HURRICANE RISK REDUCTION PROGRAM NEW ORLEANS –

STRUCTURAL SOLUTIONS AND RESILIENCE

Mathijs van Ledden

Royal Haskoning

COASTAL RESILIENCE SYMPOSIUM

HOUSTON

MAY 26 2010

Background

Personal background:

Msc at Delft University (1998)

PhD at Delft University (2003)

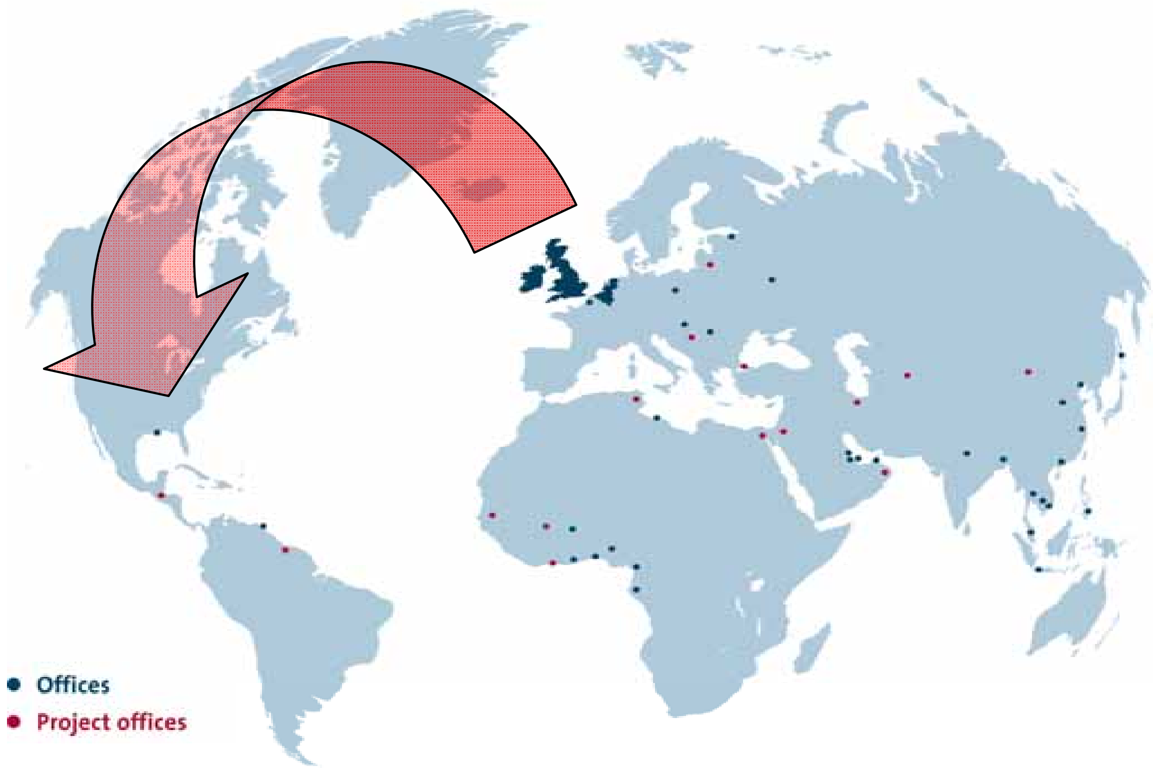
Joined Royal Haskoning in 2003

Moved to New Orleans in 2006

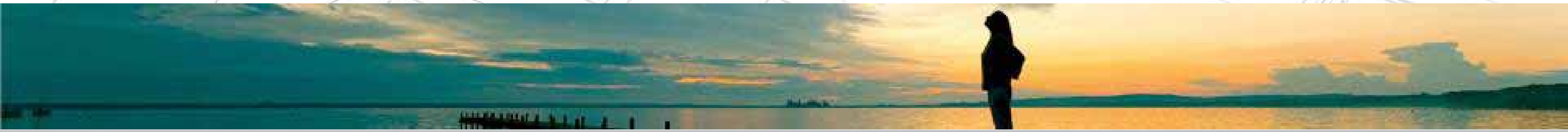
MBA at Tulane University (2010)

Royal Haskoning:

- Global consultancy firm with strong Dutch roots (1881!)
- Framework contract with USACE in 2006
- Five permanent staff and 20 temporary workers in New Orleans project



Topics for today's talk



- **Coastal challenges**
  - Storm surge threat
  - Climate change
- **Structural solutions and resilience**
  - Barriers, levees and floodwalls
  - Resilience criteria
- **Example: IHNC barrier, New Orleans**
  - Application of resilience criteria
  - Progress

Zeeland (1953) Netherlands

Wind: 150 km/hour (Cat 1)
Surge: +6m MSL
Casualties: ~2000
Damage: $ 50 bln.

