



TRANSFORMATIVE CLIMATE CHANGE ADAPTATION: Creating Greater And Greener Cities

Conference On Innovations In Climate Resilience (March 29-30, 2022, Columbus, Ohio)

RAMBOLL

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AGENDA

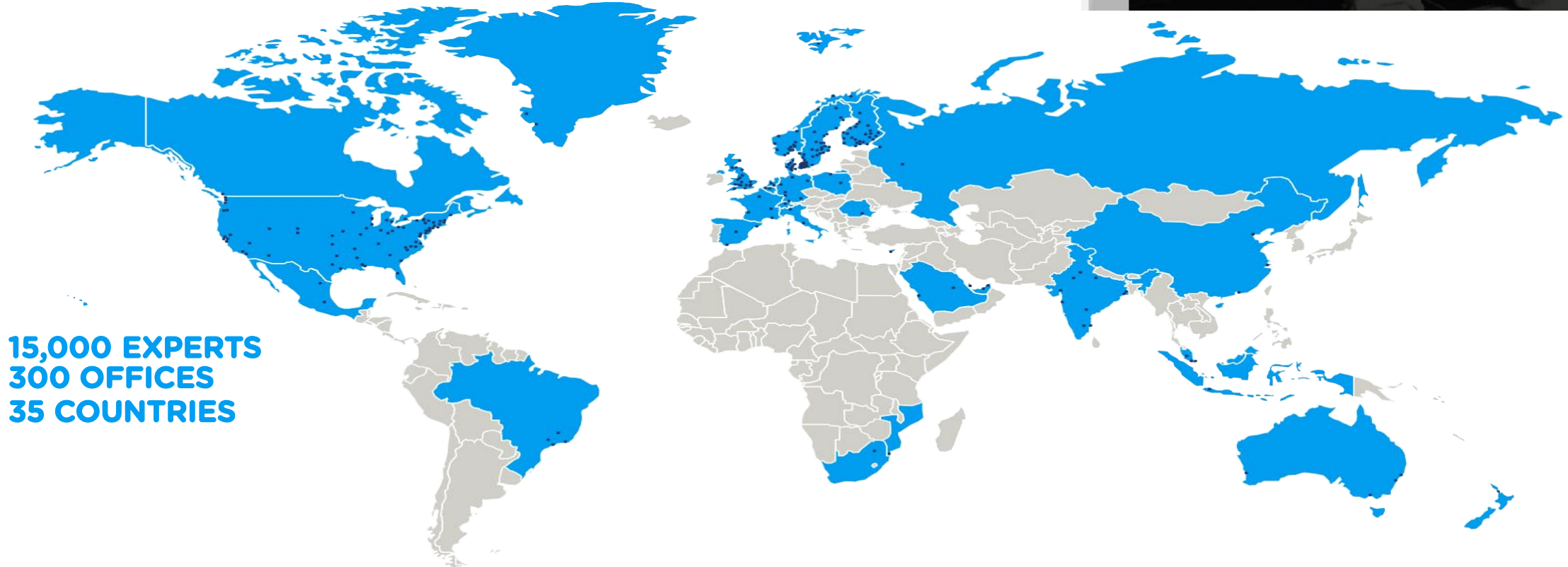
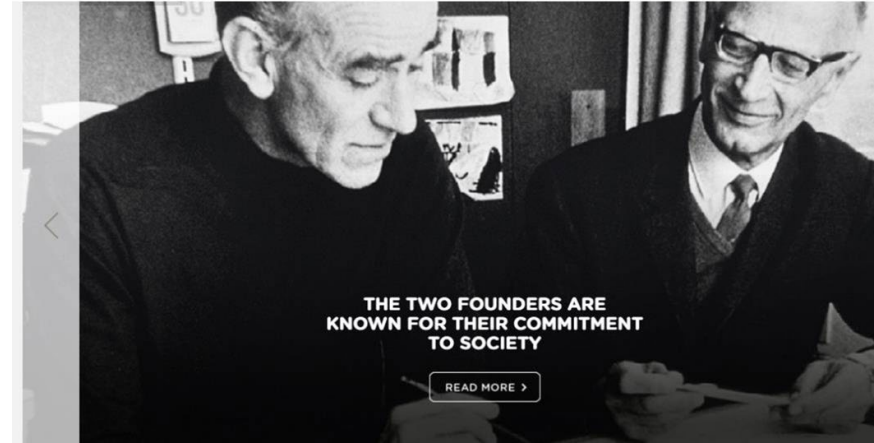
- About Ramboll
- “Cloudburst” Concept
- Exemplary Projects
- Lessons Learned



RAMBOLL AT A GLANCE

- Foundation owned environmental engineering, design and consultancy company recognized for our environmental and health practice areas
- Our founders had high ethical standards and behaved responsibly towards each other and society at large
- We joined the UN Global Compact in 2007 - a framework for businesses committed to aligning their operations and strategies with ten principles in the areas of Human Rights, Environment, and Anti-Corruption

- We strive to achieve inspiring and exacting solutions that make a genuine difference to our clients, end-users and society at large
- We evolve to keep pace with these changes (science and technology, evolving legal and social pressures) by adding new services, contributing to scientific advances and expanding geographically



15,000 EXPERTS
300 OFFICES
35 COUNTRIES

WHAT IS "CLOUDBURST"



Copenhagen 2015, Photo: Bax Lindhardt

CITY	ADAPTATION STRATEGY YEAR	EXTREME RAIN TERMINOLOGY	Return periods	
			DRAINAGE	SAFETY LEVEL
COPENHAGEN	2009	Cloudburst	5	100
LONDON	2011	Heavy rain // extreme rain	30	30-100
NEW ORLEANS	2009	Heavy rainfall // rainfall storm		10
CHICAGO	2003	Heavy rain // extreme rain event	5	100
ROTTERDAM	2008	Extreme rainfall // heavy downpour	2	100
MELBOURNE	2009	Overland flow // flash flood // storm	5	100
NYC	2007	Heavy downpour // cloudburst	5	100*

COPENHAGEN CLOUDBURST MANAGEMENT PLAN

CHALLENGE

Destructive cloudburst event in 2011 with EUR 800 million in damages

Danish Meteorological Institute projects intensity of heavy rainfall could rise by 20-50% by 2100

WHAT WE DID

- Climate adaptation & landscape architecture
- Energy strategy
- Physical planning
- Social & economic impacts
- Stakeholder and citizen consultation
- Urban water management

