



**OECD Conference on the
Financial Management of Flood Risk**

Building financial resilience in a changing climate

**PRESENTATIONS –
SESSION 4**

**12-13 May 2016
Paris, France**





OECD CONFERENCE ON THE FINANCIAL
MANAGEMENT OF FLOOD RISK: BUILDING
FINANCIAL RESILIENCE IN A CHANGING CLIMATE

Lessons from the OECD Risk Management Review on Paris floods

Charles Baubion
High-Level Risk Forum, OECD




Lessons learned from international comparison

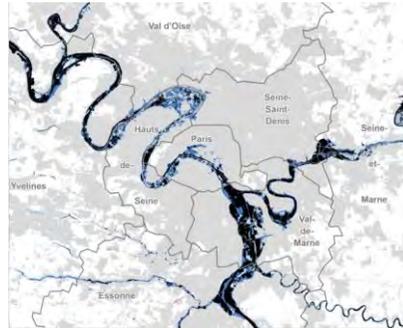
Cities or country	Year	River or event	Return period	Damages and losses (Bio €)
Prague	2002	Vlatva	500 y	3,1
New-Orleans	2005	Katrina floods		90
UK	2007	Severn & Thames	200 y	4,6
Brisbane	2011	Brisbane	120 y	11,7
Bangkok	2011	Chao Phraya	> 100 y	36,1
New-York	2012	Sandy floods	400-800 y	14,8
Central Europe	2013	Danube & Elbe	100 y	12,1



New-Orleans after Katrina 2005
Source: Romain Huret, 2010



What about Paris area?



- Economic impacts of a major flood today
- How to improve flood prevention?

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Major assets at risks

463 km² , 830 000 inhabitants

55 700 companies representing 620 000 jobs

Key government institutions, 295 schools, 79 hospitals, 11 637 power sub-stations, 140 km & 41 subway stations, 3 railway stations, sub-urban train, 85 bridges, 5 highways

Cultural heritage : the Seine Parisian banks part of UNESCO World Heritage, thousands of historical buildings, museums and art galleries

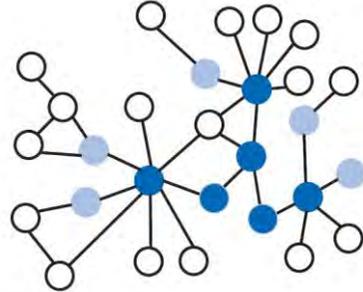
Environment: wastewater stations, industrial sites SEVESO, waste disposals, oil deposits

4

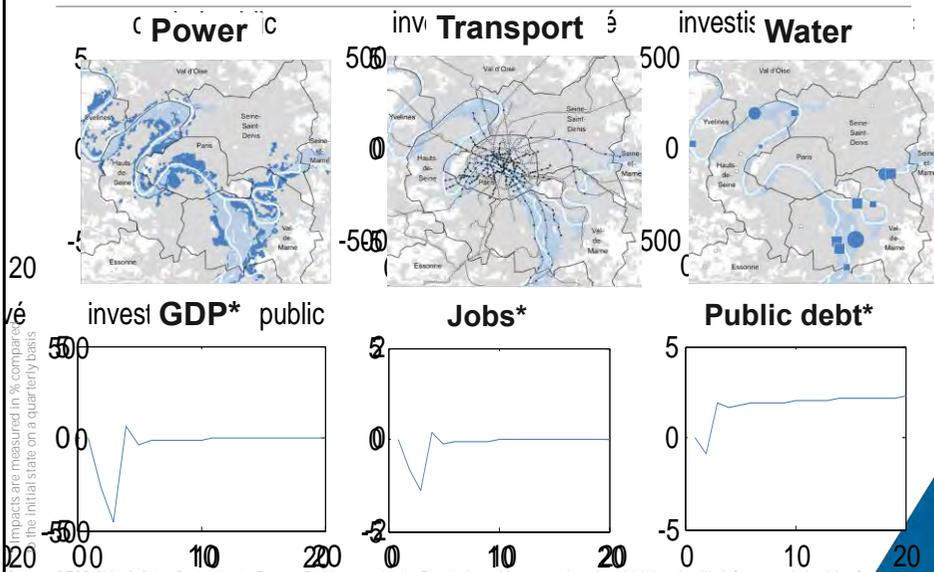


Assessing the impacts and its multiple dimensions

- Impacts on well-being, functioning of the institutions and companies
- Impacts on the environment and the cultural heritage
- Cascading impacts linked to network interruptions
- Macro-economic impacts: Ile-de-France represents 30 % of the French national GDP



A comprehensive risk assessment: critical infrastructure & macro indirect effects



Key messages Impacts

A major event with large consequences

- ✓ Direct and indirect impacts on nearly 5 millions citizens and many companies
- ✓ Continuity of government
- ✓ Long duration that could exceed a quarter

A significant economic impact

- ✓ 3-30 Bio € of direct damages
- ✓ Impacts on critical infrastructures and businesses
- ✓ 0.1 to 3 % cumulated GDP losses over 5 years
- ✓ 10 000 - 400 000 job losses following the crisis

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Setting inclusive risk governance mechanisms is a prerequisite for effective resilience policies



- **Authorities:** municipalities, region, state
 - **Policy areas:** water, urban planning, emergency
 - **Scales:** river-basin and metropolitan area
- Multiple stakeholders
- Coherence, decision-making, accountability

❖ *Leadership and inclusive coordination mechanisms are essential to define joined-up strategies, agree on common targets and align actions*

OECD Recommendation on the Governance of Critical Risks

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Integrating resilience into urban planning

- Land use and urban planning regulation is necessary but not sufficient:
 - Enforcement of regulation is difficult
 - Lack of incentives to limit construction
 - Scarcity of non-built areas
 - The opportunity of urban regeneration to foster innovation in resilient urban planning
 - Hamburg, Rotterdam, New-York, Copenhagen
 - **Great Paris** : 13 urban renewal projects in the flood plain
- **Mainstreaming climate resilience into smart and green city design and building a resilience culture**



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Strengthening the resilience of critical infrastructures



- ❖ **Great Paris**: 30 bio EUR investment in public transportation infrastructure

ENERGY WATER
TRANSPORT IT

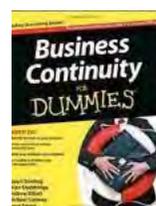
- Resilience of critical infrastructures should be based on **robustness, redundancy** and **adaptability**
- 80 % of infrastructures are privately owned or operated
 - Partnership with the private sector required
 - Contracting, regulating, incentivising

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Fostering resilience in the private sector and SMEs

- Risk awareness in global corporations is on the rise
 - Risk Officers, (Re)insurance companies, past experiences
 - Risks can be part of investment decisions → Expectations
 - Ready to act to increase resilience but information needs
 - What about SMEs ?
 - 25 % of SMEs never re-open after major disasters
- **One-stop shop for risk information**
- **Incentive mechanisms for business continuity**
- Loire basin awareness campaign
 - Business continuity for dummies in the UK



CONCLUSION

- Comprehensive risk assessments can provide a strong signal to set-up ambitious resilience policies and invest in urban resilience. Transparency and openness is key to that aim
- Inclusive risk governance is a fundamental first step to engage whole-of-government / whole-of-society resilience efforts
- Key aspects of urban flood resilience:
 - Fostering innovation for resilient urban planning
 - Working closely with operators of critical infrastructures
 - Need to incentivise resilience in the private sector
- The power of international comparison and exchange of best practices to trigger policy change: Paris has now engaged significant efforts to reduce its vulnerability to this major risk



RESILIENCE | SUSTAINABILITY

Resilient New Orleans

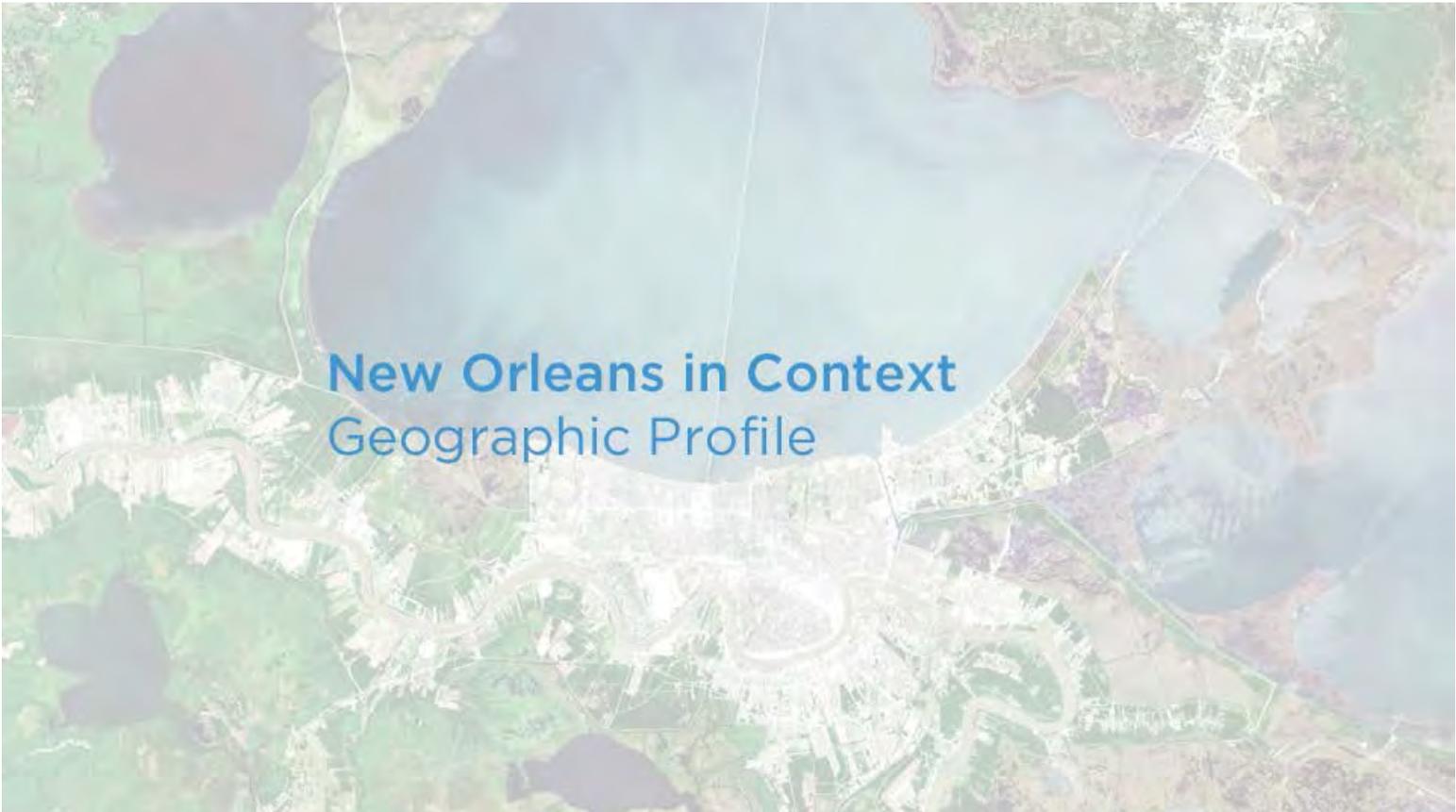
Flood Risk Reduction from Curb to Coast

12 May 2016

OECD Conference on the Financial Management of Flood Risk:
Managing flood risk at the city level

Jeff Hebert

Chief Resilience Officer
City of New Orleans



New Orleans in Context
Geographic Profile

New Orleans in Context



New Orleans and the Nation

The Mississippi River drains **40%** of the continental US.