Katrina (2005) New Orleans

280 km/hour (Cat 5)
Surge: +9m MSL
Casualties: 1836
Damage: $ 120 bln.

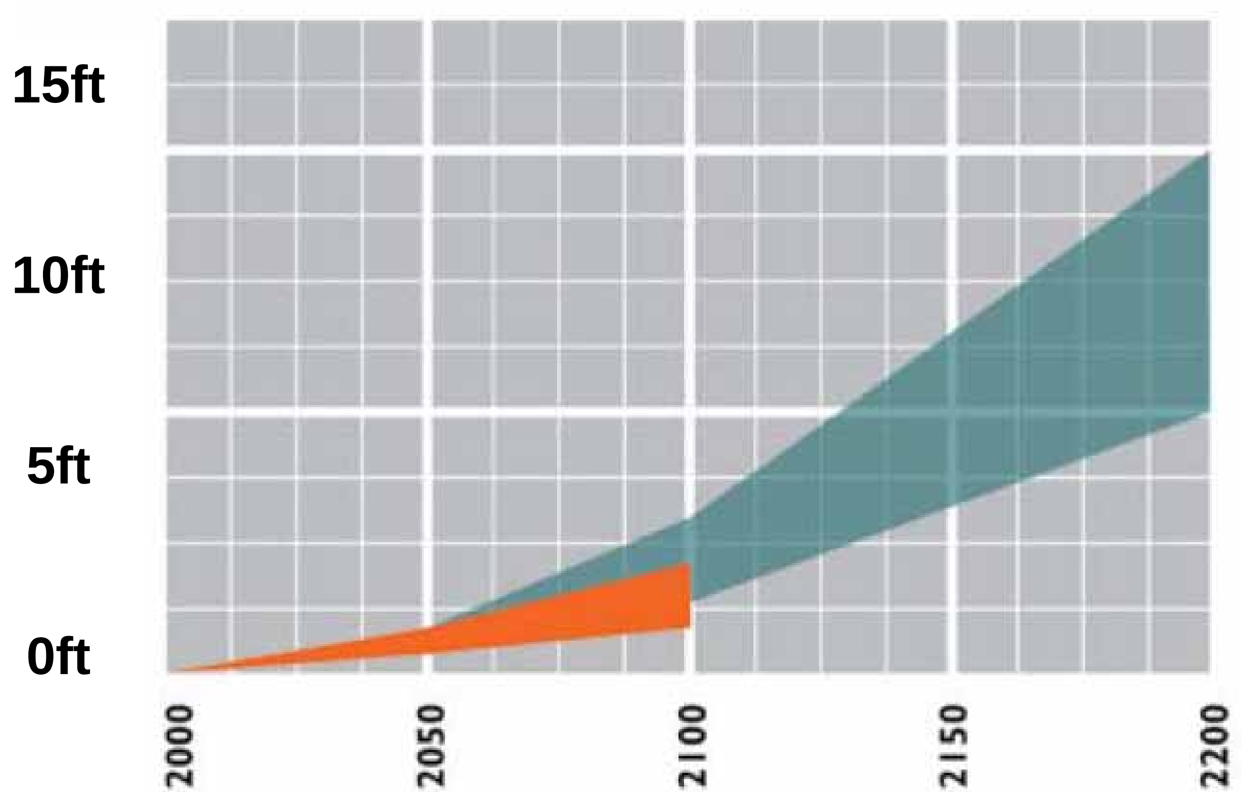
Ike (2008) Galveston

280 km/hour (Cat 4)
Surge: +6m MSL
Casualties: ~200
Damage: $ 40 bln.

Climate change

- ***Climate change*** cannot be ignored in master planning of resilient coastal solutions
- Example: Delta Plan for the Netherlands “Together working with Water”
- 12 recommendations for implementation based on outlook up to 200 years