EFFECT

Positive impact on city liveability/attractiveness

New park saves approx. €134 million over storm water pipe

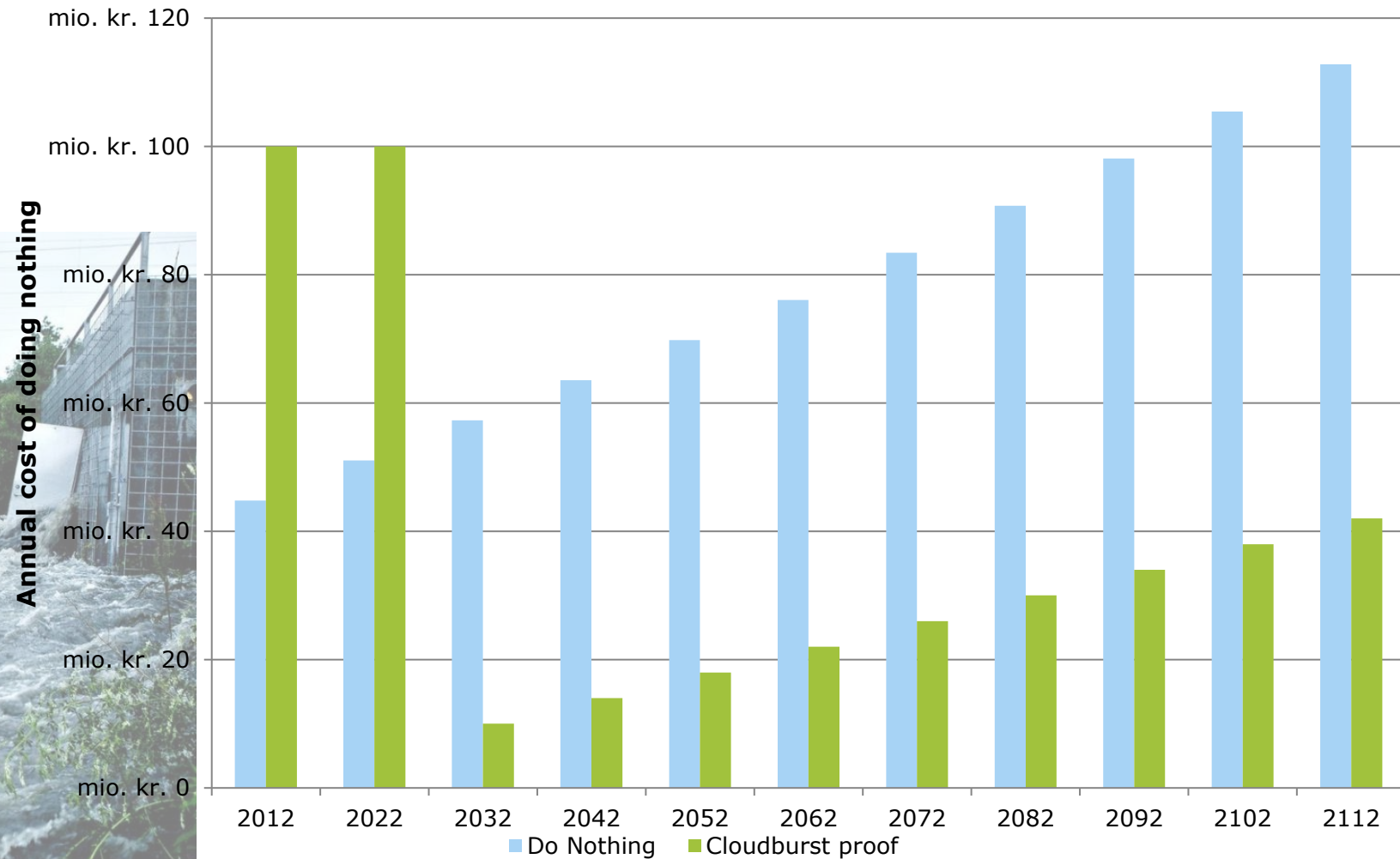
TIMELINE

Completion 2013



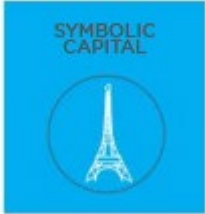
ANNUAL COST OF DOING NOTHING VS FLOOD MANAGEMENT

One single cloudburst event in 2011 cost the City of Copenhagen **\$1 Billion** in damages

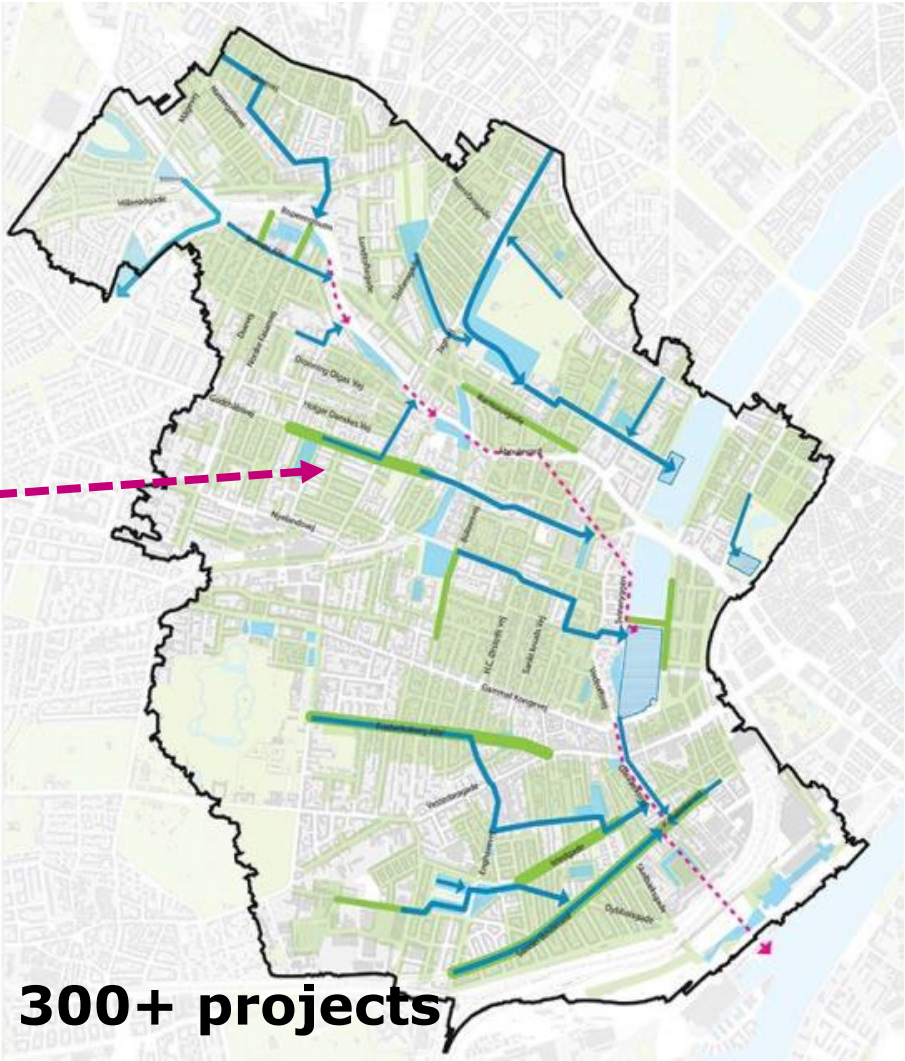
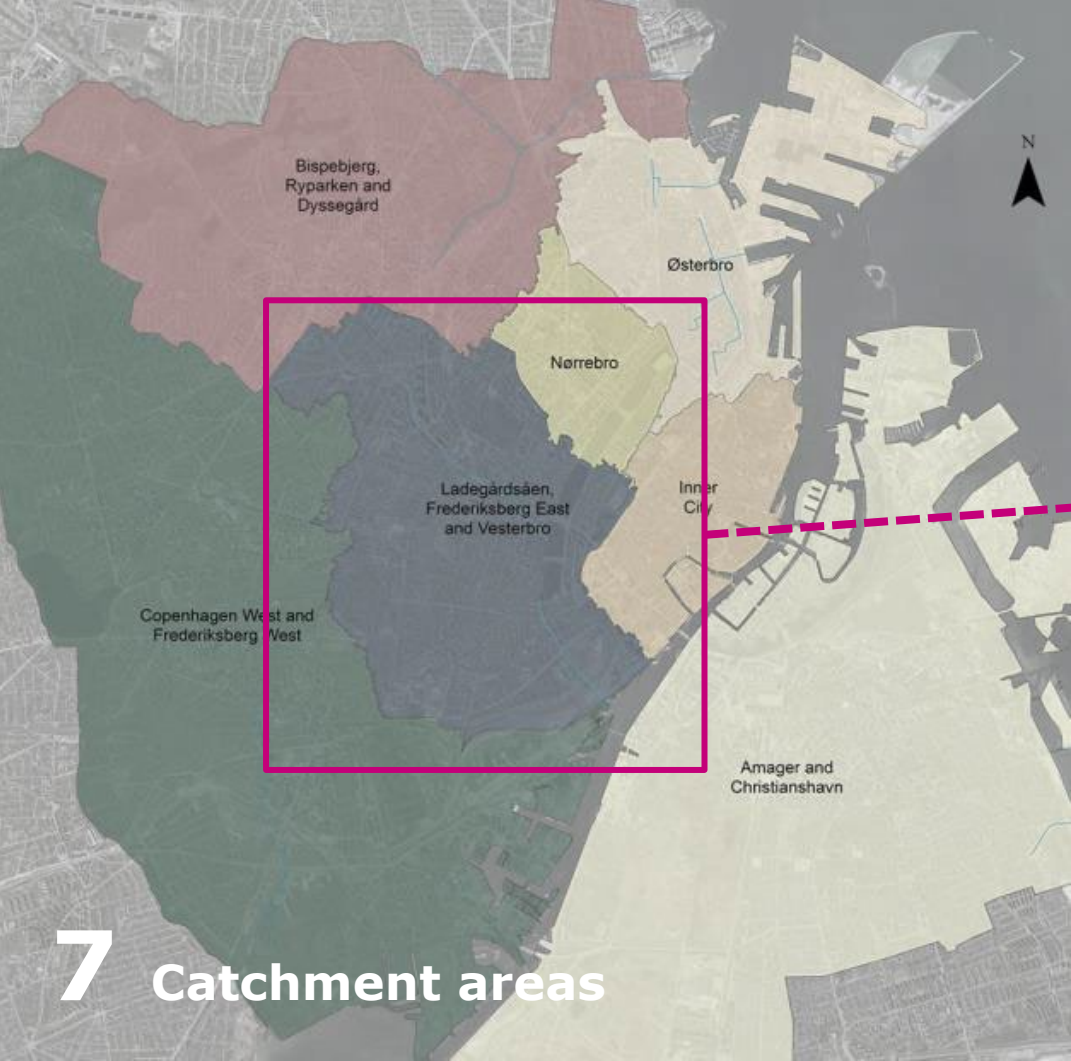