25% of US waterborne exports are shipped through Louisiana's five major ports.

New Orleans in Context



Nature and the City

Land area: 169 mi² (438 km²)

Over 1/3 of that land is wetlands.

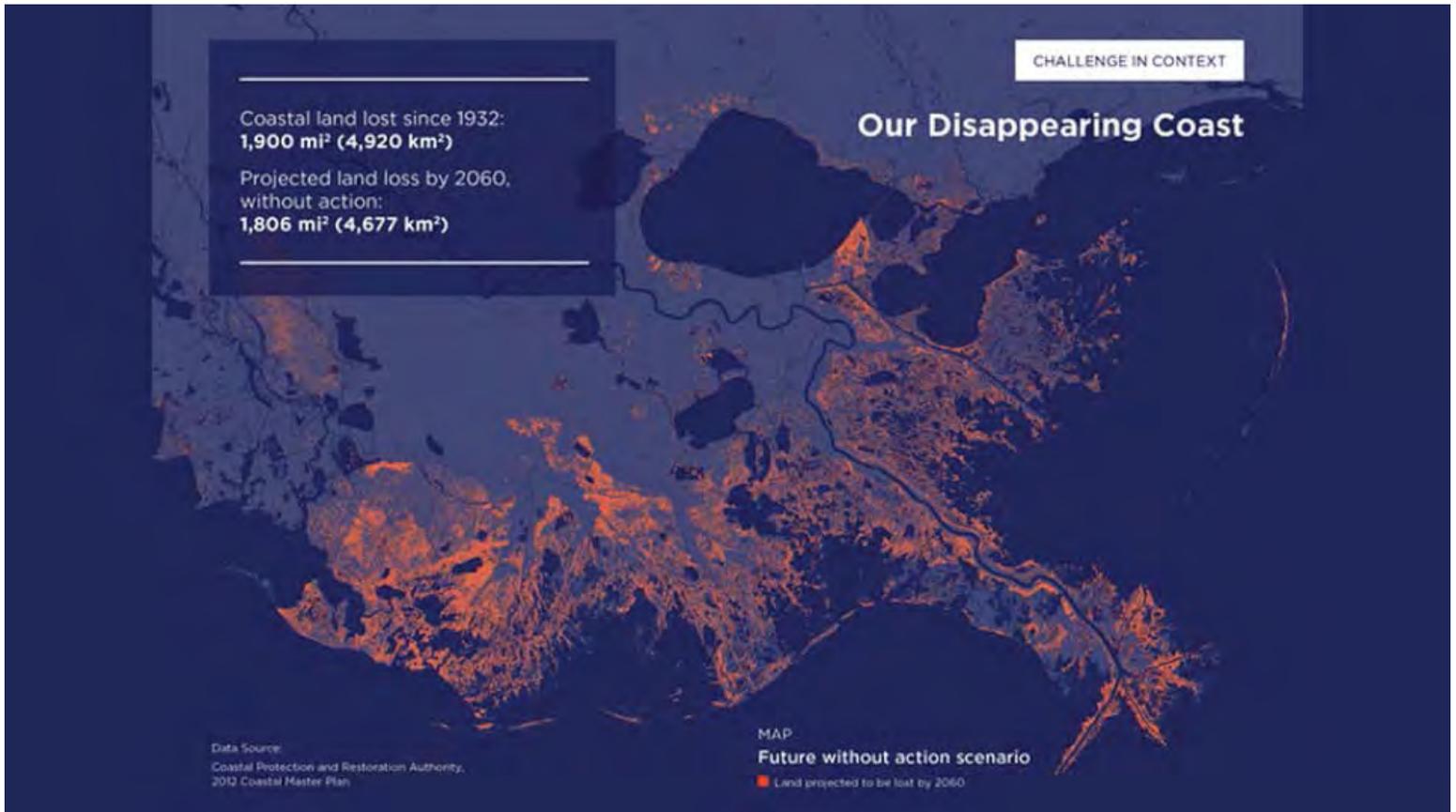
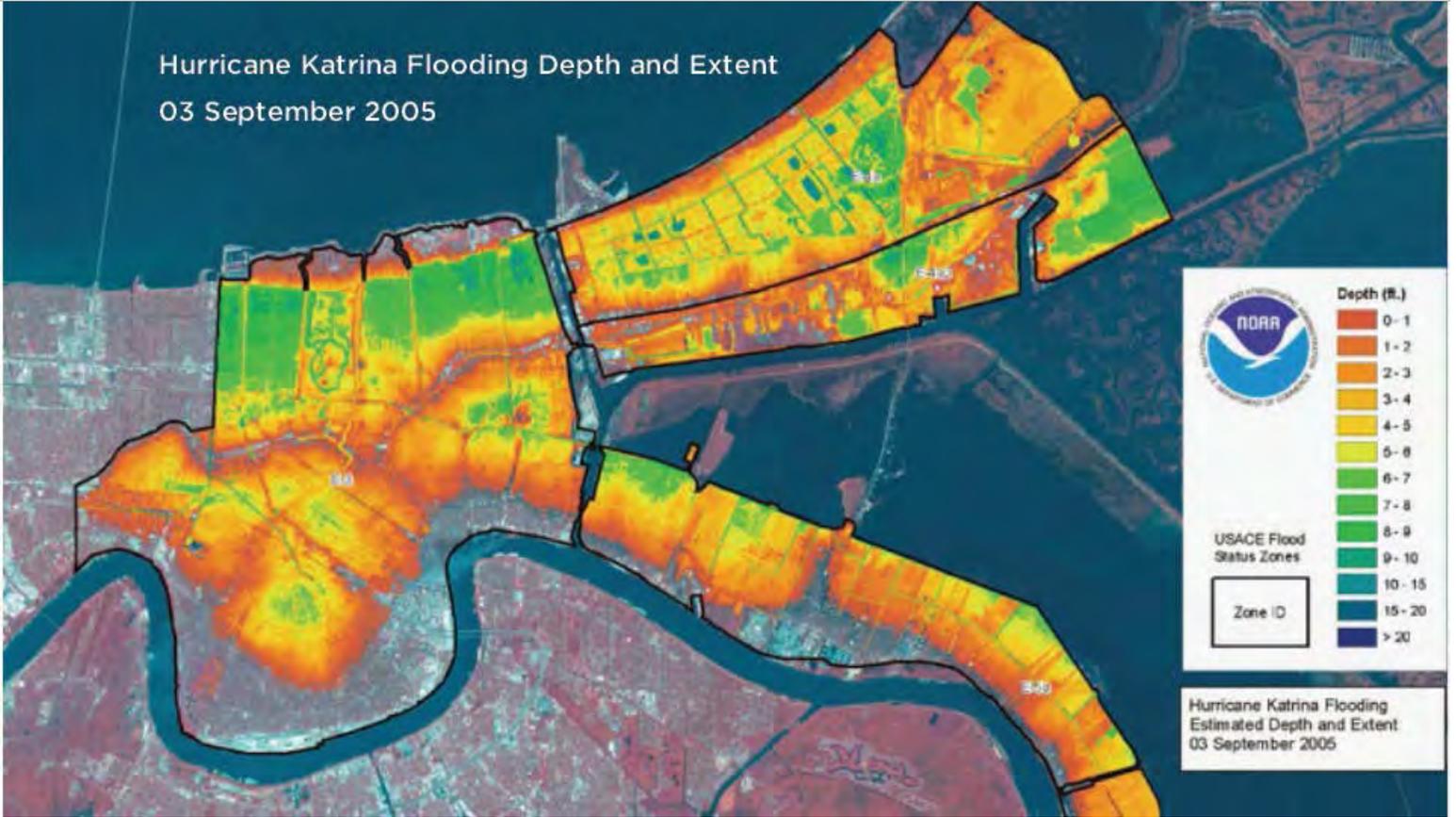
Elevation



New Orleans in Context
Living with Risk



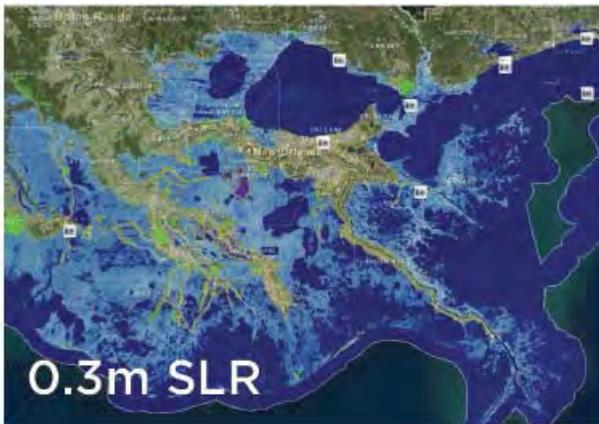
Hurricane Katrina Flooding Depth and Extent
03 September 2005



Our climate is changing.