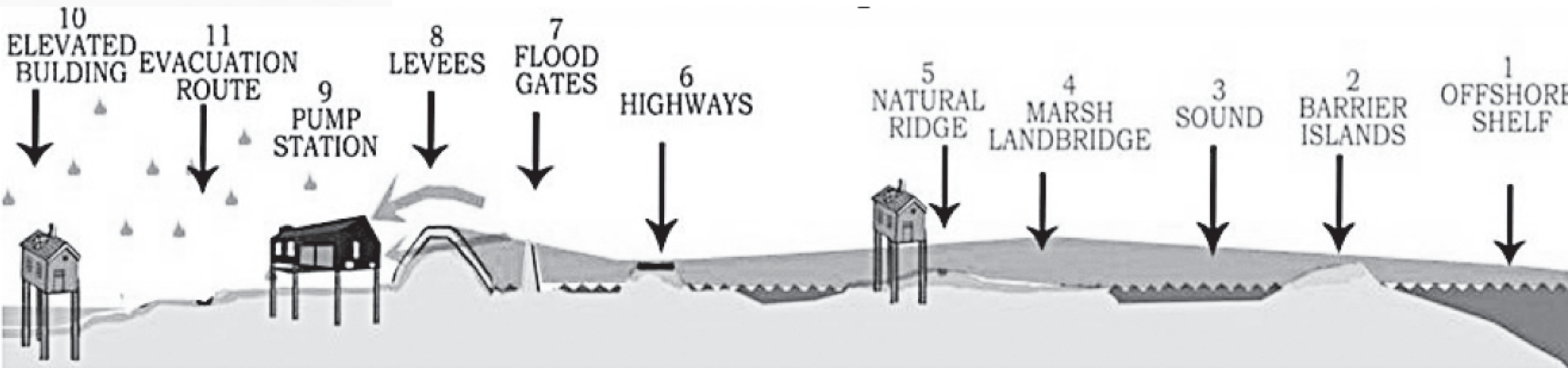
Sea level rise (w/o subsidence)



Source: Dutch Delta committee 2008

Wide array of solutions

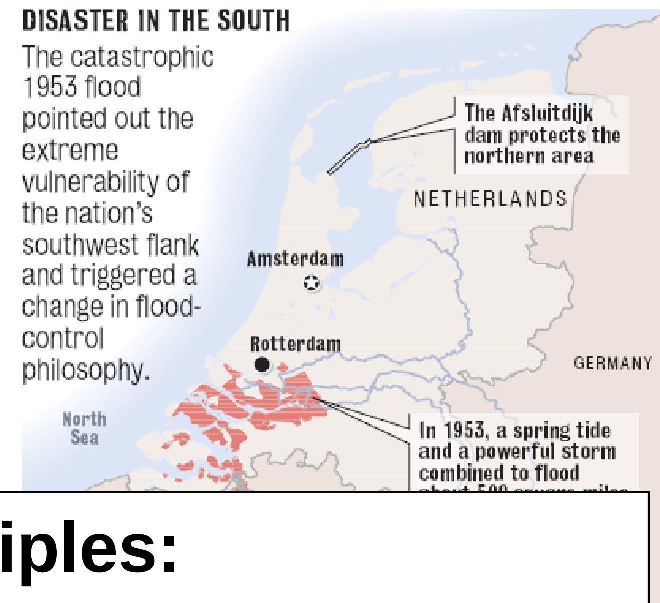
- Structural solutions are ***one*** element of reducing risk in flood-prone areas
- Others are marshes, barrier islands, spatial planning, evacuation, etc.
- “One size fits all” does not exist:
  - Find the ***right mix*** for each situation (political, physical, financial, etc.)
  - Make it ***adaptable*** in an uncertain world



