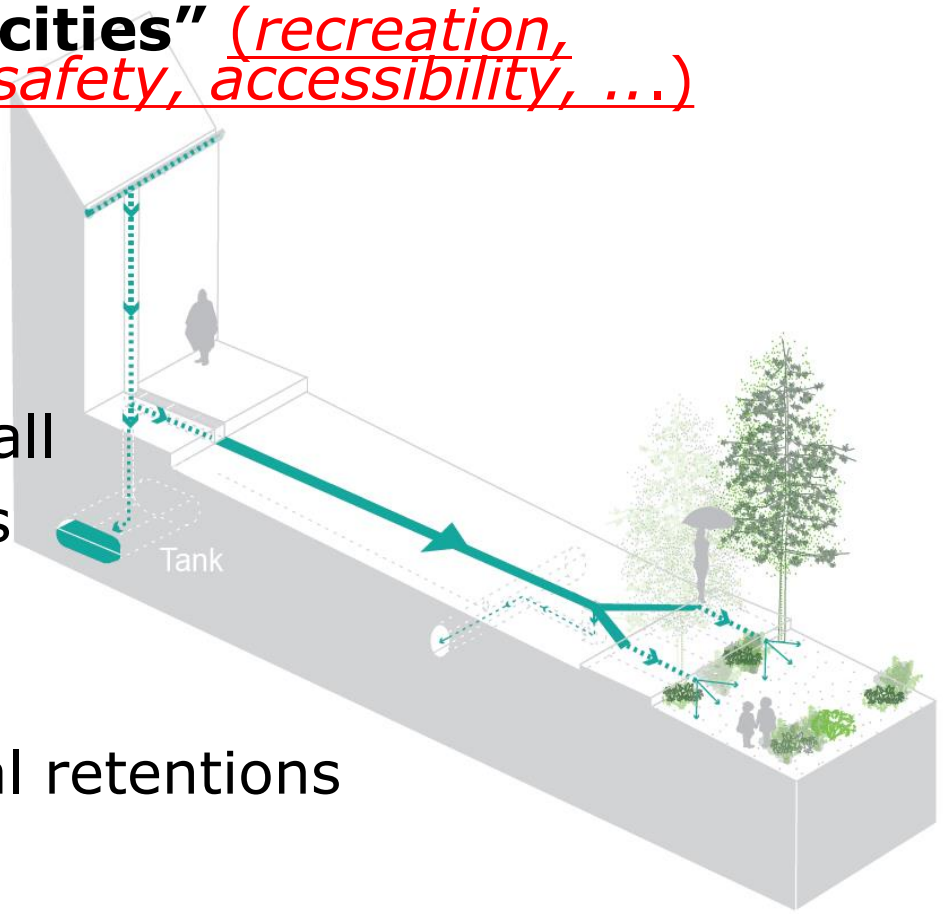




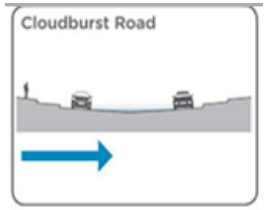
Technical approach

- **Copenhagen Climate Change and Adaption Plan (2012-2013)**
  - **extreme cloudburst** analysis
  - Combination with **sea level rise**
  - Impact of change of **mikroclimate (hot islands)**
  - Řešení citizens needs for good life **”livable cities”** *(recreation, biodiversity, synergy urban transportation, safety, accessibility, ...)*
  - Use of **green and blue infrastructure**

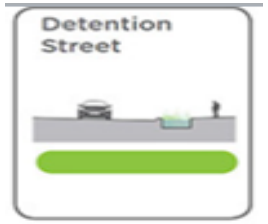
- **Technical KPIs**
  - Drainage network will handle 10 years rainfall
  - Extreme cloudbursts: 1 in 20, 50, 100 years
  - Water level in streets - 10cm
  - Climate change factor =1,4
  - Cut off 20-30% runoff + new multifunctional retentions



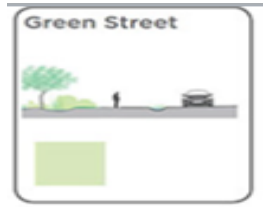
Options for City Cloudburst Adaptation



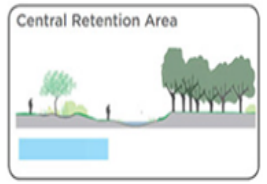
Cloudburst road – The cloudburst road is recognised by „V“ cross section shape with elevated curbs. This road is primarily designed for surface runoff drainage from cloudburst events. The water is directed to the middle of the road to protect the surrounding buildings.



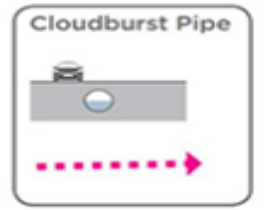
Detention street – detention streets are designed usually in the middle catchment locations