BACKGROUND

Using BGI for stormwater quality/quantity + adding value to the community

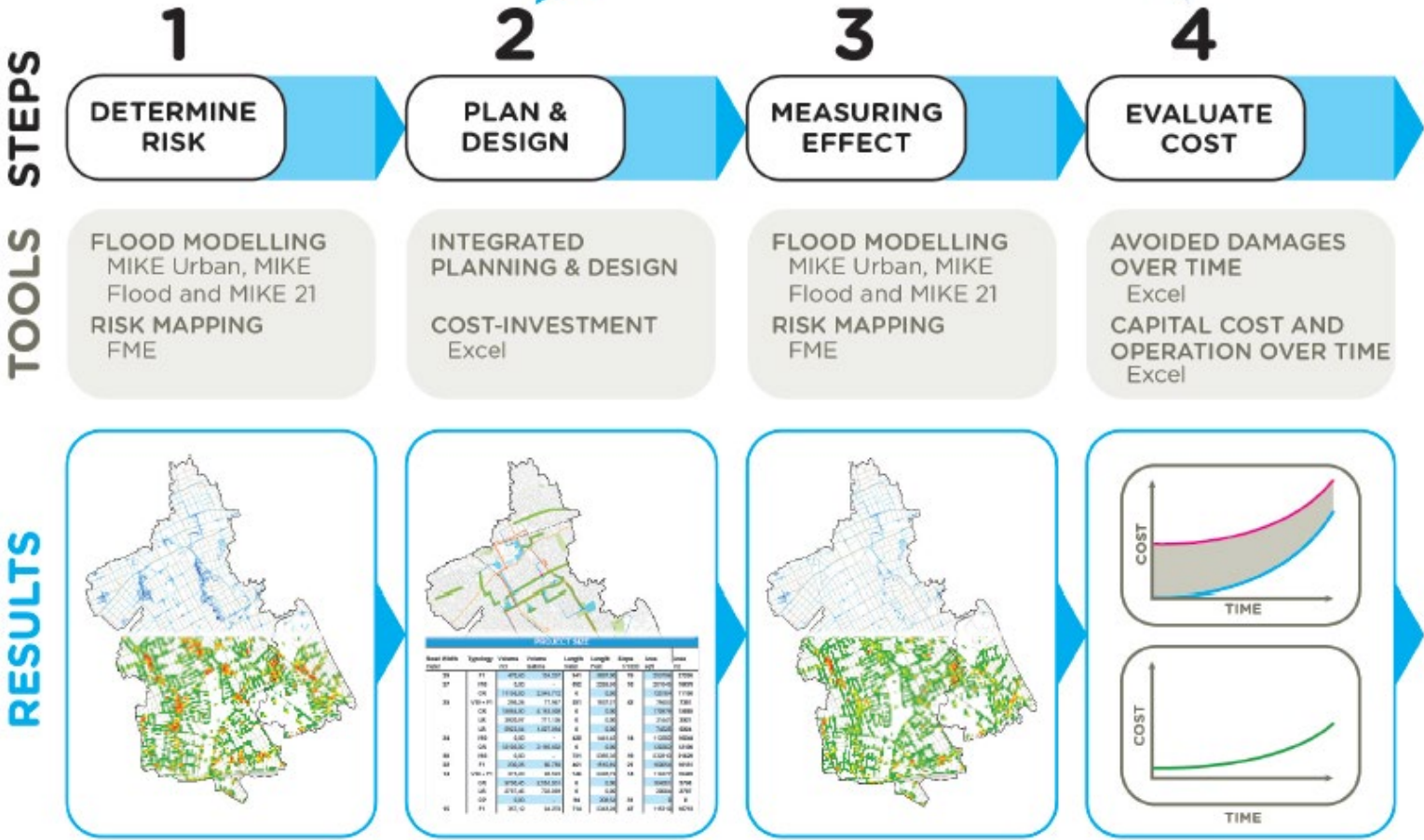


BACKGROUND

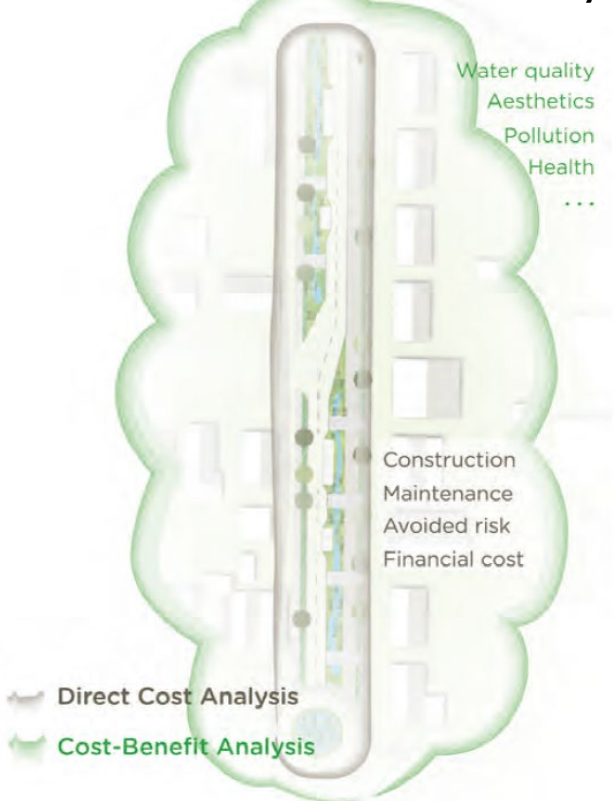


-----> **Integrated planning process**

BACKGROUND



4. Cost-benefit analysis



Integrated planning process



CLOUDBURST RESILIENCE STUDY AND PILOT PROJECT, NEW YORK CITY

CHALLENGE

NYC DEP wanted to address heavy rainfalls through integration of traditional underground drainage infrastructure with above-ground, nature-based solutions into ongoing urban infrastructure planning.

Develop the guidelines for a city-wide cloudburst plan.

WHAT WE DID

Conducted a study providing best-practice insights and advance insights and new planning paradigms through conceptual design of specific pilot projects in NYC.

EFFECT

The study identified the socio-economic benefits of nature-based solutions and paved the way for a pilot project in the South-Eastern part of Queens.