Louisiana is experiencing the highest rate of relative sea level rise in the world:

1.3m by 2100



By 2050, Louisiana will likely experience extreme temperatures

above 35° C
on 80+ days per year.
(currently <12 days/year)

Legend

- Water Depth
- Low-lying Areas
- Area Not Mapped
- Visualization Location
- Leveed Areas

Risk in Context
National Flood Insurance Program

National Flood Insurance Program
1984 Effective Flood Insurance Rate Map
(FIRM - Paper)



Grey indicates
Special Flood Hazard Zone
- <0.2% Chance/Year
(500-year Flood)

National Flood Insurance Program
1984 Effective Flood Insurance Rate Map Detail
(FIRM - Paper)



National Flood Insurance Program Special Flood Hazard Areas

Based on 1984 Effective Flood Insurance Rate
Map (FIRM)

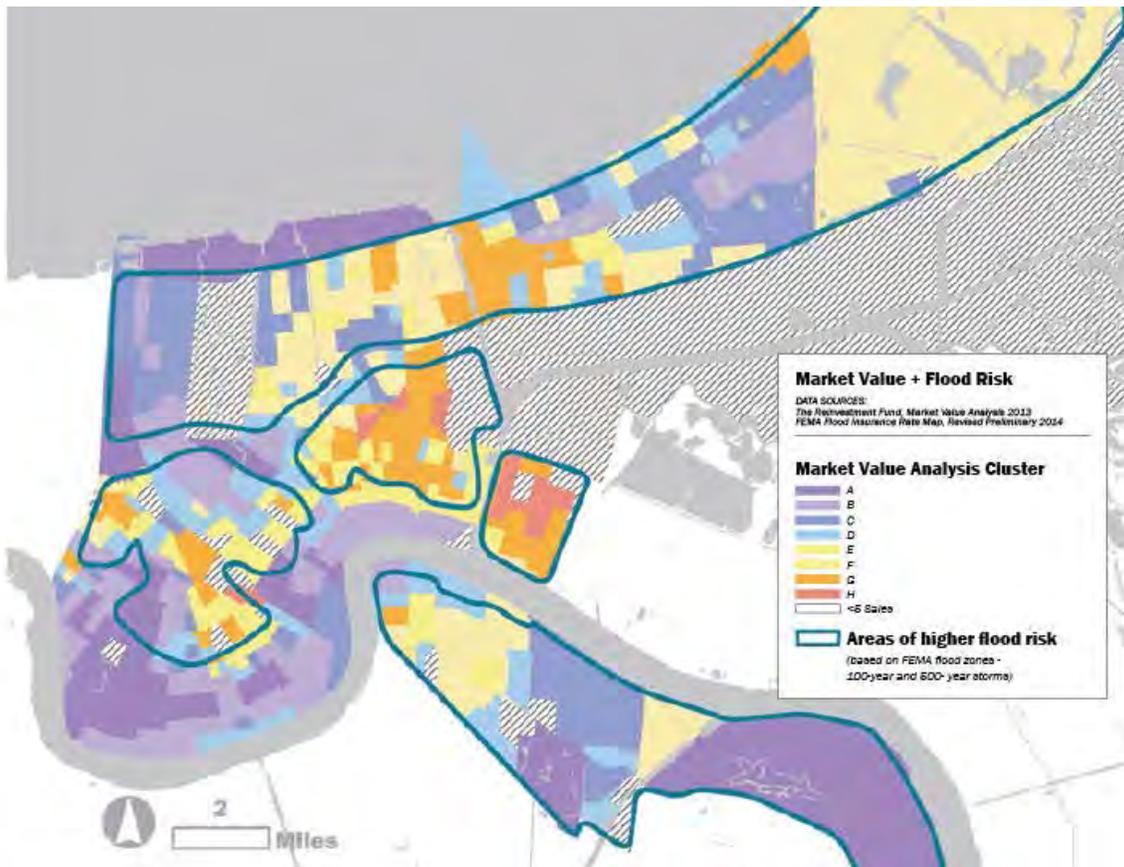
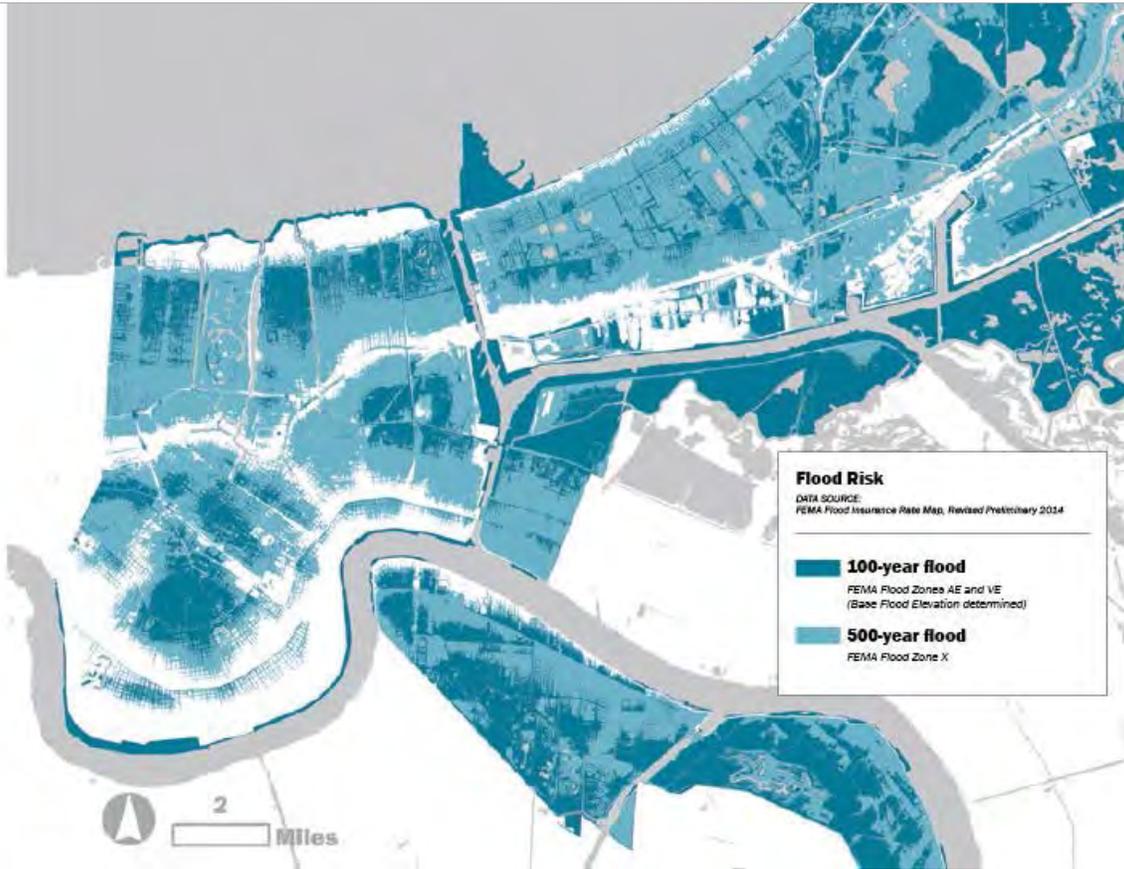
Average Flood Insurance Premium:
\$961/year (Sep 2015)



Blue indicates
Special Flood Hazard Zone
<0.2% Chance/Year
(500-year Flood)

Risk in Context
Disproportionate Flood Risk







Local Flood Risk Mitigation Investment Approach

We are shaping the future New Orleans.

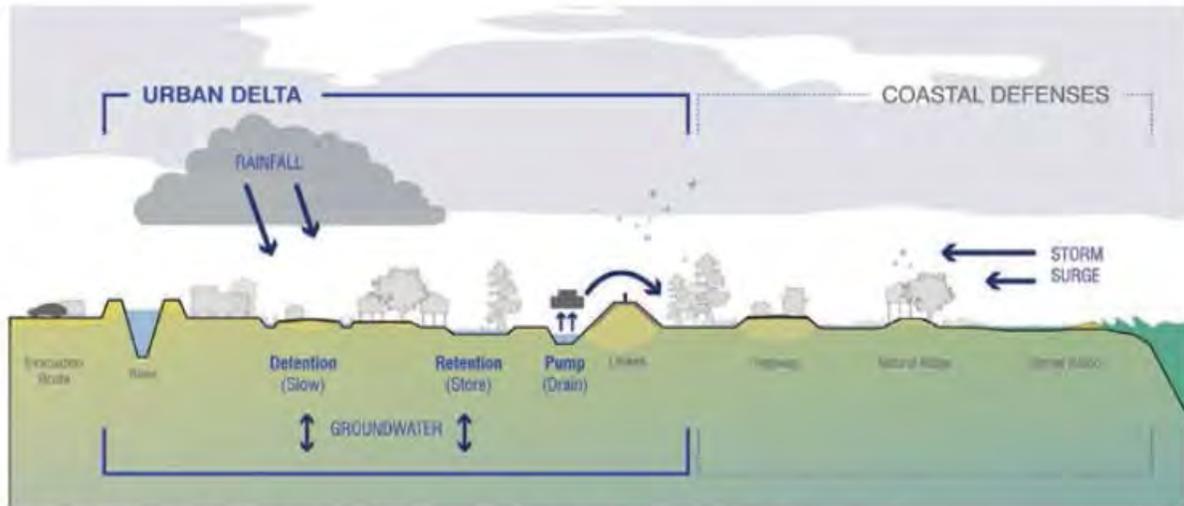
ADAPT TO THRIVE

We are
a city that
embraces
our changing
environment.

We will:

- Advance** coastal protection and restoration
- Invest** in comprehensive and innovative urban water management
- Incentivize** property owners to invest in risk reduction
- Create** a culture of environmental awareness at every stage of life
- Commit** to mitigating our climate impact

From Curb to Coast



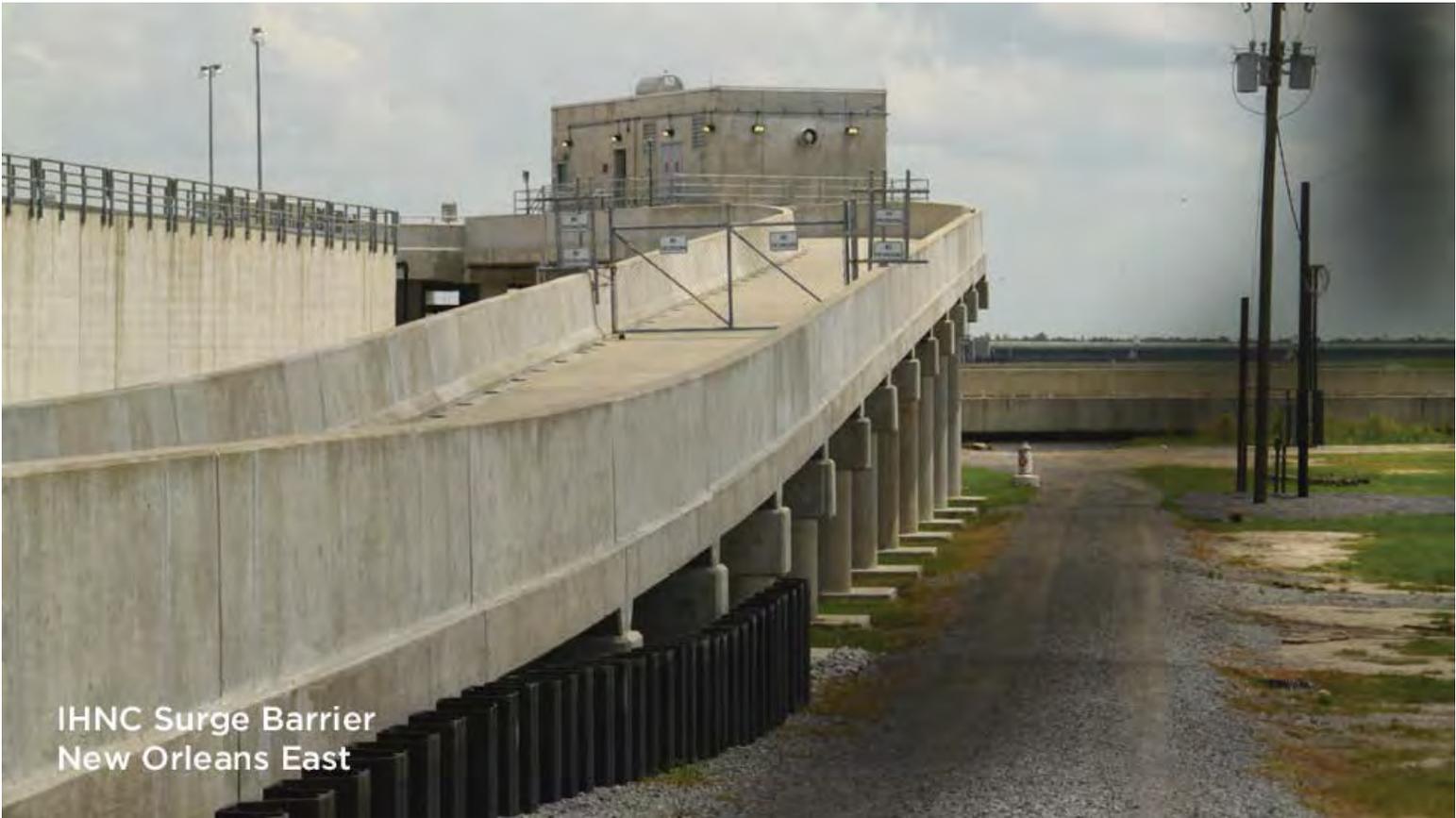
Urban water management and coastal defenses, both critical to a resilient urban delta