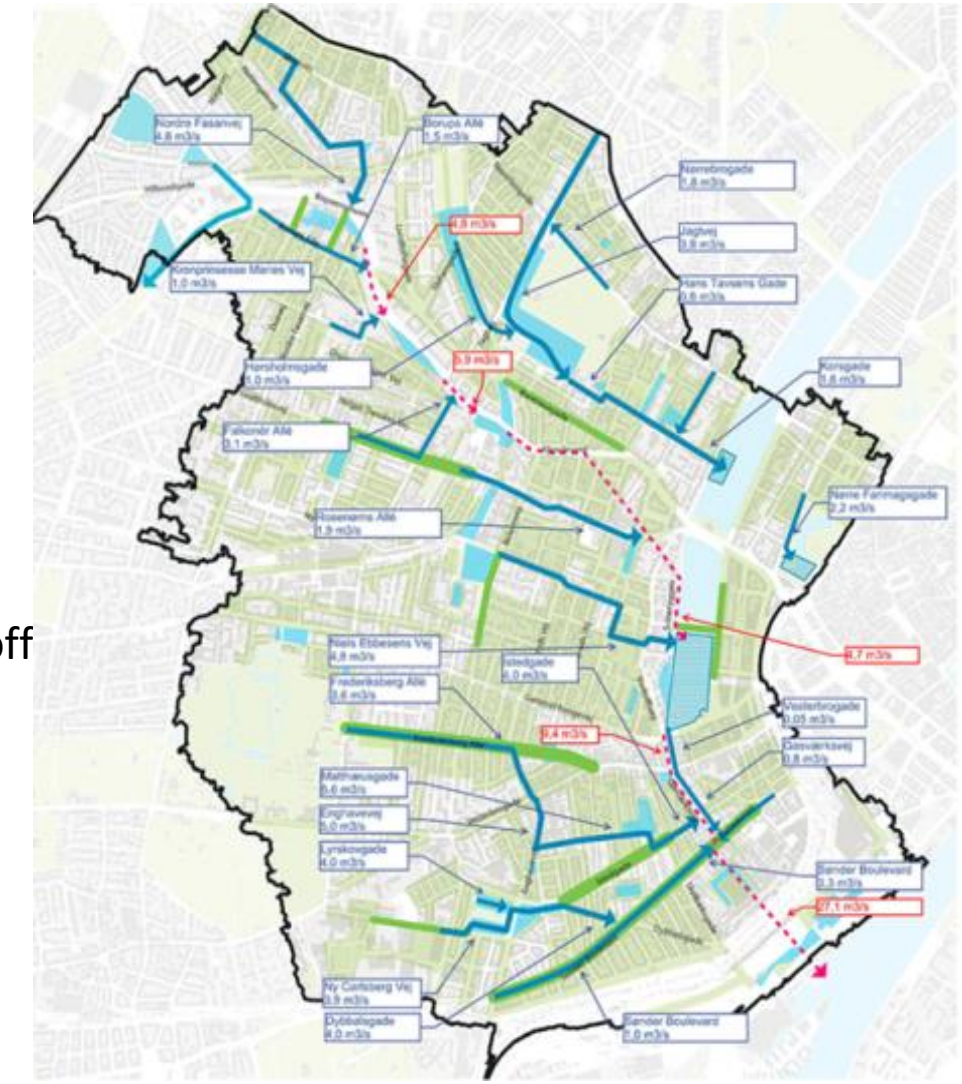
Green street – Green streets are designed usually in the upstream catchment locations to mitigate amount of runoff



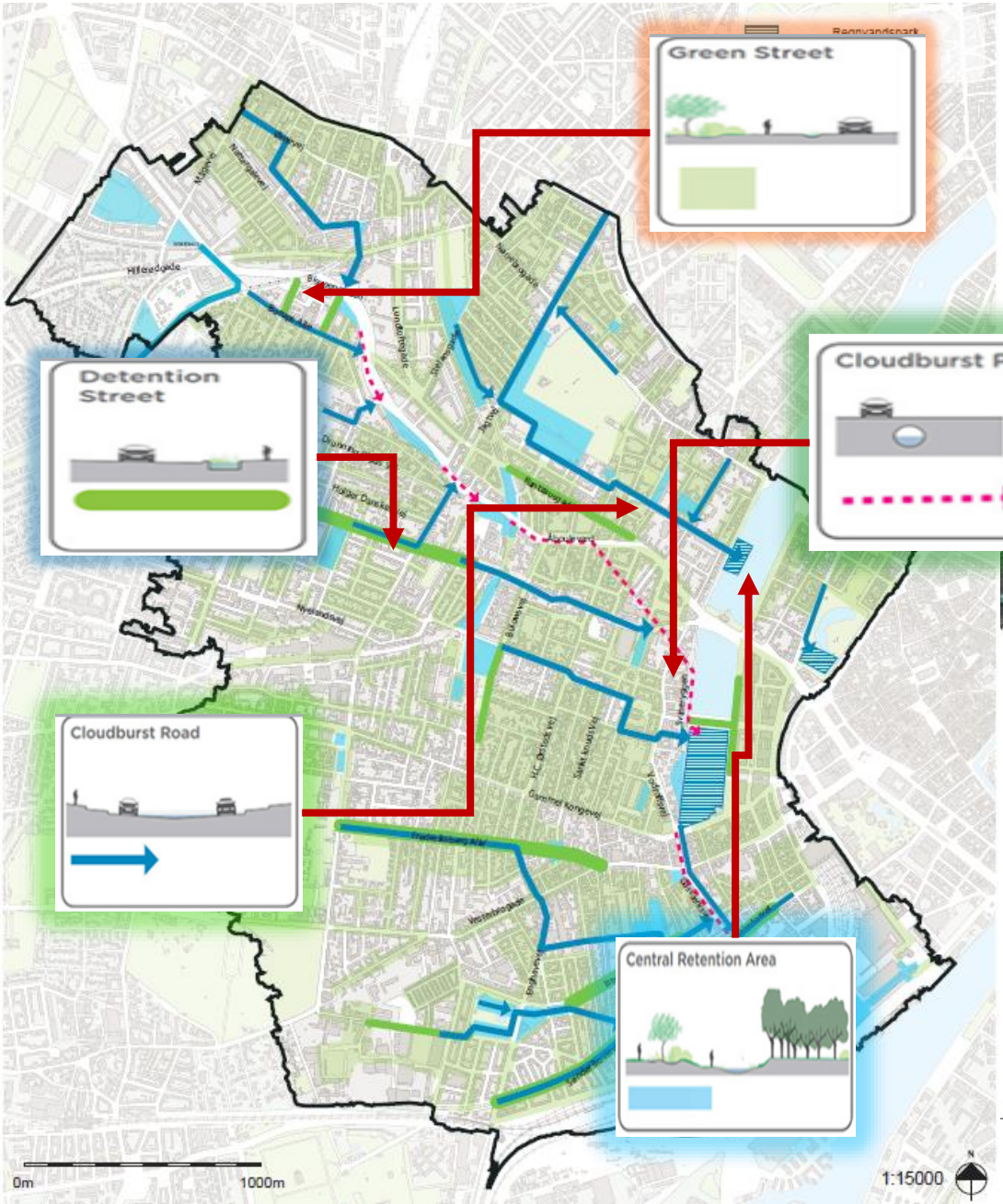
Central retention area – The central retention areas (parking depressions, parks, etc.) are designed if appropriate along the cloudburst roads to reduce the dimensions of the cloudburst road.