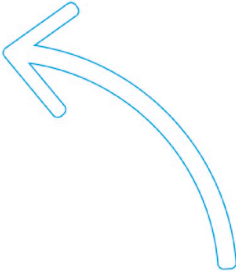
TIMELINE

2016 - 2017



CLOUDBURST RESILIENCY STUDY - NYC

- Diverse cities with universal challenges

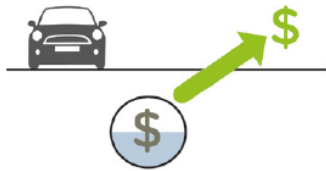


2015
Copenhagen and NYC sign Memorandum of
Collaboration on Climate Adaptation



CLOUDBURST RESILIENCY STUDY - NYC

Testing the Copenhagen Cloudburst Planning Approach in NYC



T=5 → T=100



1. Is it possible to achieve **greater urban value** and co-benefits for capital investments by using BGI for stormwater management?

2. Is it possible to **reduce risks** using BGI for a similar budget as traditional stormwater infrastructure?

3. Is it possible to **increase cooperation** across city agencies and stakeholders and maximise output of invested money through IP?



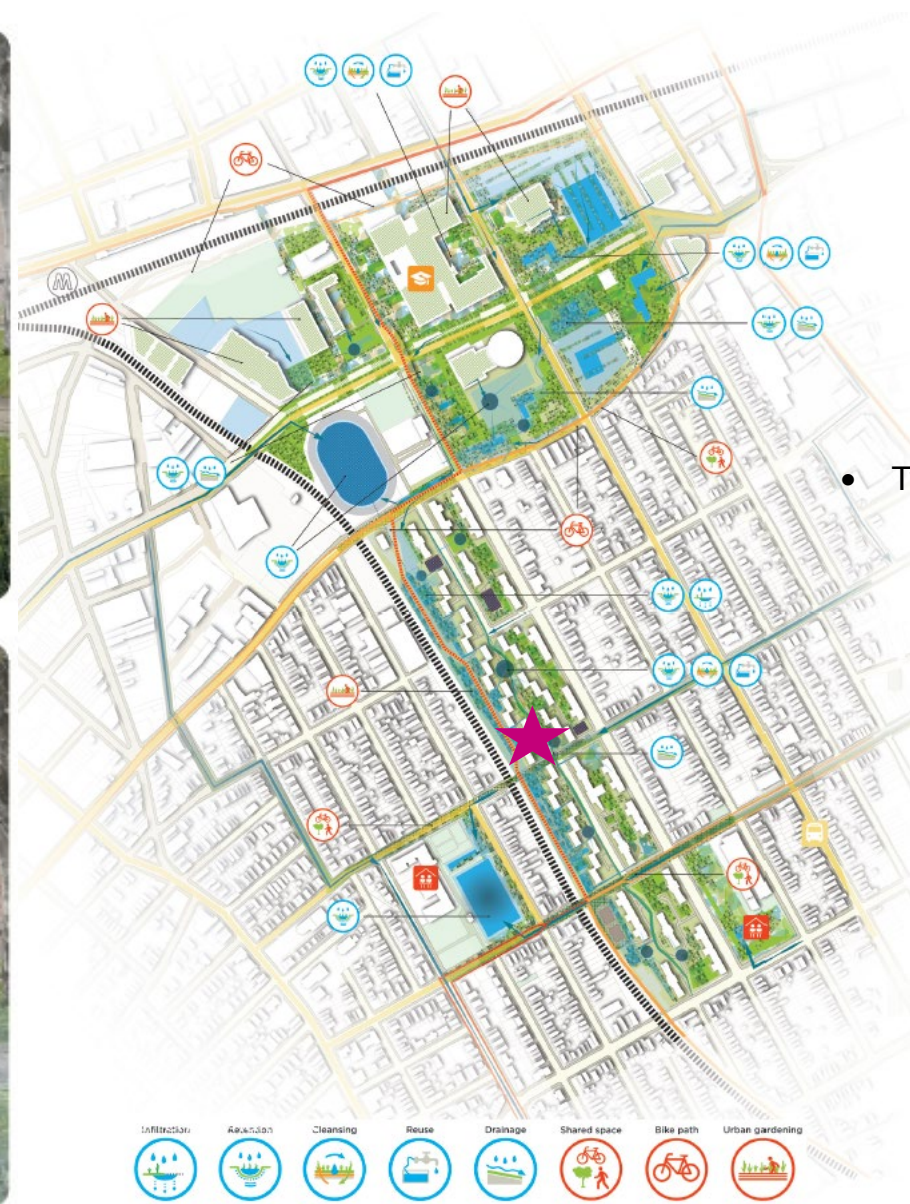
CLOUDBURST RESILIENCY STUDY - NYC

Existing Conditions



CLOUDBURST RESILIENCY STUDY - NYC

- Masterplan (68 projects)
 - 11 cloudburst roads
 - 16 cloudburst roads with retention
 - 15 retention streets
 - 4 cloudburst pipes
 - 18 central retention
 - 4 local retention
- Two pilots ★
 - South Jamaica House
 - St Albans pumping station

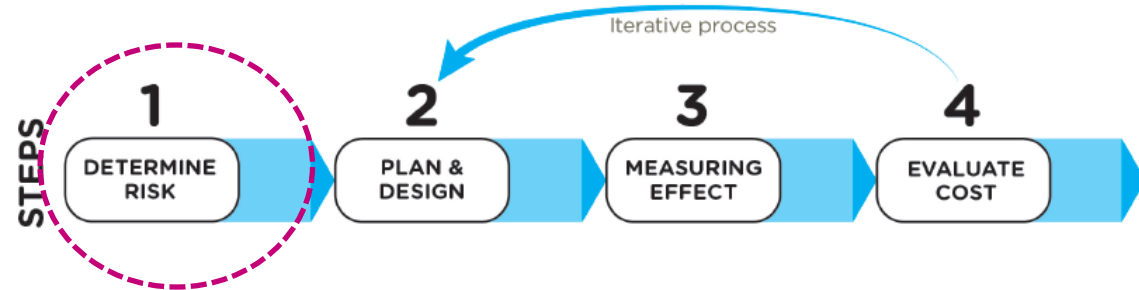
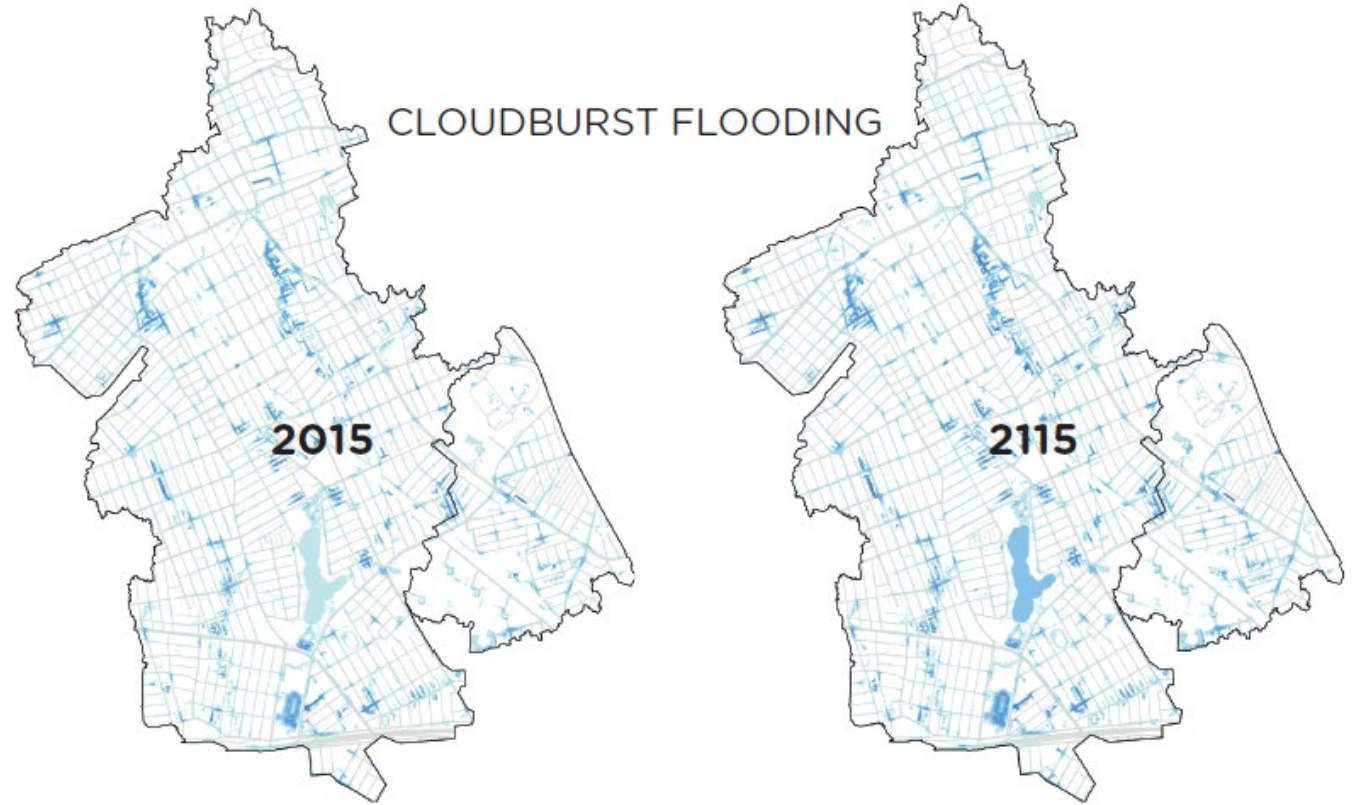