Source:
Waggoner & Ball Consulting Team

Flood Risk Reduction Investments Storm Surge Protection



IHNC Surge Barrier
New Orleans East



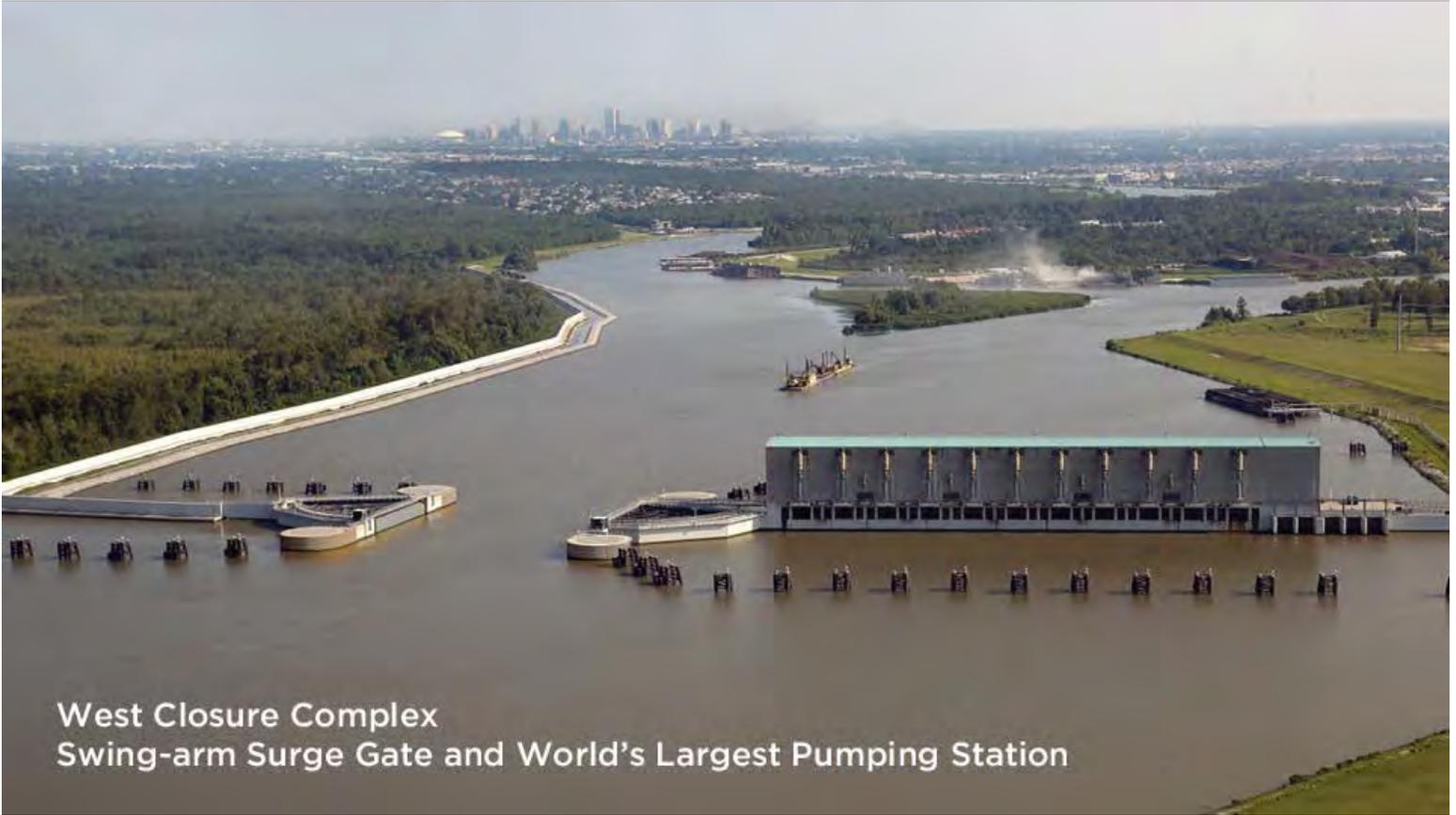
IHNC Surge Barrier
New Orleans East



IHNC Surge Barrier
New Orleans East



West Closure Complex
World's Largest Pumping Station



**West Closure Complex
Swing-arm Surge Gate and World's Largest Pumping Station**

A faded background image of a residential street with houses and trees. A semi-transparent white box is overlaid on the image, containing the text "Flood Risk Reduction Investments Urban Water Management & Integrated Infrastructure".

Flood Risk Reduction Investments
Urban Water Management &
Integrated Infrastructure



17th Street Outfall Canal Lakefront Closure & Pumping Station
Lakeview, New Orleans



17th Street Outfall Canal Wall Improvements
Lakeview, New Orleans



USACE SELA Urban Drainage Projects
Uptown, New Orleans



USACE SELA Urban Drainage Projects
Uptown, New Orleans



1930s WPA Project "Sunken Garden" Precedent
Lakeview, New Orleans



Wildair Rain Garden - Dry
Gentilly, New Orleans



Wildair Rain Garden - Wet
Gentilly, New Orleans



Deslonde Rain Garden - Wet
Lower Ninth Ward, New Orleans



Deslonde Rain Garden
Lower Ninth Ward, New Orleans

Infrastructure Investments Scaling Pilot Projects



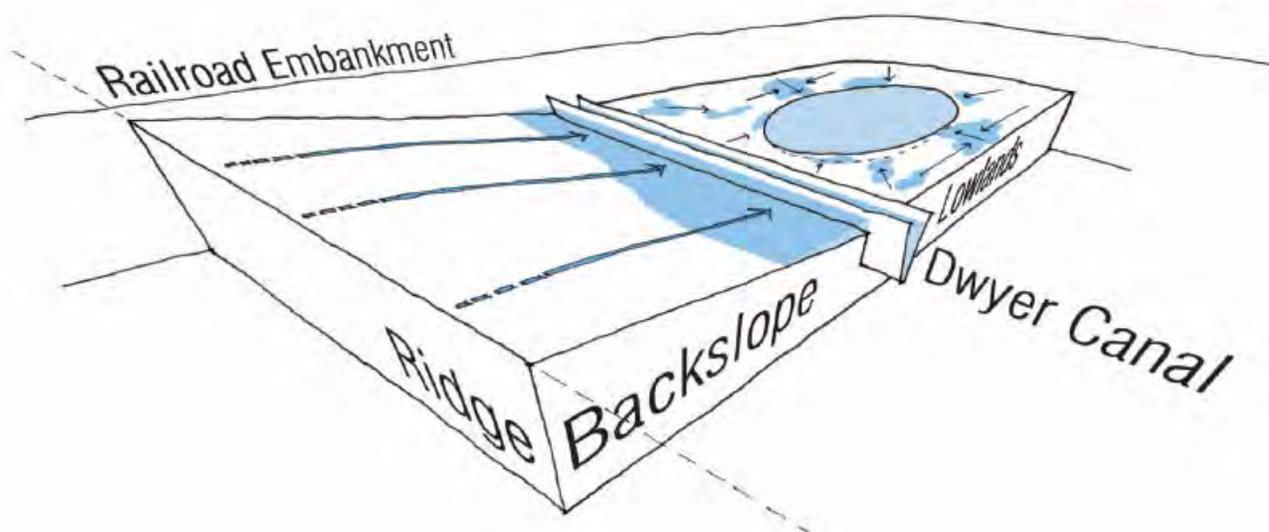
Mirabeau Water Garden



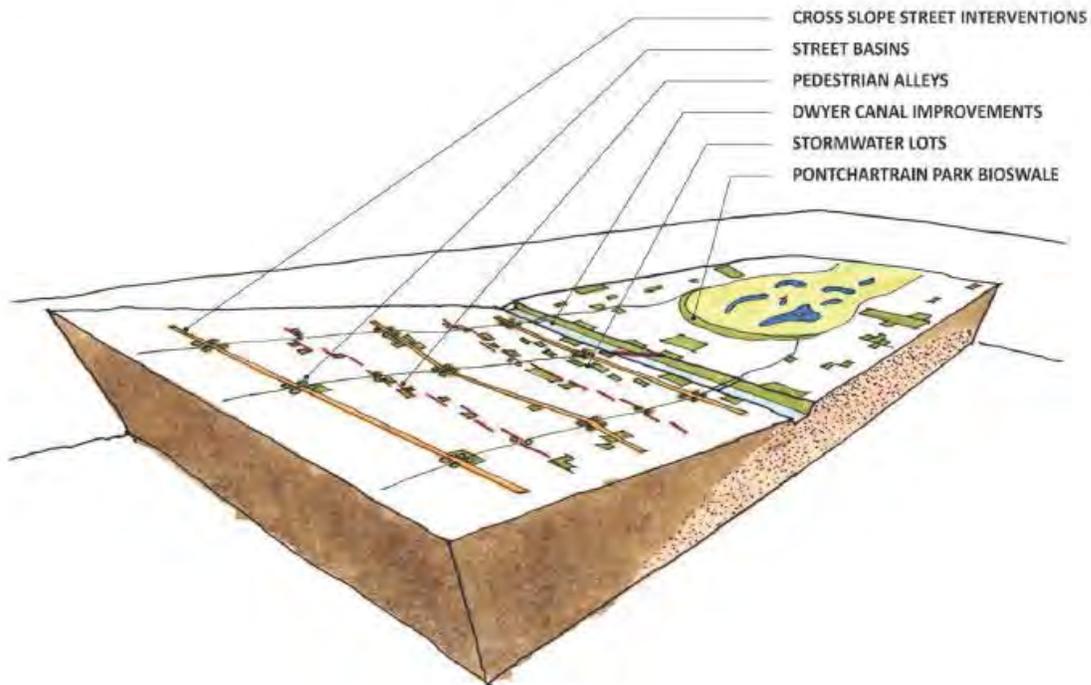
- 25-acre site of former convent of the Sisters of Saint Joseph
- Designed to temporarily store up to 38,000 cubic meters of water to mitigate flooding
- Site will eliminate flooding caused by 10-year storm within watershed.
- Flooding from a 100-year storm will be reduced by 72%.
- Designed to serve as a space for recreation and environmental learning