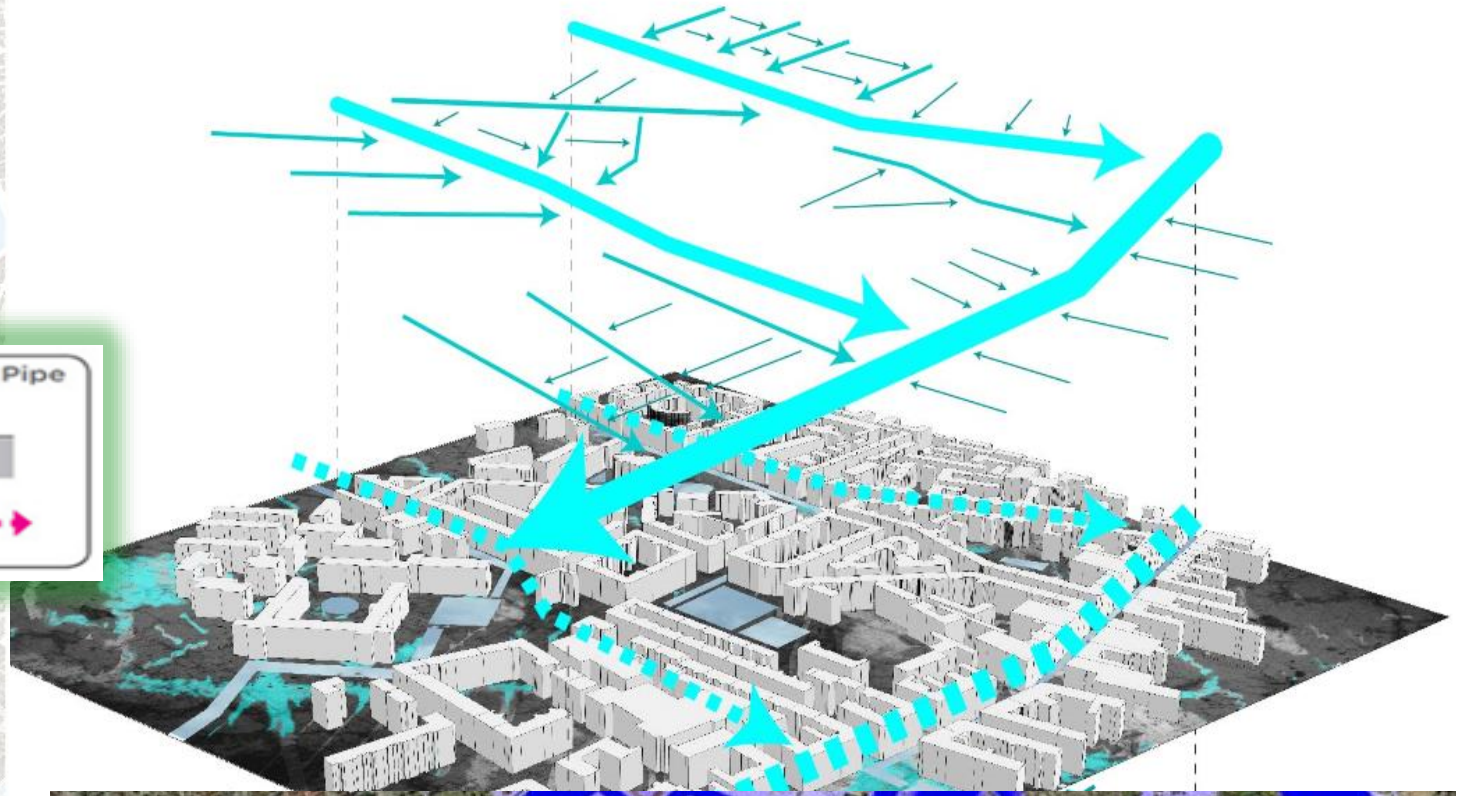


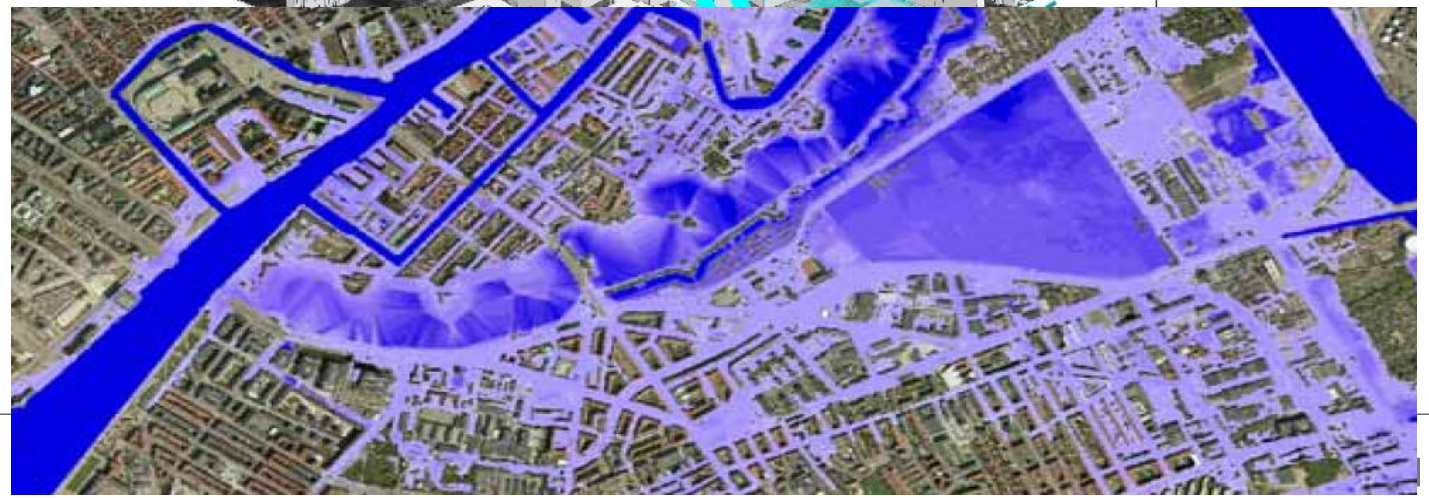
Cloudburst pipe – Classical urban drainage option