CLOUDBURST RESILIENCY STUDY - NYC

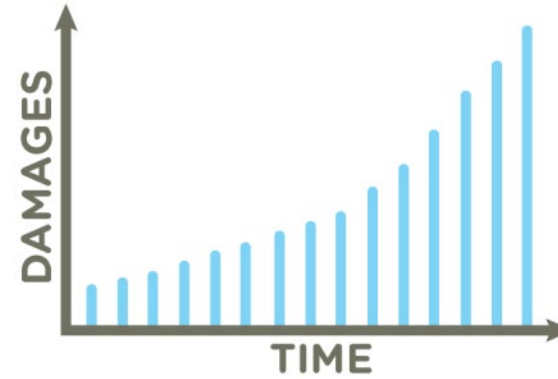


Probability of flooding is based on hydraulic model results for today and in the future

Probability increases over time due to climate change

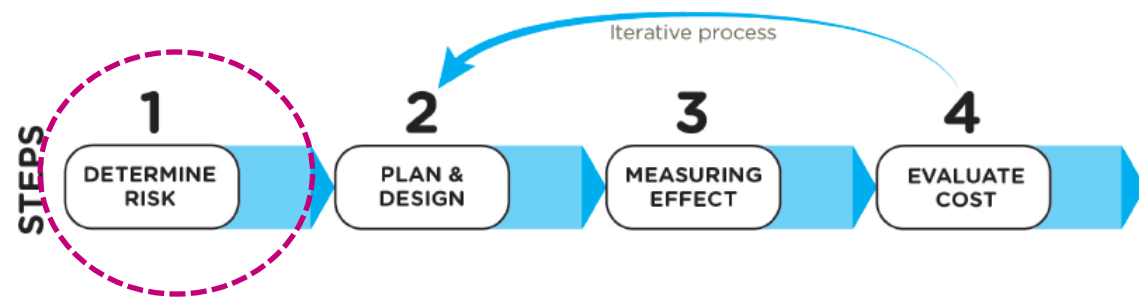


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Consequence is based on Hazus (FEMA) damage costs

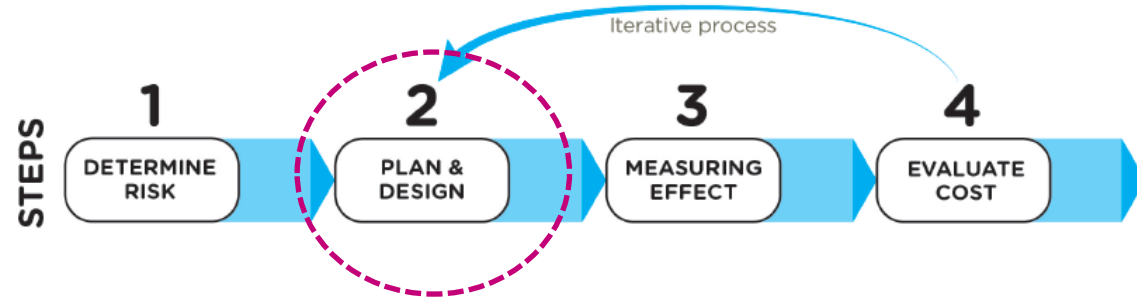
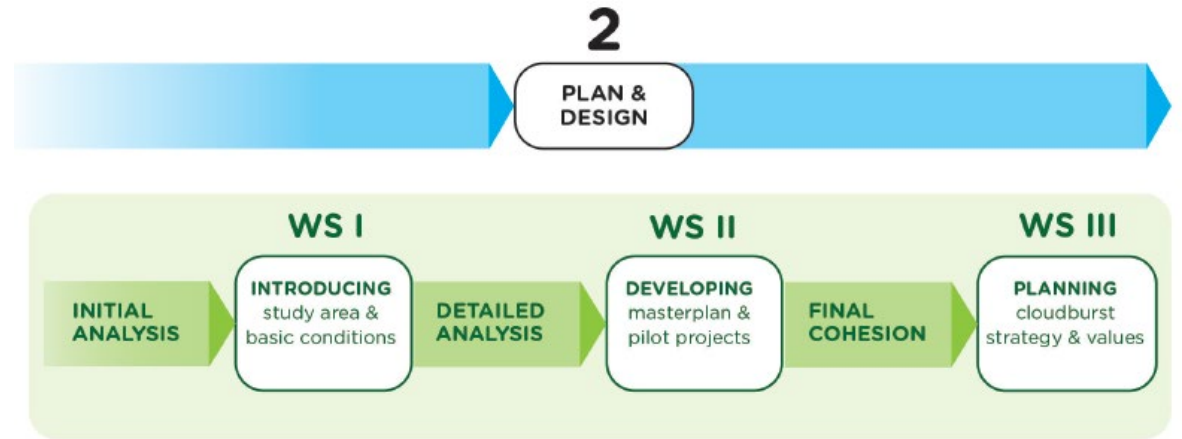
Risk is expressed in expected annual damage costs