With Surge

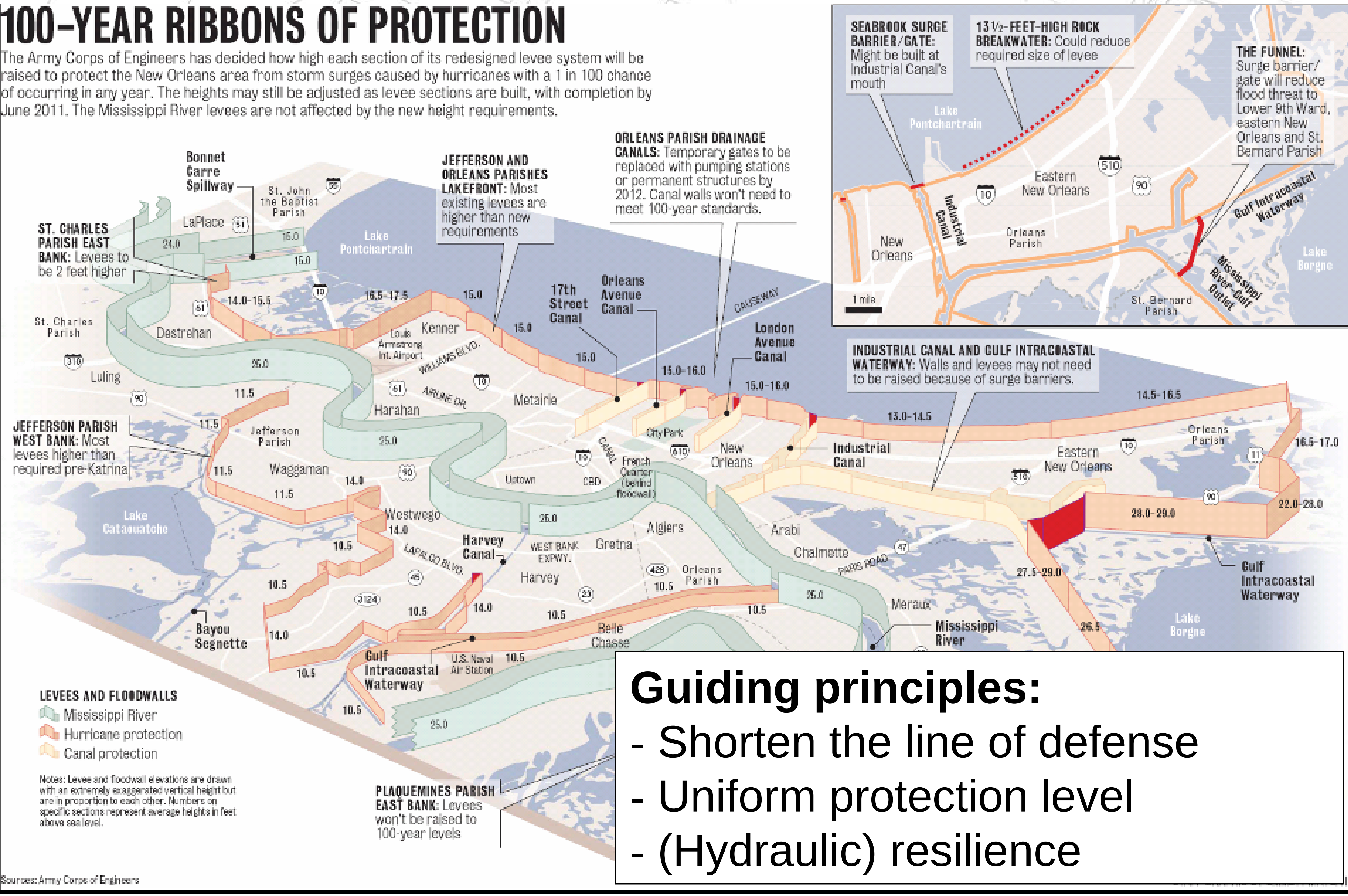
Structural solutions

Much of the Netherlands is below sea level, in some places 20 feet below, a vast outwash where three major European rivers wind their way to an often violent North Sea. Not surprisingly, water management is a national religion, and today the Netherlands is the global gold standard in flood control.



Guiding principles:
- Shorten the line of defense
- Differentiate in protection levels
- Use flexible solutions if possible
- Resilience?