Copenhagen – City Cloudburst Adaptation Plan

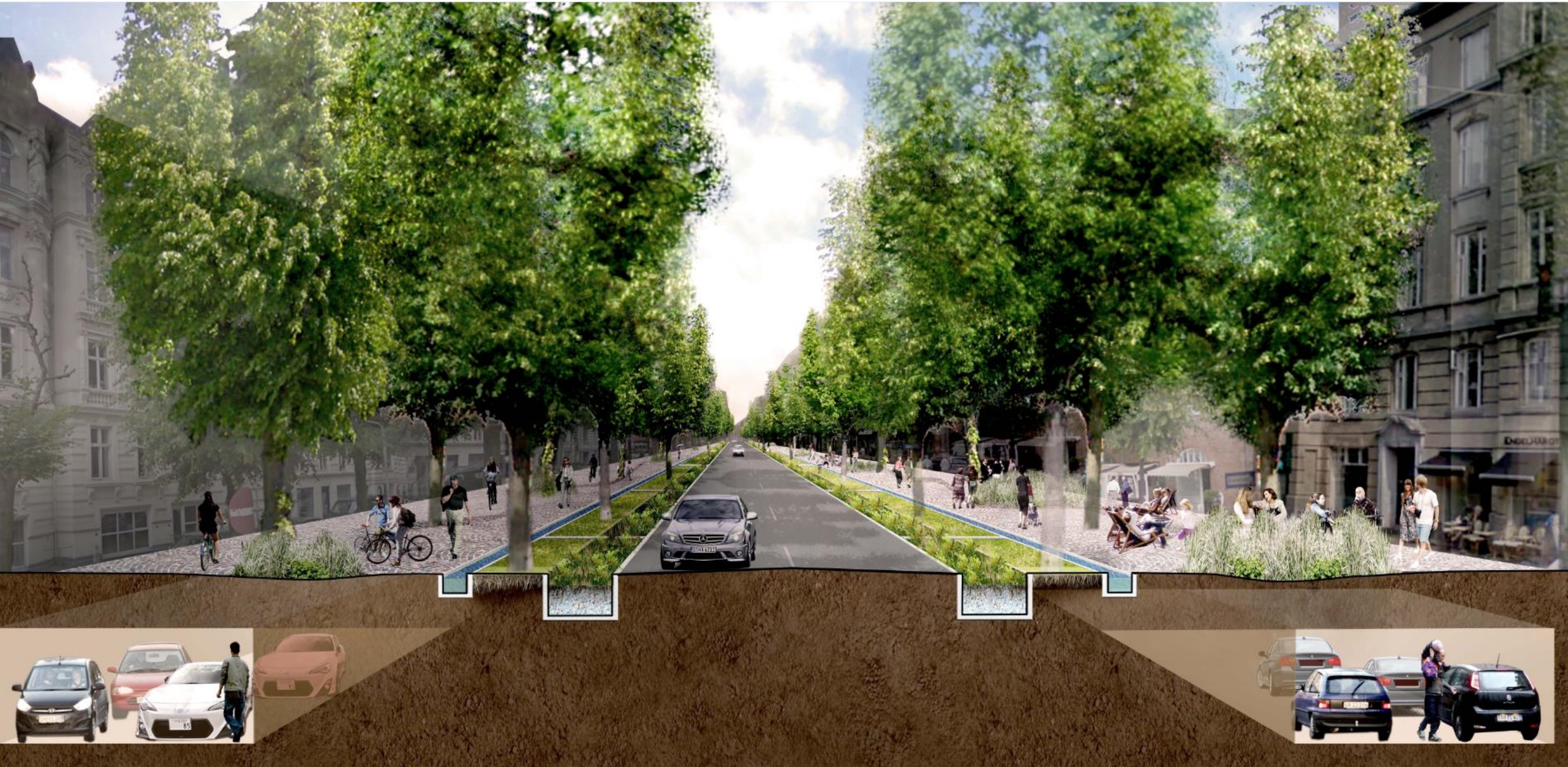




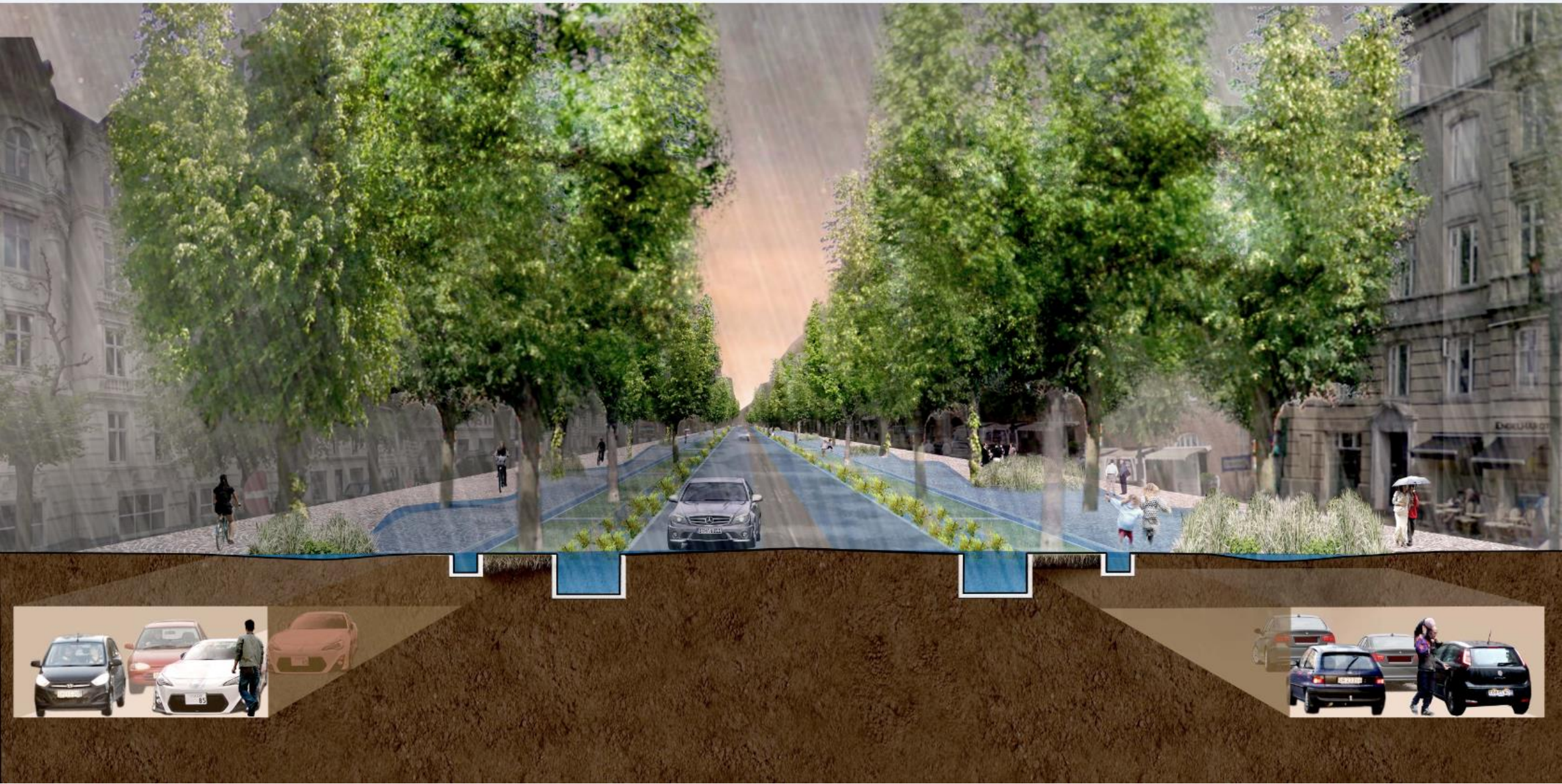