CLOUDBURST RESILIENCY PLANNING STUDY

Plan & Design framed across **3** workshops

- Ownership (be part of the “evolution”)
- Build collaboration
- Add value



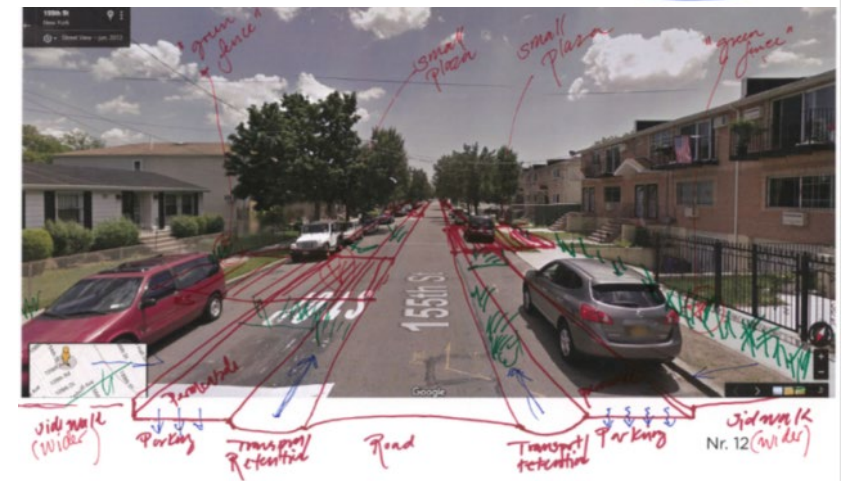
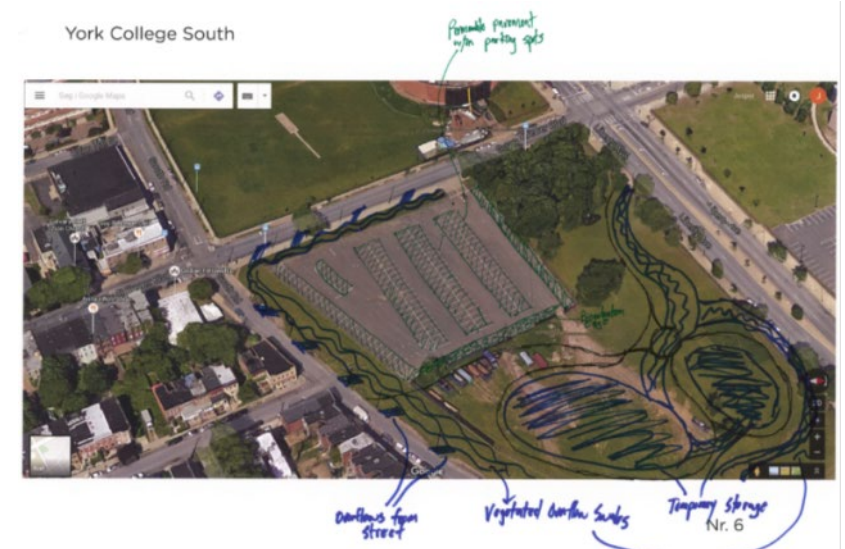
CLOUDBURST RESILIENCY PLANNING STUDY

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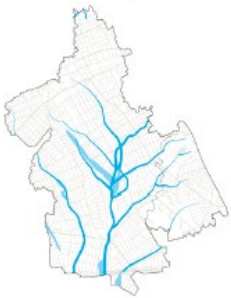
PLAN & DESIGN

MASTERPLANNING

- RISK** Where does water come from? Where are the risks?
- POTENTIAL** Where can water be stored?
- TERRAIN** Where does the water flow? Where should it flow?
- FRAMES** What can we (not) accept?
- SYNERGY** Where can we improve urban connectivity?



Historic waterways and areas



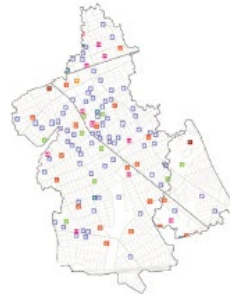
Elevation map



Terrainbased flowlines



Social infrastructure



Transport infrastructure

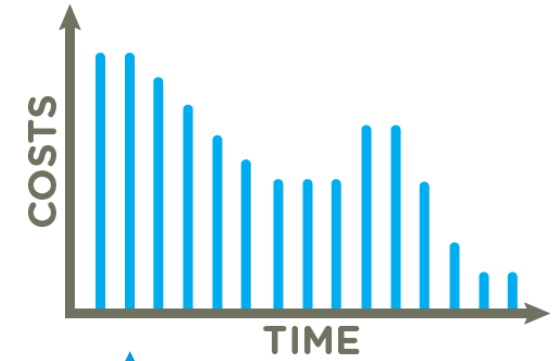


Green connections

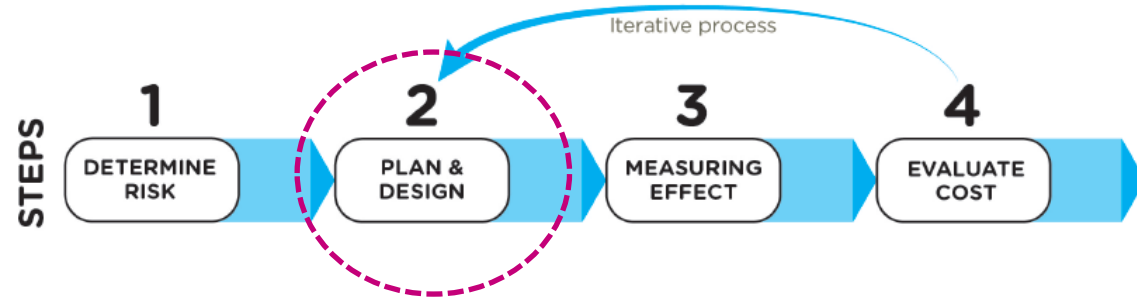


CLOUDBURST RESILIENCY PLANNING STUDY

PROJECT INFORMATION			PROJECT SIZE				HYDRAULIC S		
ID	Name	Solution	Road Width meter	Typology	Volume m3	Length meter	Area m2	Areal ha	Area m2
QN01	Jamaica Ave	Retention street		20 F1	470.60	941.19	19002	23.1	231.000
QN02	Jamaica Ave onto Guy R Brewer Blvd	Cloudburst street		13 V10	0.00	691.77	8820	15.5	155.000
QN03	York College Plaza	Central retention		CR	11158.00	0.00	11158	14.6	146.000
QN04	Douglas Ave onto Liberty Ave	Cloudburst and retention street		15 V10 + F1	235.26	530.51	4543	13.0	130.000
QN05	York College East	Central retention		CR	15884.50	0.00	15885	2.4	24.000
QN06	South Jamaica Center	Local Retention		LR	2320.97	0.00	2321	12.1	121.000
QN07	York College West	Local Retention		LR	6923.84	0.00	6924	7.3	73.000
QN08	Merrick Blvd onto 166th St	Cloudburst street		16 V10	0.00	439.35	6988	5.3	53.000
QN09	York College Stadium	Central retention		CR	12105.50	0.00	12106	7.3	73.000
QN10	Liberty Ave	Cloudburst street		22 V10	0.00	720.96	15501	10.2	102.000
QN11	101st Ave	Retention street		13 F1	230.26	480.52	5895	30.7	307.000
QN12	Tuckerton St onto 154th St	Cloudburst and retention street		11 V10 + F1	373.20	746.39	8180	18.9	189.000
QN13	Jamaica Housing	Central retention		CR	9708.45	0.00	9708	25.8	258.000
QN14	153th St	Local Retention		LR	2787.46	0.00	2787	10.7	107.000
QN15	166th St at St James	Cloudburst Pipe		CP	0.00	94.04	0	22.3	223.000
QN16	108th Ave	Retention street		9 F1	357.12	714.23	6428	12.7	127.000
QN17	Station 6 and 6D	Central retention		CR	4818.36	0.00	4818	49.1	491.000
QN18	108th Ave into Jamaica Housing	Cloudburst and retention street		9 V10 + F1	197.61	395.22	3557	13.3	133.000
QN19	108th Ave into Marooni Park	Cloudburst and retention street		9 V10 + F1	42.54	85.08	766	8.1	81.000
QN20	Merrick Blvd	Retention street		19 F1	81.66	163.33	3182	3.6	36.000
QN21	Corner Park	Central retention		CR	720.47	0.00	720	7.3	73.000
QN22	108th Dr	Cloudburst street		10 V10	0.00	154.84	1471	17.4	174.000
QN23	JHS 008	Central retention		CR	3299.96	0.00	3300	4.2	42.000
QN24	109th Ave	Retention street		12 F1	407.92	815.83	9790	24.7	247.000
QN25	109th Ave into Marooni Park	Cloudburst and retention street		9 V10 + F1	146.49	292.98	2747	33.1	331.000
QN26	Marooni Park	Central retention		CR	13364.30	0.00	13364	41.3	413.000
QN27	109th Ave West	Retention street		12 F1	78.30	156.60	1879	64.5	645.000
QN28	155th St	Cloudburst street		10 V20	0.00	887.54	9129	72.1	721.000
QN29	PS 40Q	Central retention		CR	4040.96	0.00	4041	2.2	22.000
QN30	110th Ave at PS 40Q	Cloudburst and retention street		12 V10 + F1	83.72	167.45	1926	3.0	30.000
QN31	110th Ave East	Cloudburst and retention street		11 V10 + F1	278.00	556.00	6116	25.4	254.000
QN32	Station 6A, 6B and 6C	Central retention		CR	4427.25	0.00	4427	29.0	290.000