Hurricane Risk Reduction System

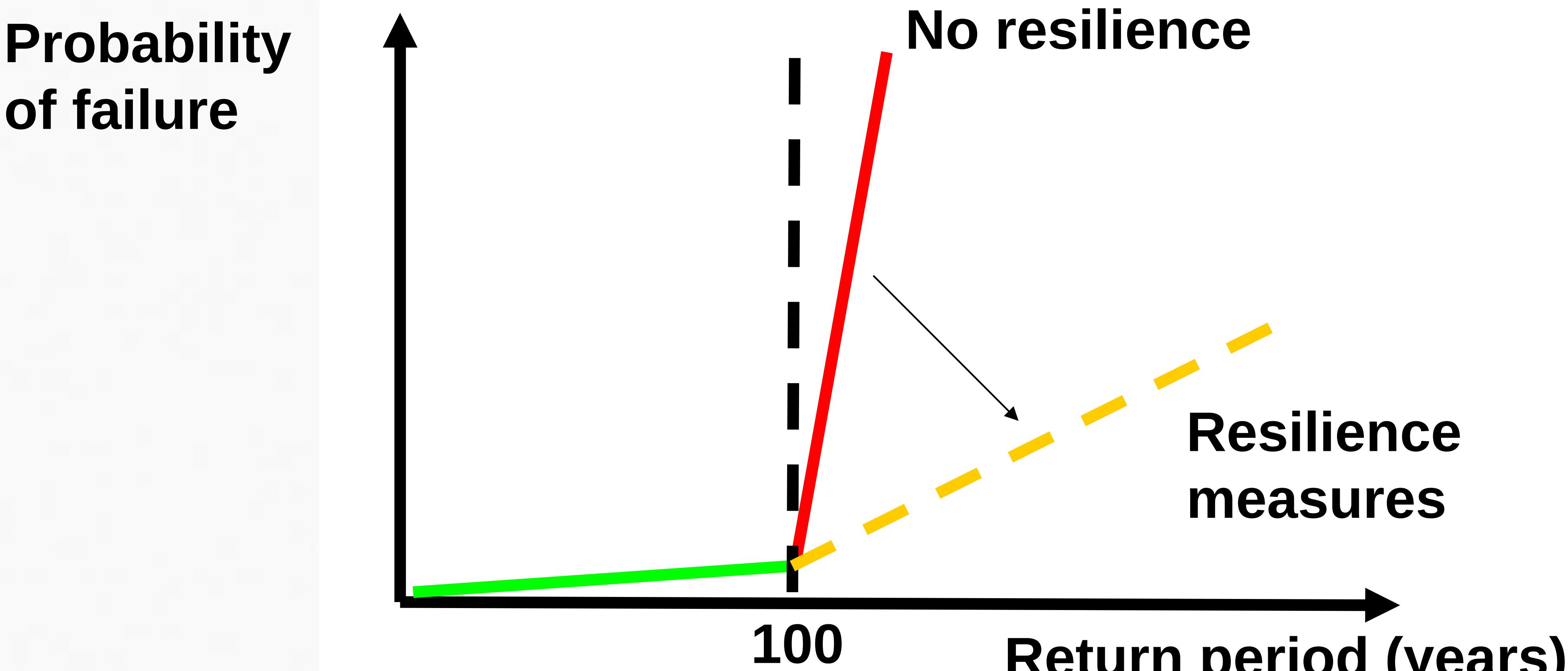


Guiding principles:

- Shorten the line of defense
- Uniform protection level
- (Hydraulic) resilience

Resilience in design criteria (1)

Definition structural resilience: the ability to withstand events ***higher*** than the design event



Resilience in design criteria (1)

Examples of resilience measures:

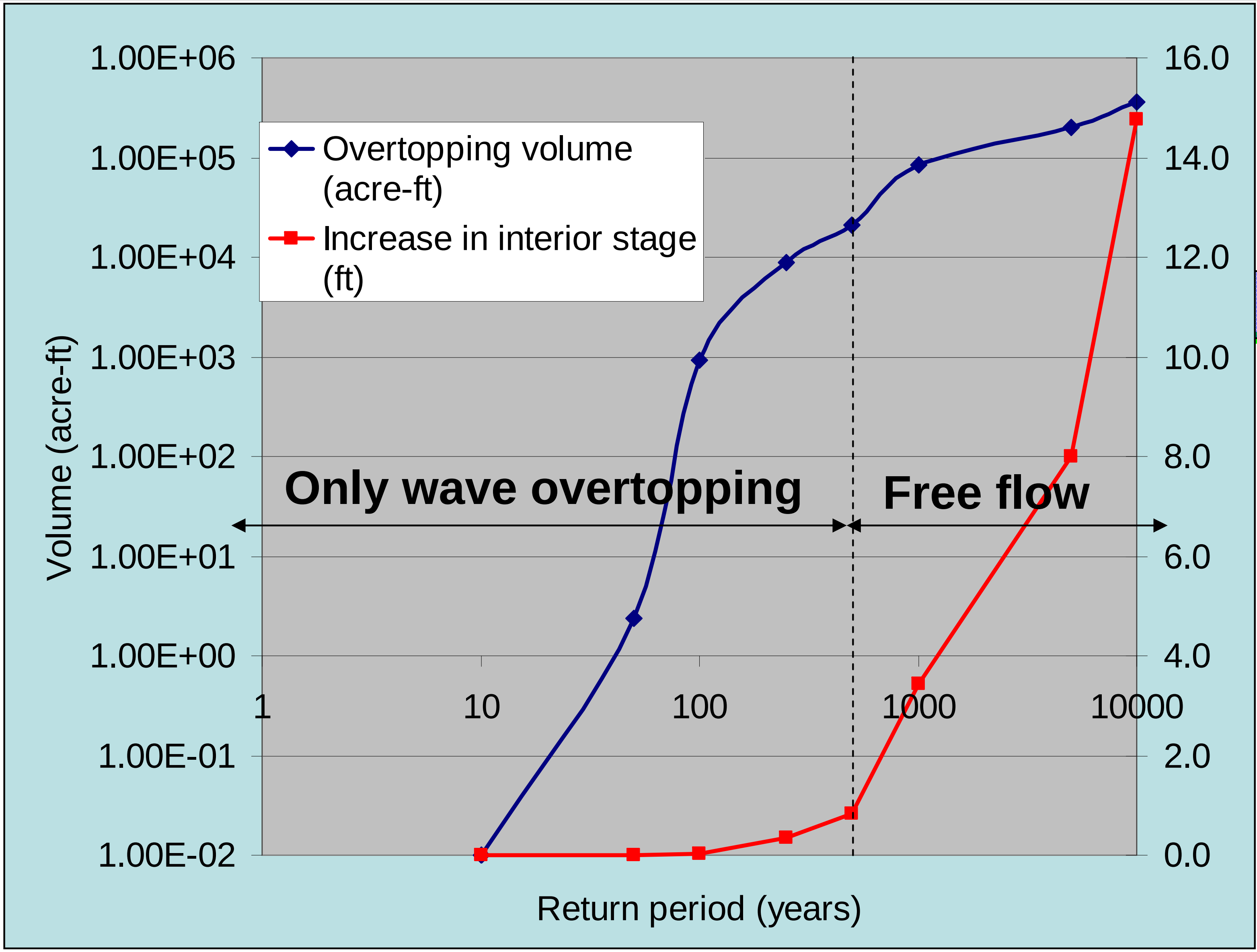
- Add armoring to prevent catastrophic breaching
- Introduce checks for higher design events with lower safety factors

When important?