HEAVY RAINFALL SIMULATION RESULTS

Urbanistic and landscape design



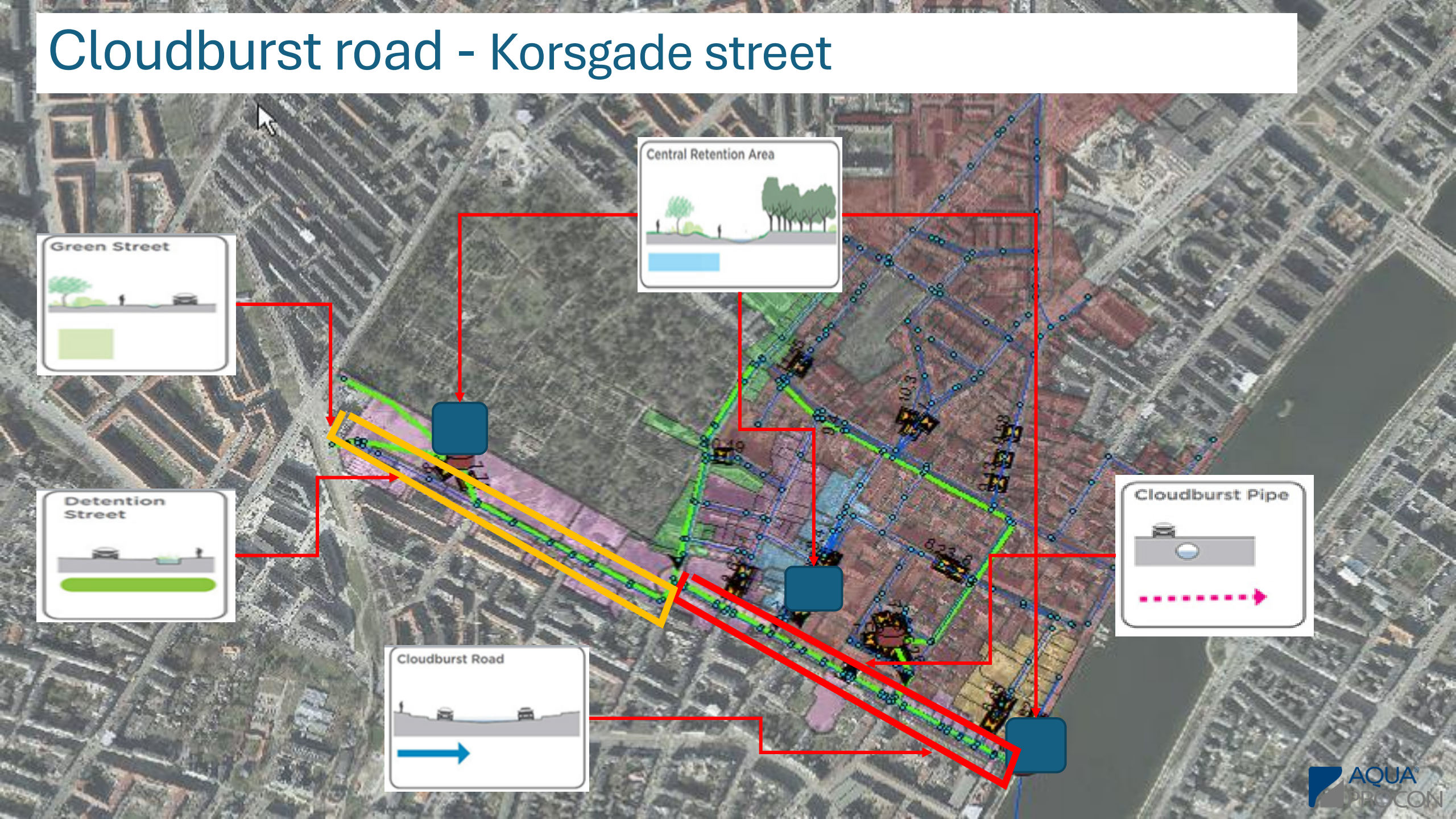
Urbanistic and landscape design