Pontilly Neighborhood Stormwater Network



Pontilly Neighborhood Stormwater Network



Pontilly Neighborhood Stormwater Network



- Combines improvements to the Dwyer Canal with a network of interventions along streets, in alleyways, and within vacant lots designed to store and slow stormwater
- Will reduce flood risk and beautify green spaces in the Pontchartrain Park and Gentilly Woods neighborhoods

Benefits of the Projects



Reduced risk of flooding and subsidence



Neighborhood beautification & redevelopment



Recreation & health



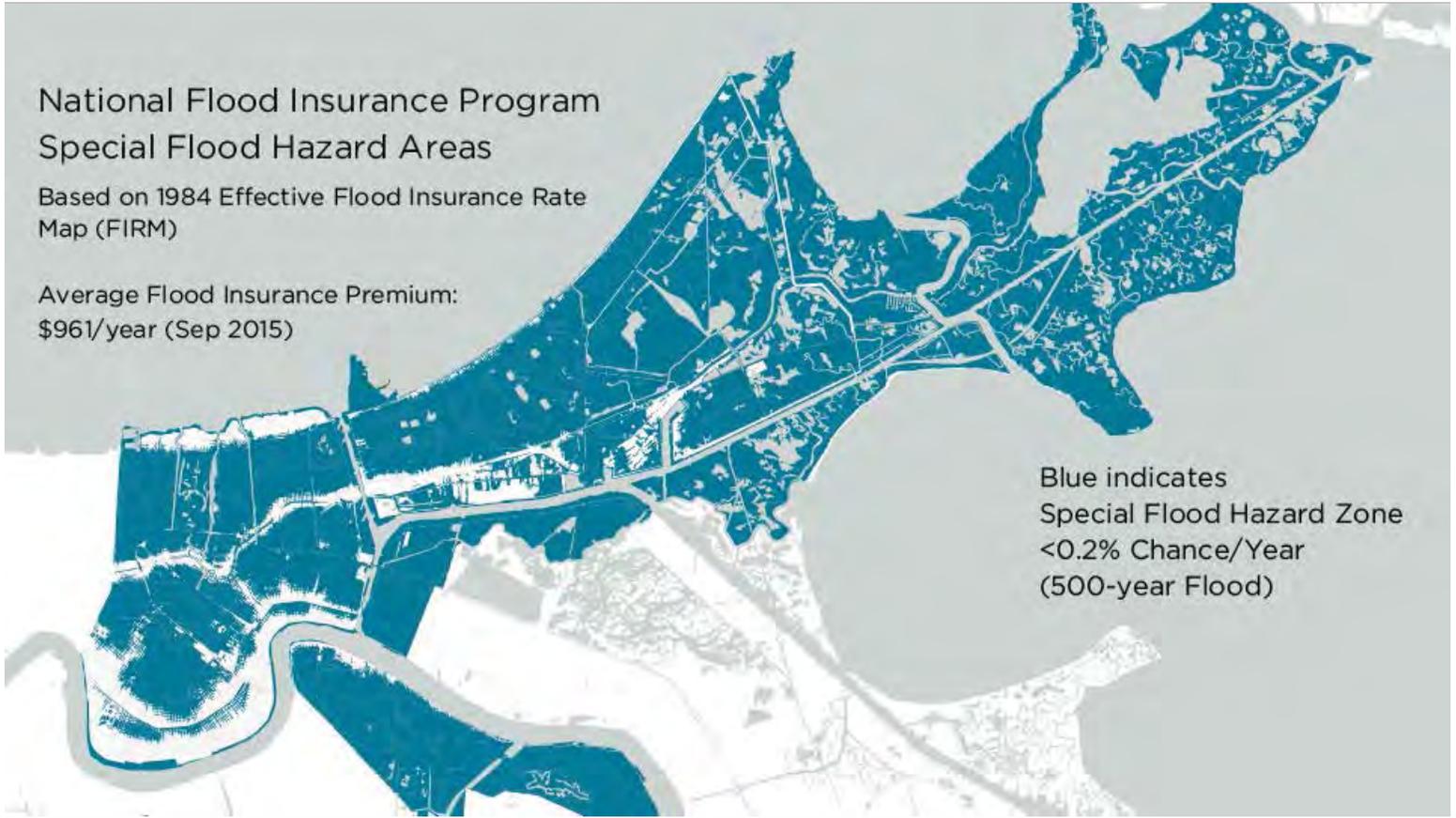
Environmental awareness

Infrastructure Investments
Risk Mitigation Returns

National Flood Insurance Program Special Flood Hazard Areas

Based on 1984 Effective Flood Insurance Rate
Map (FIRM)

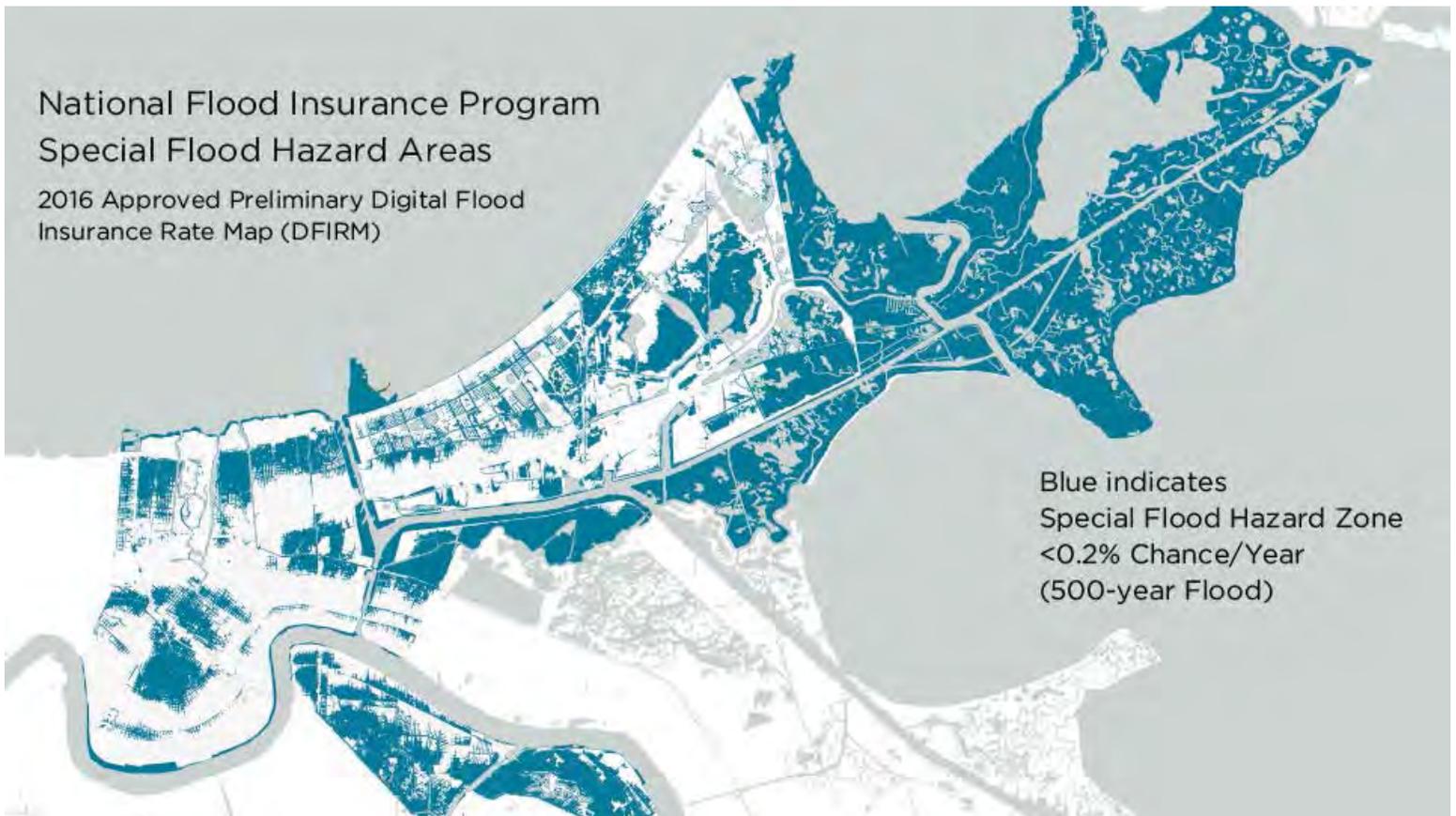
Average Flood Insurance Premium:
\$961/year (Sep 2015)



Blue indicates
Special Flood Hazard Zone
<0.2% Chance/Year
(500-year Flood)