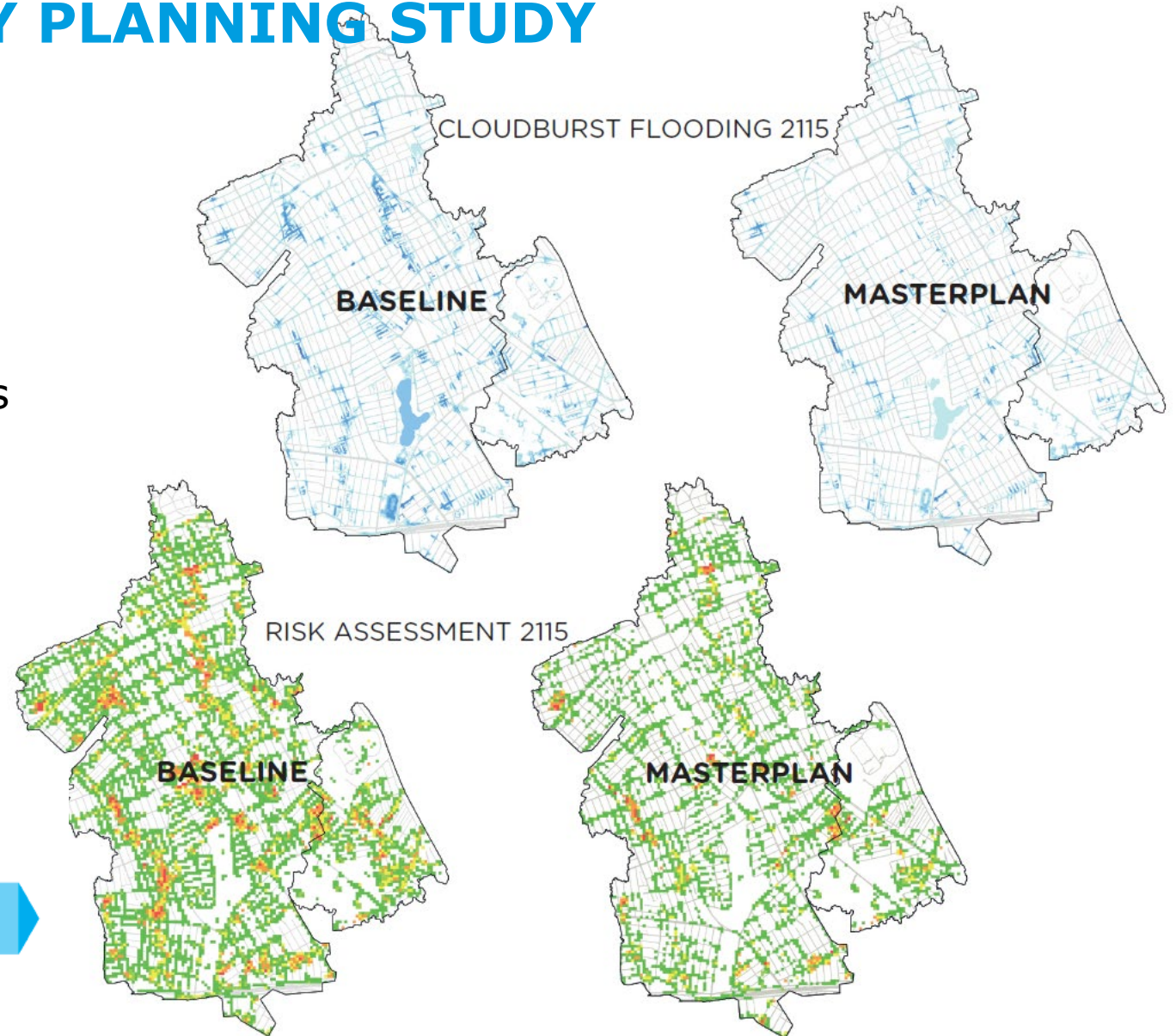
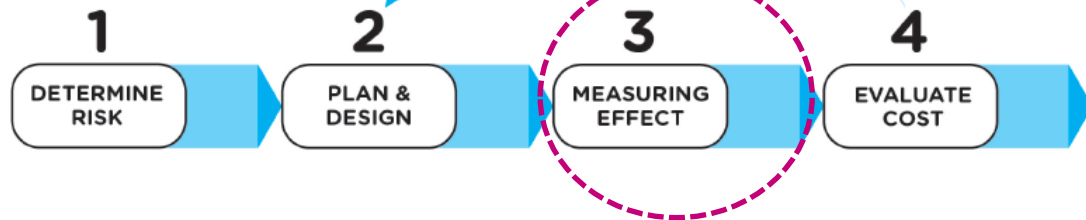
Construction and maintenance costs **over time**



CLOUDBURST RESILIENCY PLANNING STUDY

less flooding
decreased damage costs

STEPS

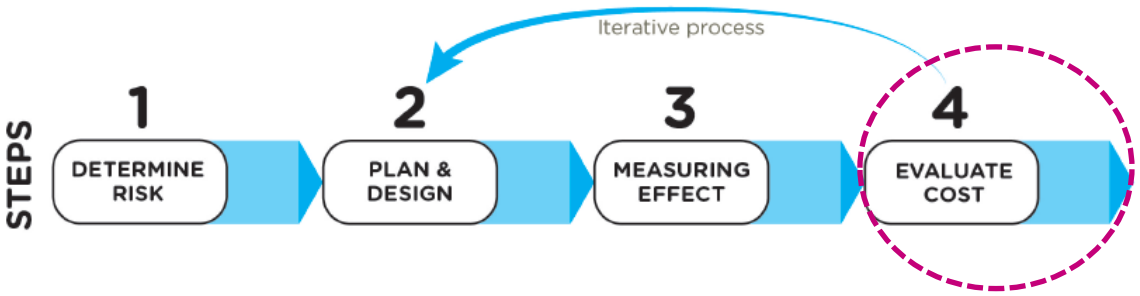
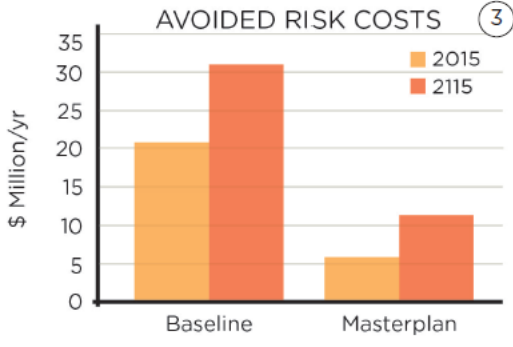
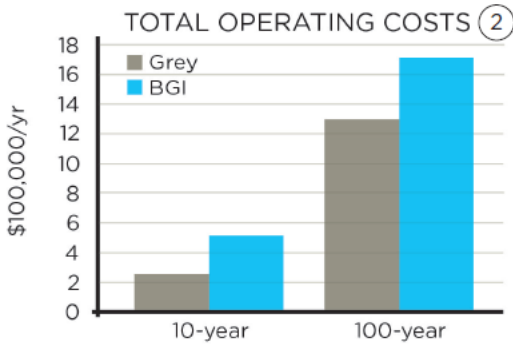
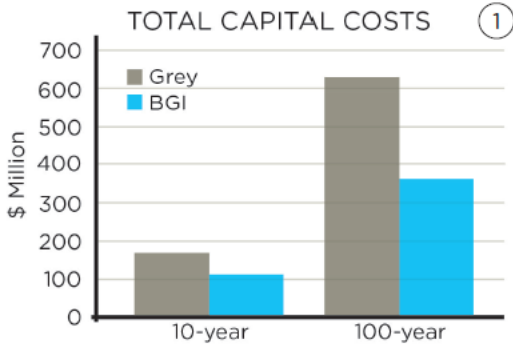