- Low to modest design standards
- Strong increase in hazard (surge, waves) or consequences for events above design event

Resilience in design criteria (3)

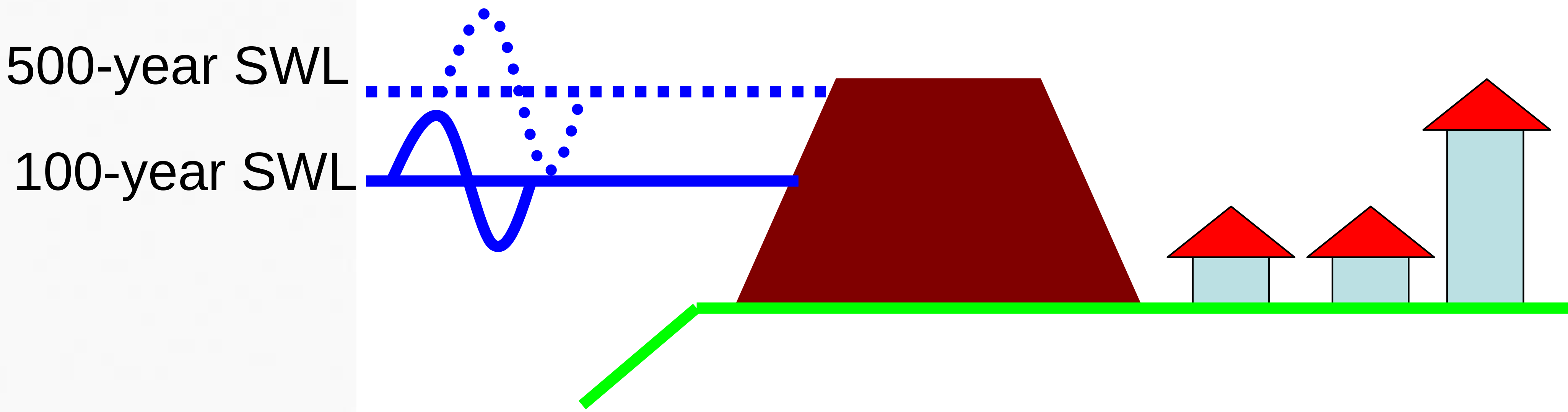
Example
100-yr design



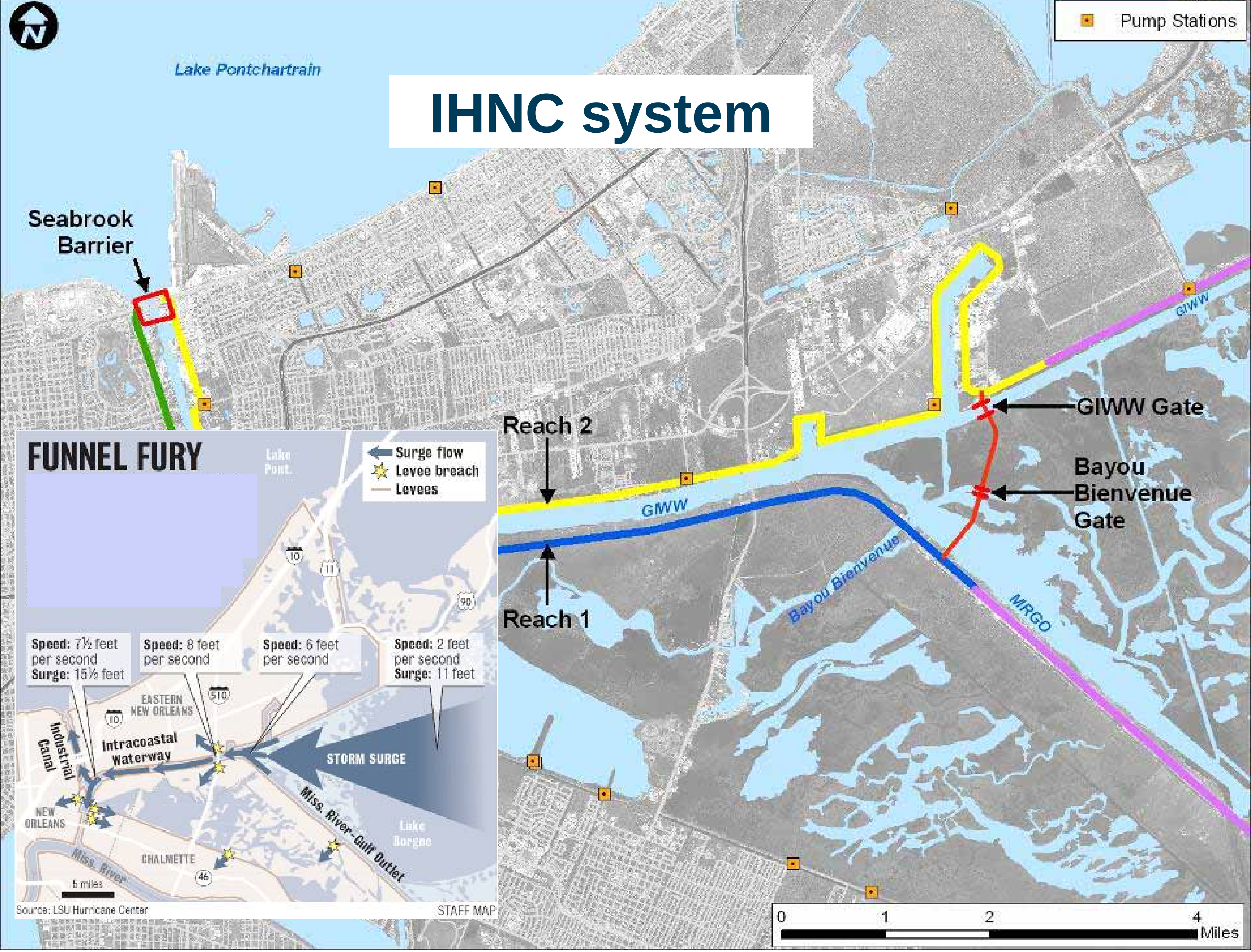
Resilience in design criteria (4)