National Flood Insurance Program Special Flood Hazard Areas

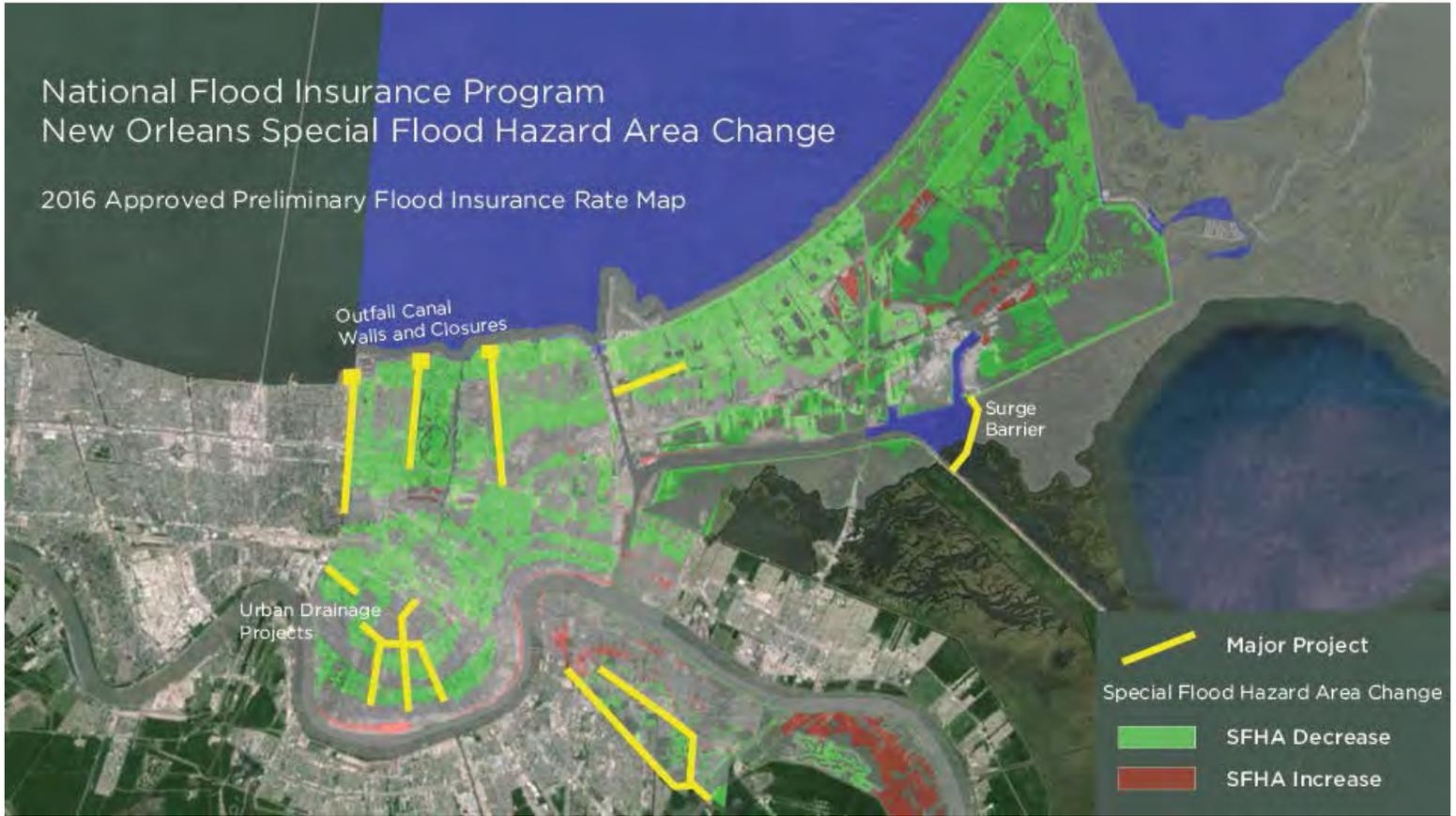
2016 Approved Preliminary Digital Flood
Insurance Rate Map (DFIRM)



Blue indicates
Special Flood Hazard Zone
<0.2% Chance/Year
(500-year Flood)

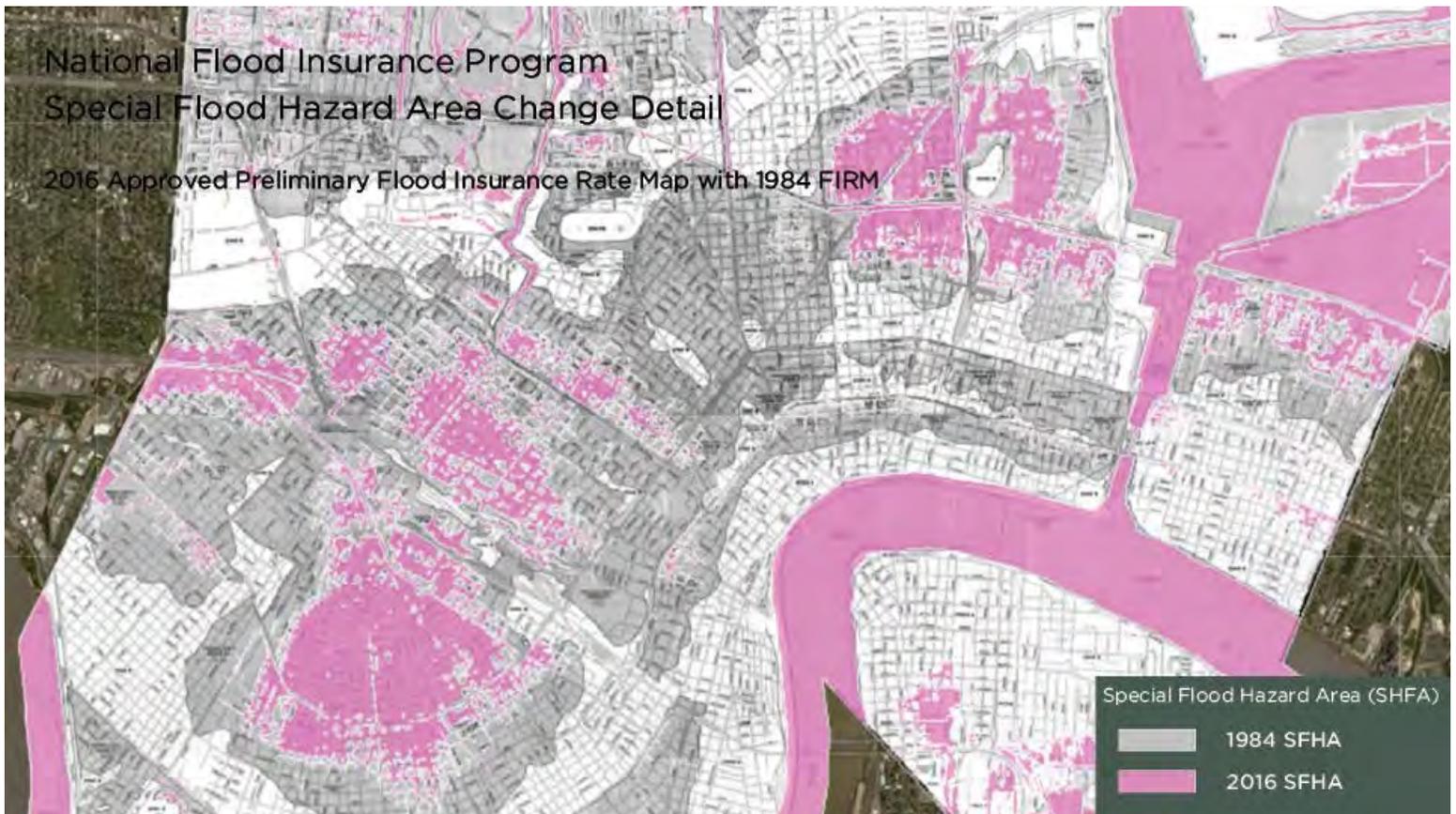
National Flood Insurance Program New Orleans Special Flood Hazard Area Change

2016 Approved Preliminary Flood Insurance Rate Map



National Flood Insurance Program Special Flood Hazard Area Change Detail

2016 Approved Preliminary Flood Insurance Rate Map with 1984 FIRM



Results of New Flood Insurance Rate Map (FIRM) Adoption:

Insurance rates will decrease for approx. 53% of properties

Rates will increase for approx. 3% of properties.

Avg. flood policy in New Orleans: \$961

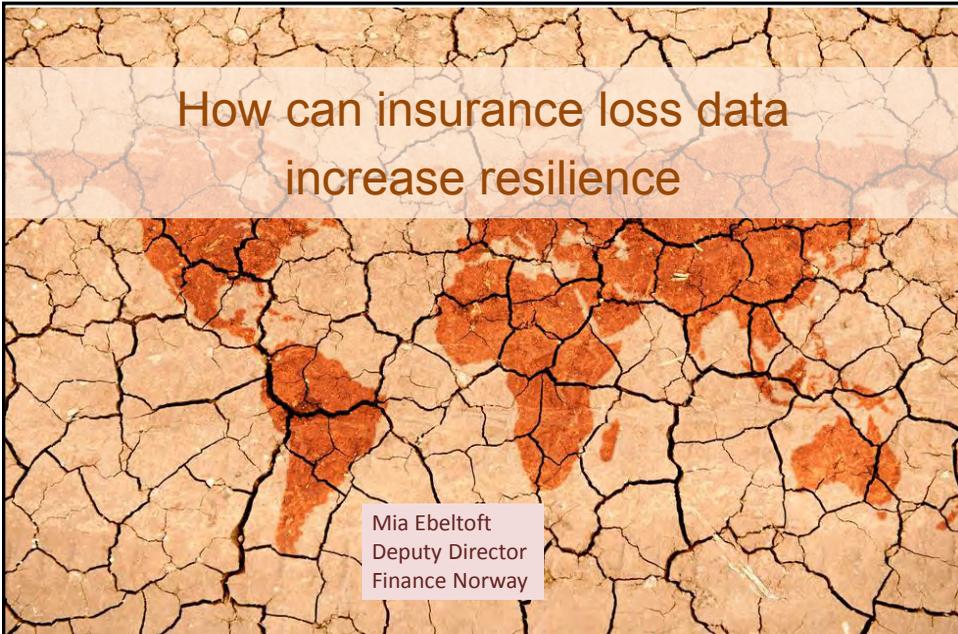
Those in new "X zones" will be <\$500 for \$250k coverage

City is working with FEMA to adopt latest building codes to achieve 5% premium reductions in 2017.