CLOUDBURST RESILIENCY PLANNING STUDY

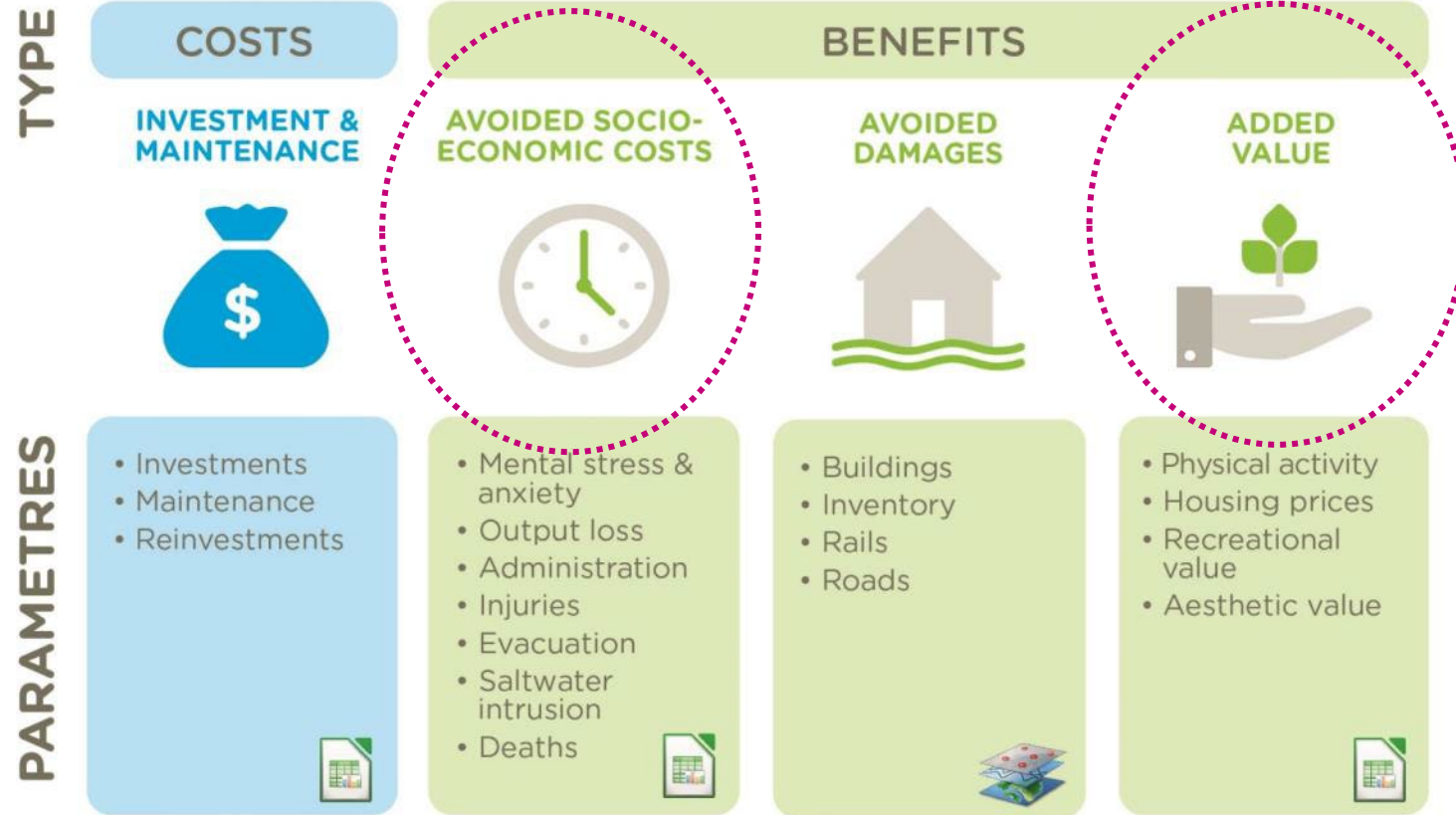
Capital investment: \$330 million

Avoided risk costs: \$310 million

\$20 million net loss



CLOUDBURST RESILIENCY PLANNING STUDY



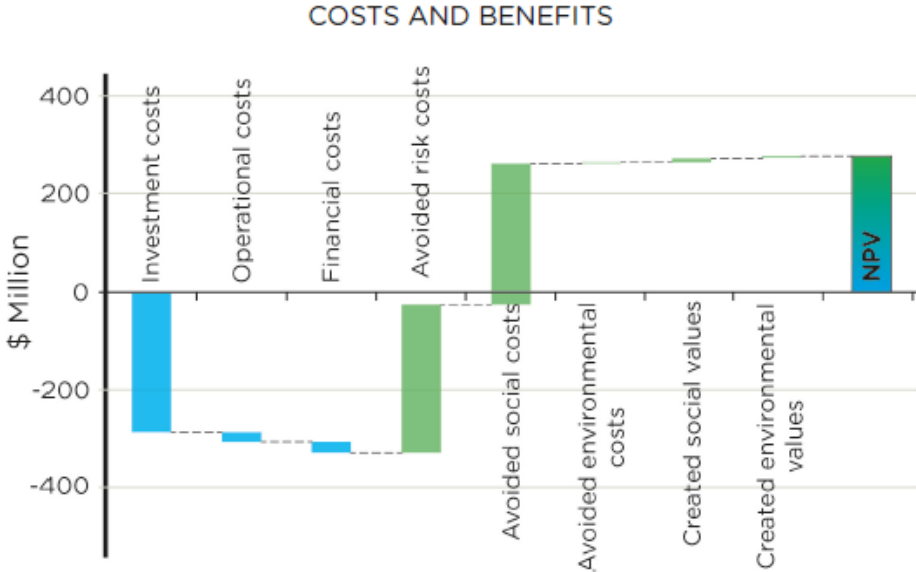
CLouDBURST RESILIENCY PLANNING STUDY

- Avoided social and environ. costs: \$290 million
- Created social and environ. costs: \$3 million

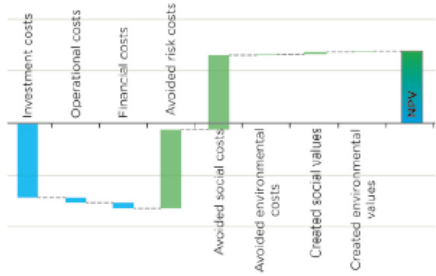
\$273 million net gain

The **BENEFIT-COST RATIO** indicates that for every \$1 the City invests in BGI, the City makes \$1.9 in return in generated co-benefits in the local area.

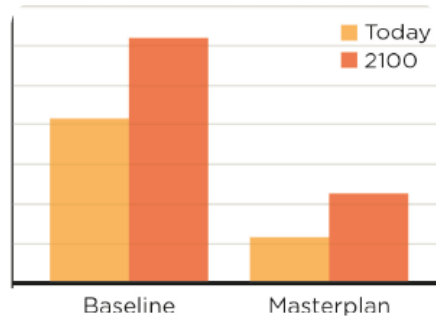
AVOIDED COSTS		CREATED VALUES	
SOCIAL	ENVIRONMENTAL	SOCIAL	ENVIRONMENTAL
Injuries	Improved water quality control	Health benefits	Pollutant removal
Mental stress and anxiety		Recreational value	Carbon sequestration
		Aesthetic value	



CLouDBURST RESILIENCY STUDY - NYC



Urban value increased through BGI



Risks reduced using BGI



Cooperation increased through integrated planning

“Ramboll not only has the water engineering techniques but can also factor them and all the other aspects into the big calculation – and simplify it.”

Cost-effectiveness means not only the amount of savings in terms of avoided property damage but also the extent to which the new green areas will improve residents’ health and quality of life.”

Alan Cohn, Climate Program Director at NYCDEP

Thank you!

Julie Conroy
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Climate Adaptation and Landscape Architecture
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RAMBOLL

Bright ideas.
Sustainable change.