SØNDER BOULEVARD – cloudburst road

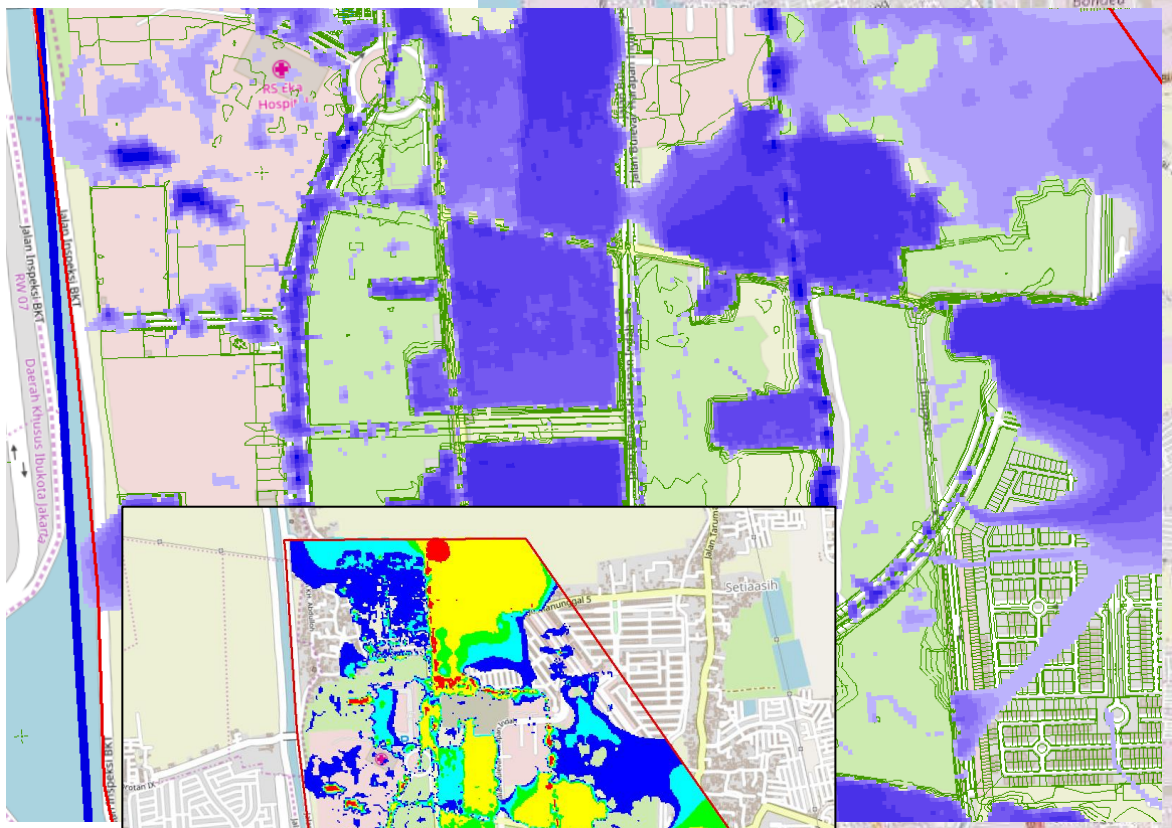
SØNDER BOULEVARD – cloudburst road

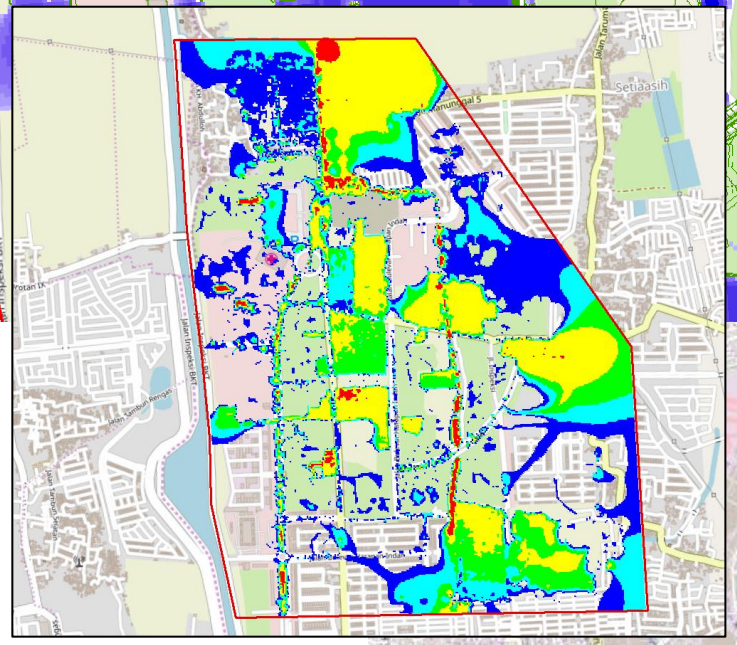
