

Ad Hoc Expert Meeting on

**Climate Change Impacts and  
Adaptation: A Challenge for  
Global Ports**

29 – 30 September 2011

**Adaptation Strategies for Seaports:  
Global Implications and Local  
Perspectives**

Presentation by

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# ***Adaptation strategies for seaports: Global implications and local perspectives***

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30 September, 2011

**Ad Hoc Expert Meeting on Climate change impacts and adaptation:  
a challenge for global ports**

# Stanford University's projects on engineering and policy responses to climate change

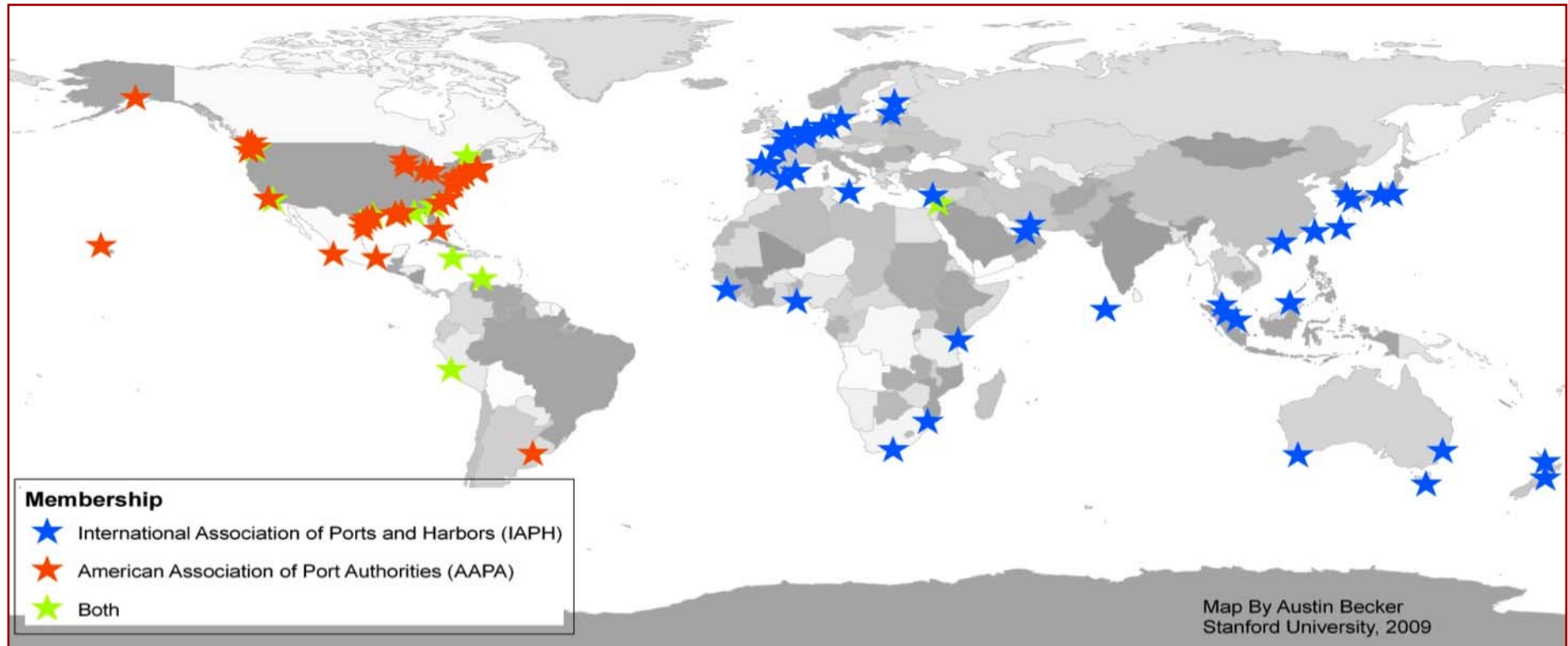


**I. What are port authorities doing about climate change adaptation?**

**I. What examples illustrate implementation of resilience strategies?**

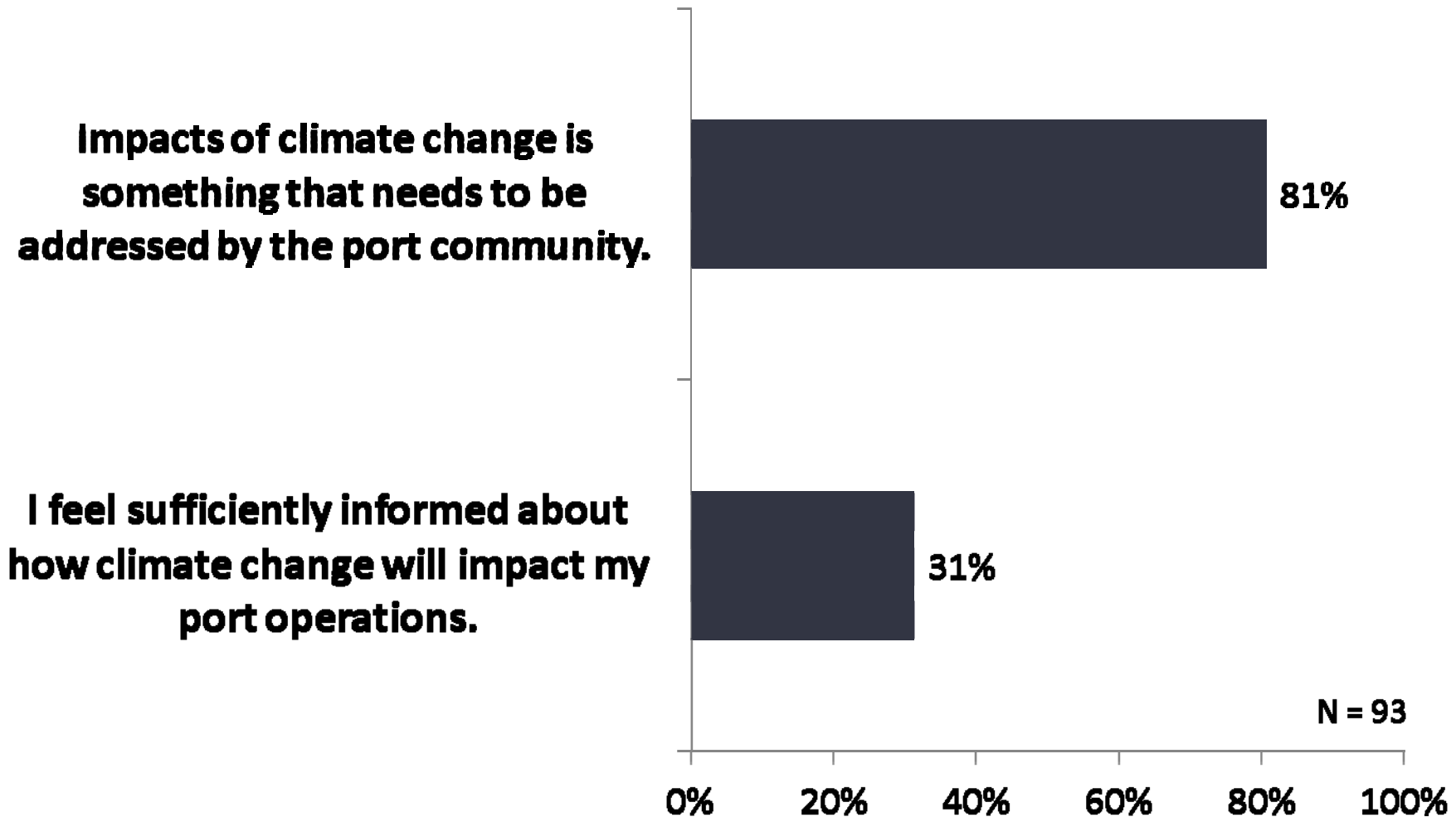
**II. What if every port implemented a major resilience improvement strategy?**