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How can insurance loss data increase resilience

Mia Ebeltoft
Deputy Director
Finance Norway

OECD Conference on the Financial Management of Flood Risk,
Paris, May 12/13, 2016



Norwegian insurance system

- Nat Cat= Act of God - not risk-based
- Solidarity system- “no one`s fault”
- Urban flooding= not an “Act of God”

- Included in property insurance = nearly 100 % penetration

Property insurance

- Fire
- Theft
- Water& Urban flooding

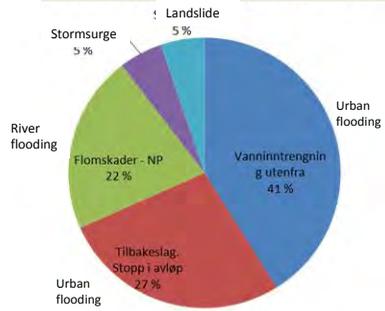
Natcat coverage automatic included (mandatory) under the “fire” insurance



Urban flooding: 70 % of insurance loss



Insurance pay outs 2008 - 2014

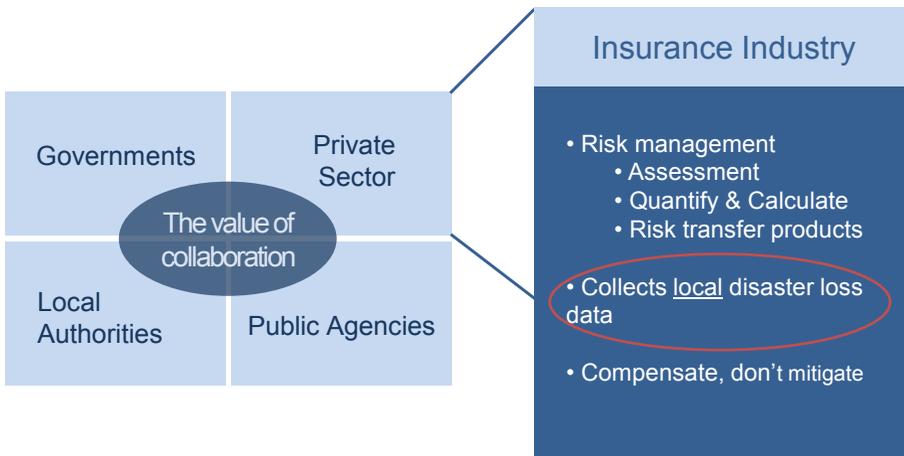


Blue+red
= Urban
flooding



3

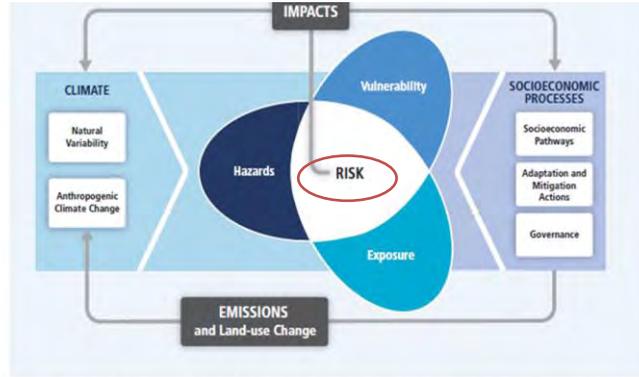
Holistic risk picture: You need collaboration cross sectors



4

Insurance loss data help authorities (mitigators) understand

risk



Source: IPCC

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Pilot project:
Using insurance claims data to strengthen municipalities' efforts to prevent climate-related natural hazards

Collaboration project between Finance Norway
Western Norway Research Institute
Norwegian University of Science and Technology

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What kicked off the project

- Increase in precipitation combined with old water and sewage-infrastructure have lead to increase in damages and insurance claims
- Frustrated customers – repetitive damage (same locations)
- The Municipalities don't have data showing risk- and vulnerable areas
- Municipalities have tried to get insurance loss data from insurance
- Needed exemption from data protection law



What kicked off the project?



- **In order to improve adaptation, and to be able to prioritize, and to take the right, optimal decisions, you need to understand what is at risk and where are the "risk zones" (vulnerable areas).**
- **The report NOU2010:10 recommended to (and by that challenges the insurance industry):**
 - "Establish a database for **public use and research** using aggregate, anonymised data on climate-related damage from the insurance companies and the Norwegian Natural Perils Pool"».



First joint «public/private» project

- Initiated by Finance Norway - lead the project in close connection with researchers
- Financed by Finance Norway and partly the Ministry of Climate and Environment
- Build on dialog and feed-back from municipalities
- Ten pilot municipalities joined
- Project period: Sept 2013 to Feb 2015



Finance Norway

Main goals

- Understand how insurance loss data can help climate - resilient work in the municipalities
- Strengthen municipalities' knowledge base for preventing water-related natural hazards
- Secure and preserve an insurance system against nature- and water-based hazards
 - Avoid an increasing number of damages and
 - Higher premiums, more differentiated premiums and withdrawal of insurance coverage

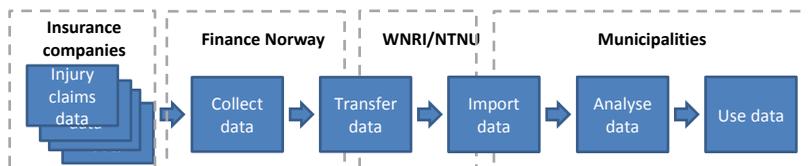
Finance Norway

Type of data

- Type of insurance loss data
 - Loss data down to address
 - Nat Cat loss data: storm, storm surge, river flooding, landslides
 - Storm water and back flow damages (urban flooding)
 - Private, companies and municipalities building
- Other indicators
 - Damage date, cause of damage, amount paid in compensation



The project step-by-step

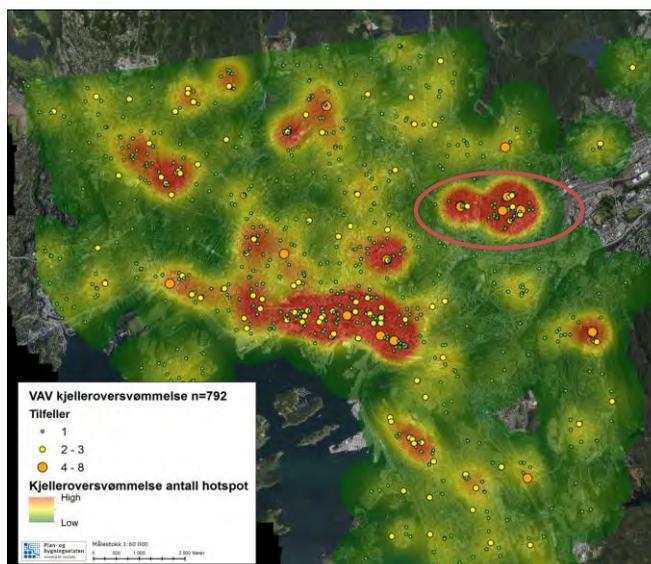


Main conclusion

- Generally
 - Increase collaboration within the municipalities (planning og technical)
 - Got new insights into risks previously unknown
 - Improved understanding of how climate change affects society
- Land-use planning
 - Improved knowledge base to
 - select areas with the lowest possible risk of natural hazards
 - prioritize security measures
- Construction and maintenance of water and sanitation
 - Improved knowledge base for
 - prioritizing management, maintenance, rehabilitation, and reinvestment
 - collaboration between municipal water/sanitation and planning units
- Preparedness
 - Improved knowledge base for risk and vulnerability analyses

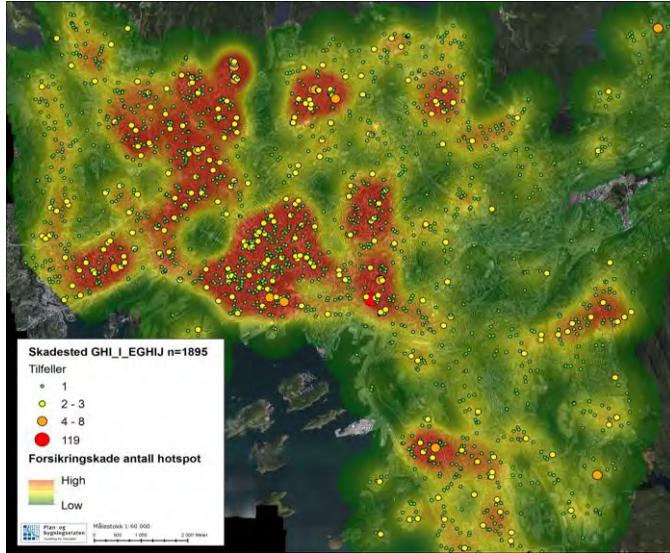
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Oslo city's own loss data



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Insurance urban flooding loss data



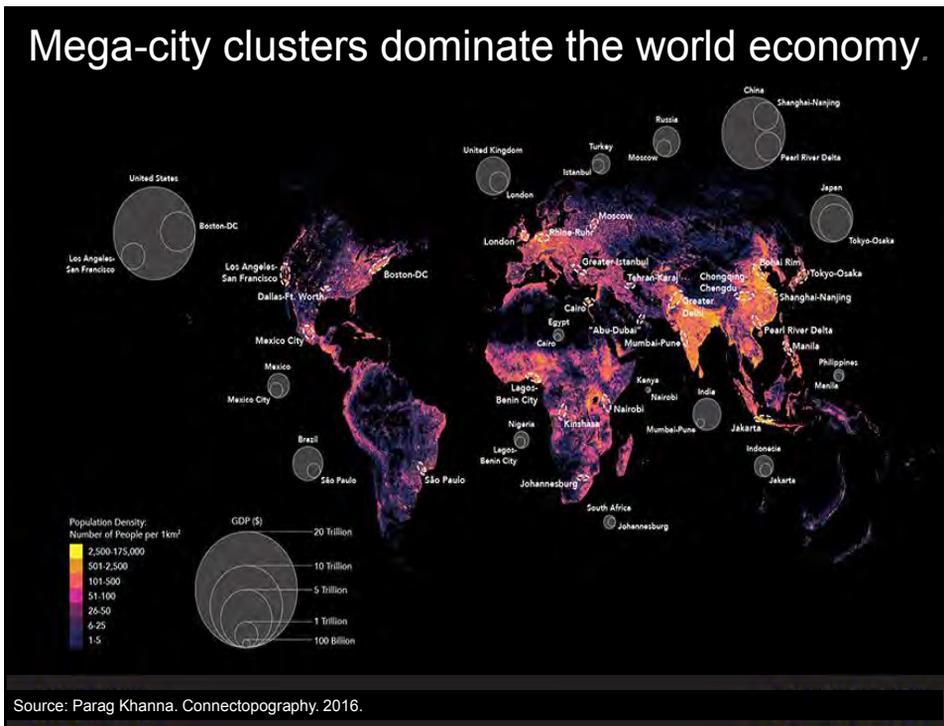
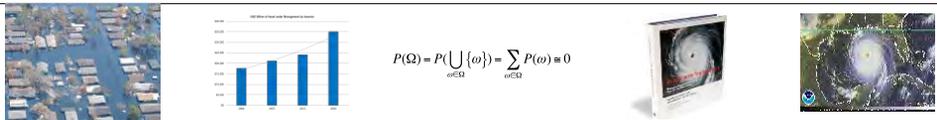


Improving Resilience to Flood Risk: The case of New York City

Erwann O. MICHEL-KERJAN

Executive Director, Wharton Risk Management and Decision Processes Center
Chairman, OECD Board on Financial Management of Catastrophes
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OECD Conference on the Financial Management of Flood Risk:
Building Financial Resilience
May 2016



A case study with one of the largest cities in the world, New York



Key Questions from the Mayor's Office

What are current *and* future flood risk levels in NYC?
 Can we quantify these in a transparent manner?

Which **strategies** could be implemented to reduce the costs of future floods and save lives?

-What are their respective **costs** and **benefits**?

-Is it economically beneficial for NYC to invest *today* in making buildings flood resilient, or in flood-protection infrastructure?

-**Who should pay** for such investments? What **innovative financial instruments** can be designed to do so?