Cloudburst road - Korsgade street



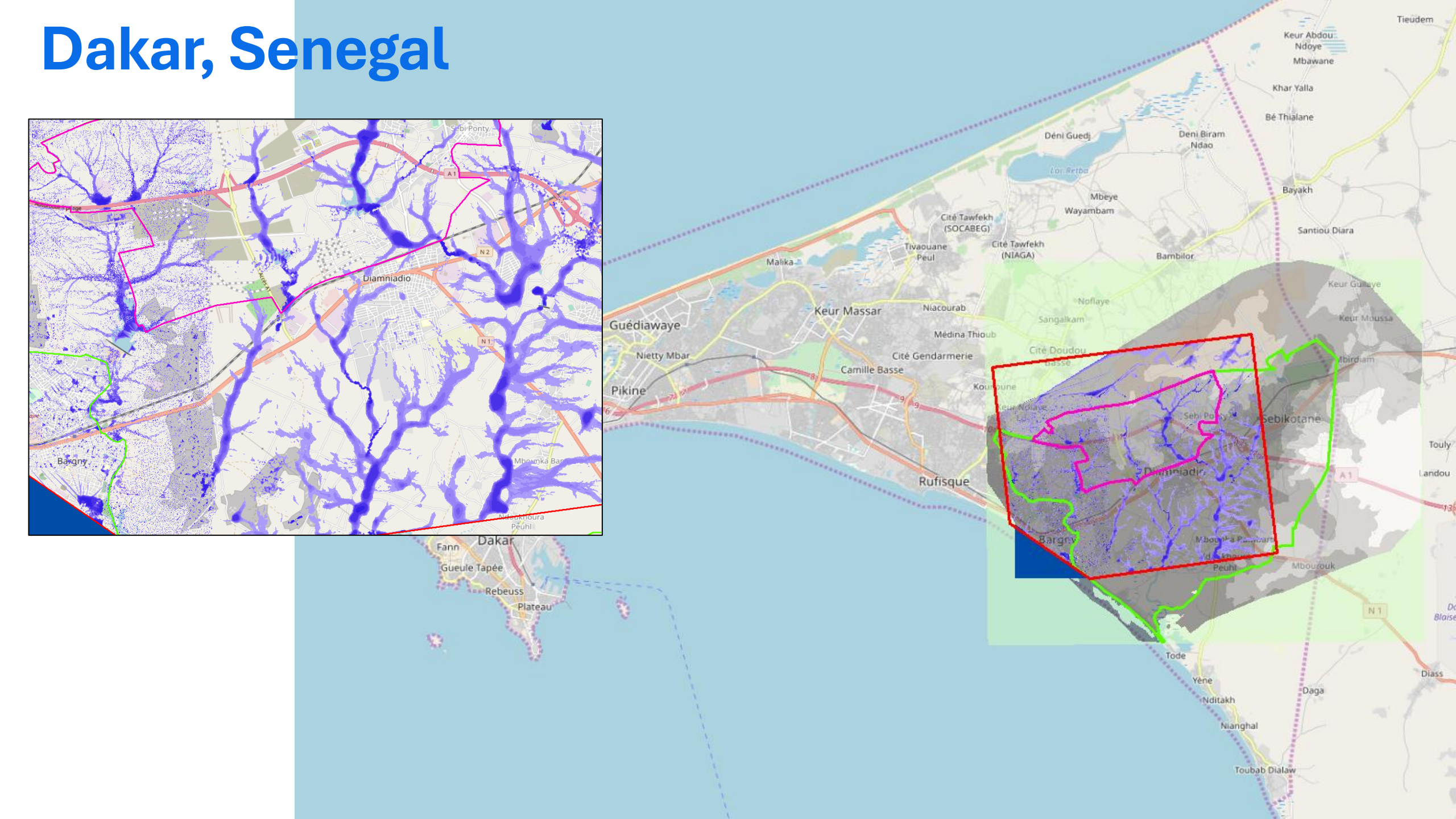
NYC – extreme rainfall drainage concept