Hydraulic resilience criteria:

- All design elevations are higher than the 0.2% event still water level
- Wave forces and overtopping rates are calculated for 0.2% event and being used to analyze structural / geotechnical behavior



IHNC system



Pump Stations
Lake Pontchartrain
Seabrook Barrier
Reach 2
Reach 1
GIWW Gate
Bayou Bienvenue Gate
GIWW
Bayou Bienvenue
MRGO
0 1 2 4 Miles
FUNNEL FURY
Surge flow
Levee breach
Levees
Lake Pont.
Speed: 7½ feet per second
Surge: 15½ feet
Speed: 8 feet per second
Speed: 6 feet per second
Speed: 2 feet per second
Surge: 11 feet
EASTERN NEW ORLEANS
Industrial Canal
Intracoastal Waterway
STORM SURGE
Miss. River-Gulf Outlet
NEW ORLEANS
CHALMETTE
Miss. River
Lake Borgne
5 miles
Source: LSU Hurricane Center
STAFF MAP

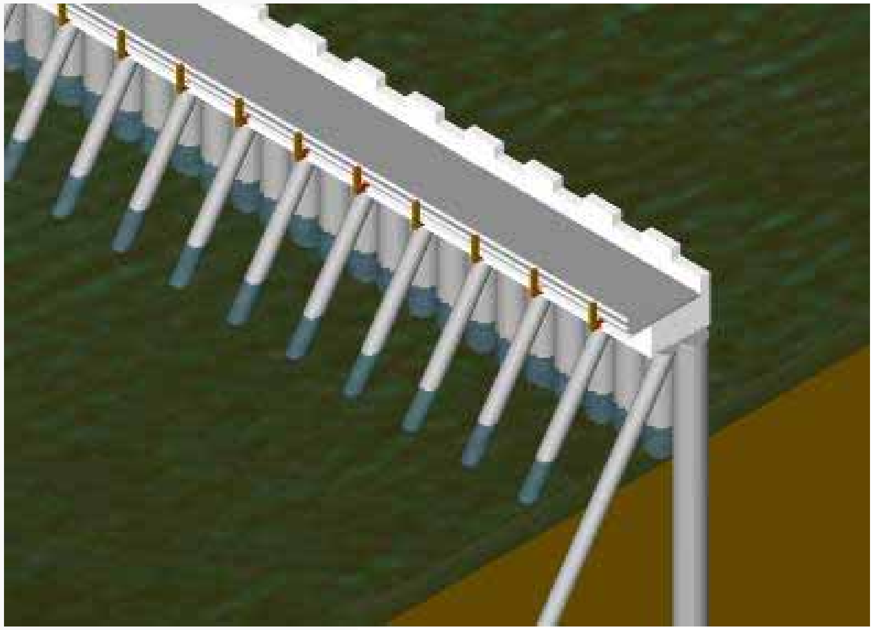
HURRICANCE GUSTAV
SEPTEMBER 1, 2008

Gustav produced surge levels in the IHNC around 11ft

2% surge : 13.5ft
1% surge : 15ft

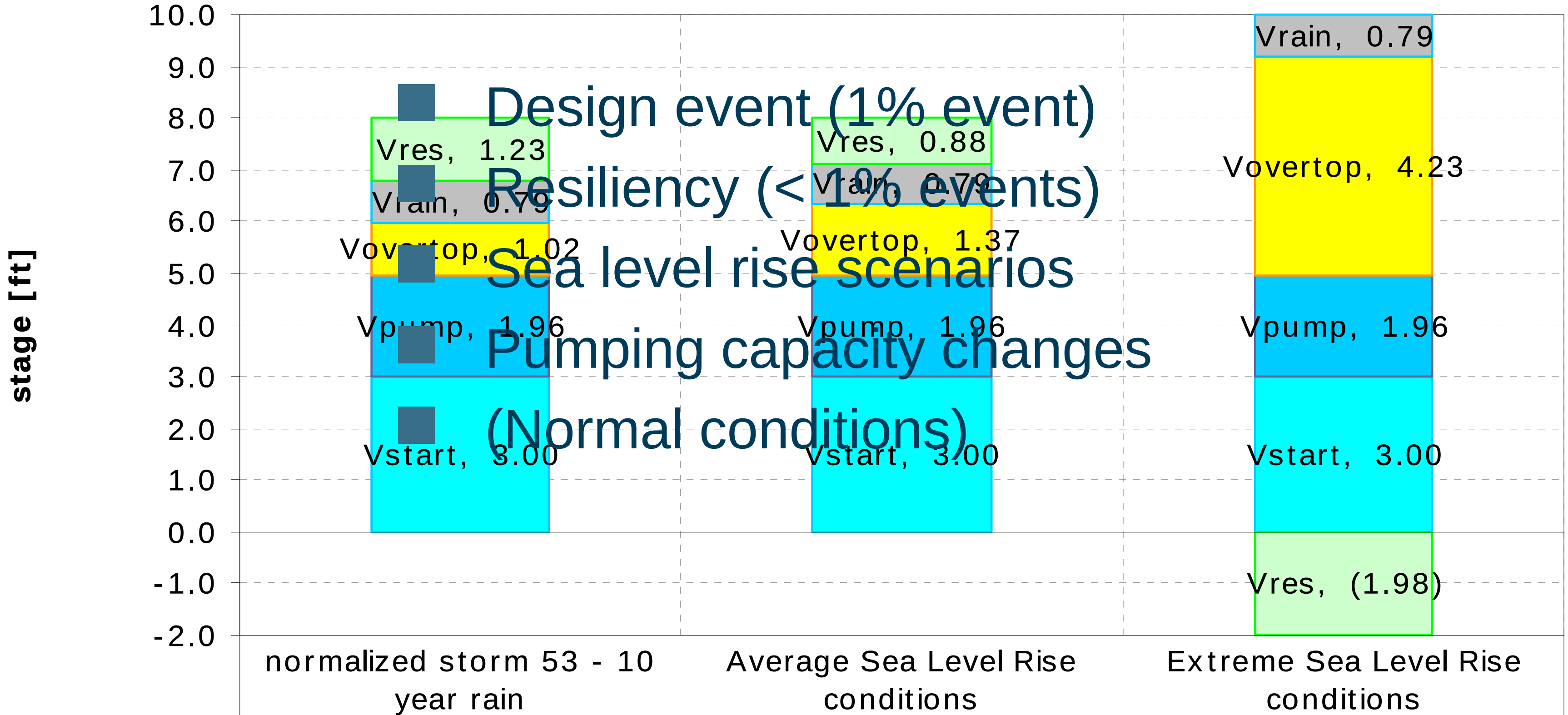
Resilience IHNC barrier

- Height of the barrier is above the 500-year still water level
- Structural resilience check of design for wave forces and surge during 500-year event



Resilience for climate scenarios

- Design event (1% event)
- Resiliency (<1% events)
- Sea level rise scenarios
- Pumping capacity changes
- (Normal conditions)



	normalized storm 53 - 10 year rain	Average Sea Level Rise conditions	Extreme Sea Level Rise conditions
Vres	1.23	0.88	(1.98)
Vrain	0.79	0.79	0.79
Vovertop	1.02	1.37	4.23
Vpump	1.96	1.96	1.96
Vstart	3.00	3.00	3.00

December 2008 – Ground breaking

April 2009 – Arrival of first set of piles

June 2009 – Construction in full swing

March 2010 – Sand fill BB gate

May 2010 – Floodwall almost complete

Concluding remarks

- Structural solutions are one of the ***necessary*** components for protecting areas below sea level
- Structural resilience needs to be considered as integral part during the design of sustainable coastal solutions
- Hydraulic design of New Orleans risk reduction system is a showcase for dealing with structural resilience
- Extension is needed into other disciplines to make these solutions resilient for all failure mechanisms


Thanks for your attention
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