Wharton
UNIVERSITY OF PENNSYLVANIA

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(MIT)



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Why the New York Area?

- One of the largest coastal mega-cities
- **Important economic hub** for the U.S. and international community (tourism, trade, financial markets)
- High urban exposure to flooding
- **\$80 billion flood-related losses** from Superstorm Sandy in 2012
- Massive impediments to flood resilience (**8 out of 10** residents and **9 out of 10** small businesses were **uninsured** against flood losses)
- Costly delays in restoring and upgrading damaged infrastructure

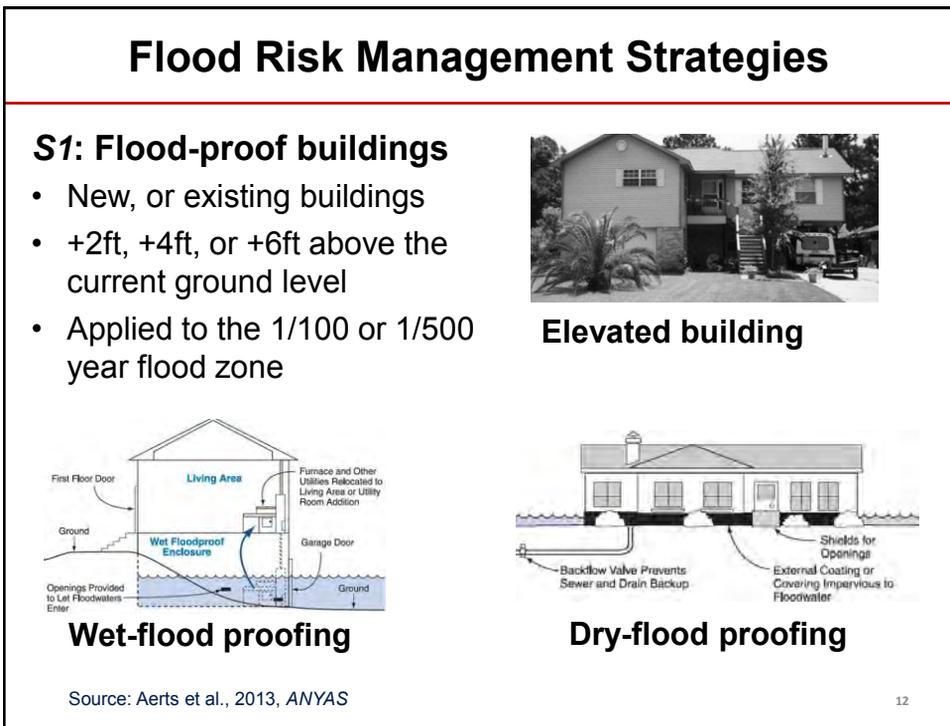
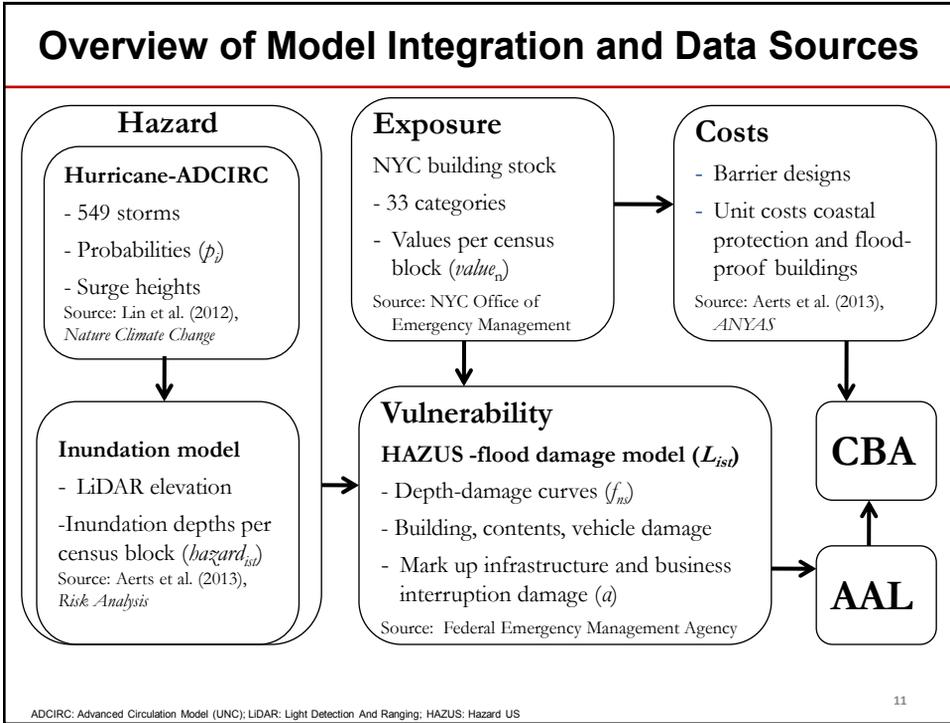
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Sandy 2012



First, one needs to assess flood risk





S2a: Flood Protection 'Environmental Dynamics'



Three storm surge barriers

- Arthur Kill
- Verrazano Narrows
- East River

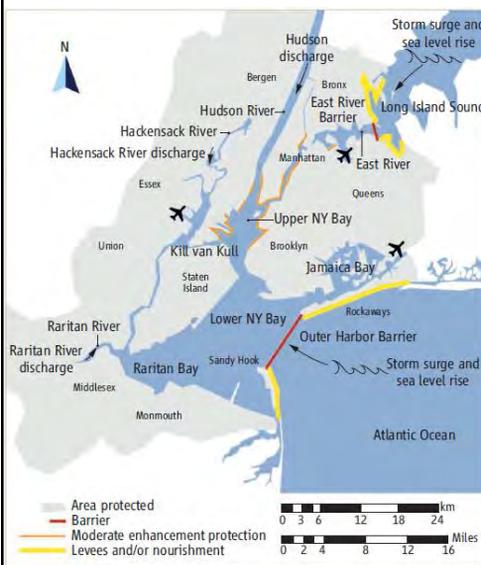
Coastal protection near barriers

Open system to preserve ecosystem dynamics



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S2c: Flood Protection Barrier NYC-New Jersey (NJ)



Large outer harbor barrier

Large reduction coastline

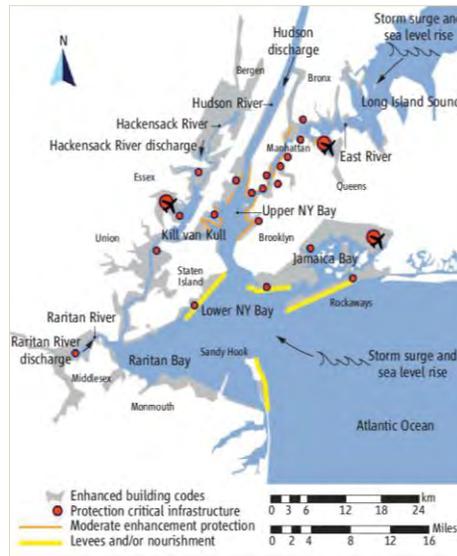
Protects larger area in NJ

May disrupt water flows



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S3: Hybrid Solution of Local Protection



Sources: Aerts, Botzen, Emanuel, Lin, de Moel, and Michel-Kerjan (2014). *Science*, Vol. 344.

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Overall Methodology and Model Framework

Steps for economic evaluation of each strategy:

- 1) Estimate the investment and maintenance costs (C_t)
- 2) Estimate the reduced (t) average annual flood loss (B_t)
- 3) Cost-Benefit Analysis over a time horizon (T) (here, 100 years)

$$\text{Net Present Value} = NPV = \sum_{t=1}^T \frac{(B_t - C_t)}{(1+r)^t}$$

$$B/C \text{ ratio} = \sum_{t=1}^T \frac{(B_t)}{(1+r)^t} / \sum_{t=1}^T \frac{(C_t)}{(1+r)^t}$$

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Main Uncertainties Accounted for in the CBA

Lifetime barriers: $T=100$ or 150 years

Investment timing barriers: delay by 25 years

Discount rate: $r=7\%$ or $r=4\%$ (aligned with EPA: 2.5%; White House: 3%-to-7%)

Effectiveness dry and wet flood-proofing:
high (-88% and -50%) or low (-75% and -30%) scenarios

Model uncertainty: 95% confidence interval based (Aerts et al., 2013, *Risk Analysis*)

Climate change effects on risk: 4 Global Circulation Models (Lin et al., 2012, *Nature Climate Change*) and 2 NYC sea level rise scenarios (NPCC, 2010)

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Results (communicated to NYC Mayor's Office and other decision makers)

	Where/ how much	Environ.dyn. S2a	Bay closed S2b	NJ-JY connect S2c	Hybrid solution S3
Costs					
Total investment	NYC	\$16.9–21.1 billion	\$15.9–21.8 billion	\$11.0–14.7 billion	\$6.4–7.6 billion
Total investment	NJ	\$2 billion	\$2 billion	n/a	\$4 billion
Total investment	NYC+NJ	\$18.9–23.1 billion	\$17.9–23.8 billion	\$11.0–14.7 billion	\$10.4–11.6 billion
Maintenance	NYC+NJ	\$98.5 million	\$126 million	\$117.5 million	\$13.5 million

None of these strategies are cost effective (too expensive) for the City of New York if implemented today and paid by the city alone

Middle climate change scenario: GFDL climatology model (higher storm frequency and SLR) from NOAA's Geophysical Fluid Dynamics Laboratory

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Who Should Pay for NYC's Resilience Investments?

- A city that generates significant positive externalities to the rest of the U.S. (trade, tourism, port) and the world (financial market)
- If positive externalities are captured and the cost is shared more widely, then the benefit-cost ratio will make these resilience investments much more appealing financially for the city

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A Proposal for "Resiliency Investment"

Possible Solutions:

1) NYC issues a "**Resiliency Bond**" to cover their share (spreads upfront cost; designed according to a specific standard)

2) Establish a **NYC Resiliency Fee** to be paid by all tourists who visit the city (similar to the current 9/11 security fee on each airplane ticket)

$\$10 * 50 \text{ million tourists/year} = \$500 \text{ million/year} = \$5\text{bn in the next 10 years}$

Sources:

E. Michel-Kerjan (2012). **How Resilient Is Your Country?**, *Nature*, vol. 491.

E. Michel-Kerjan (2015). **We Must Build Resilience into our Communities**. *Nature*, vol. 524.

E. Michel-Kerjan (May 2015). **Resiliency Investment: Insurers As Game Changers**. Scor Conference/COP21

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Since 2010 the Wharton Risk Center has published over **100 journal articles, reports, working papers or policy Briefs** on flood risk, resilience and insurance.

All accessible at:

<http://opim.wharton.upenn.edu/risk/papers>