Jacarta KHI, Malaysia

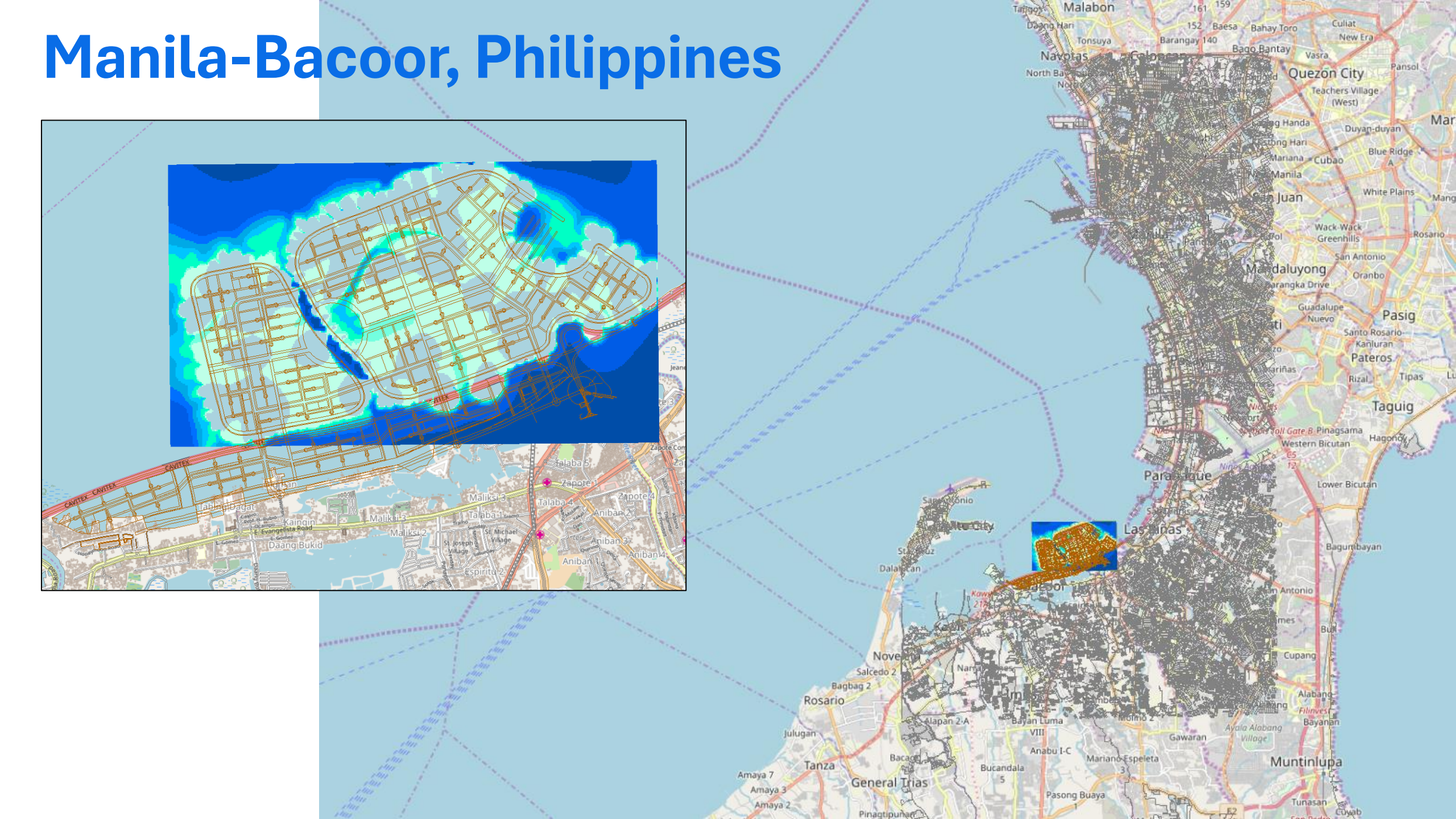




Dakar, Senegal



Manila-Bacoor, Philippines



Auckland airport, New Zealand