# Part I. Survey of port authorities

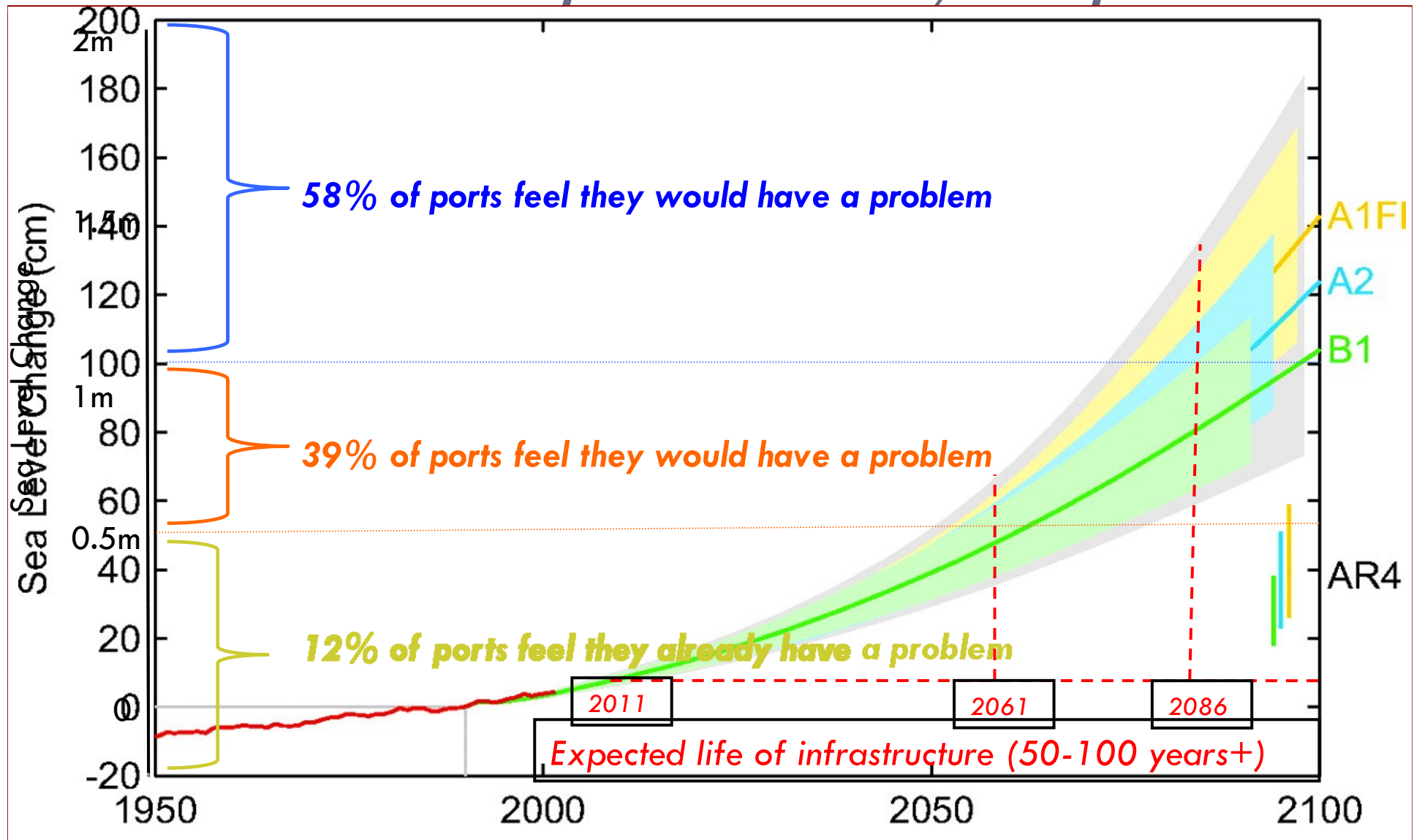


**Publication:** Becker, A., S. Inoue, M. Fischer, B. Schwegler. (2011). "Climate change impacts on international seaports: Knowledge, perceptions, and planning efforts among port administrators." Journal of Climatic Change.

# *Finding 1: Survey respondents concerned, but felt uninformed*



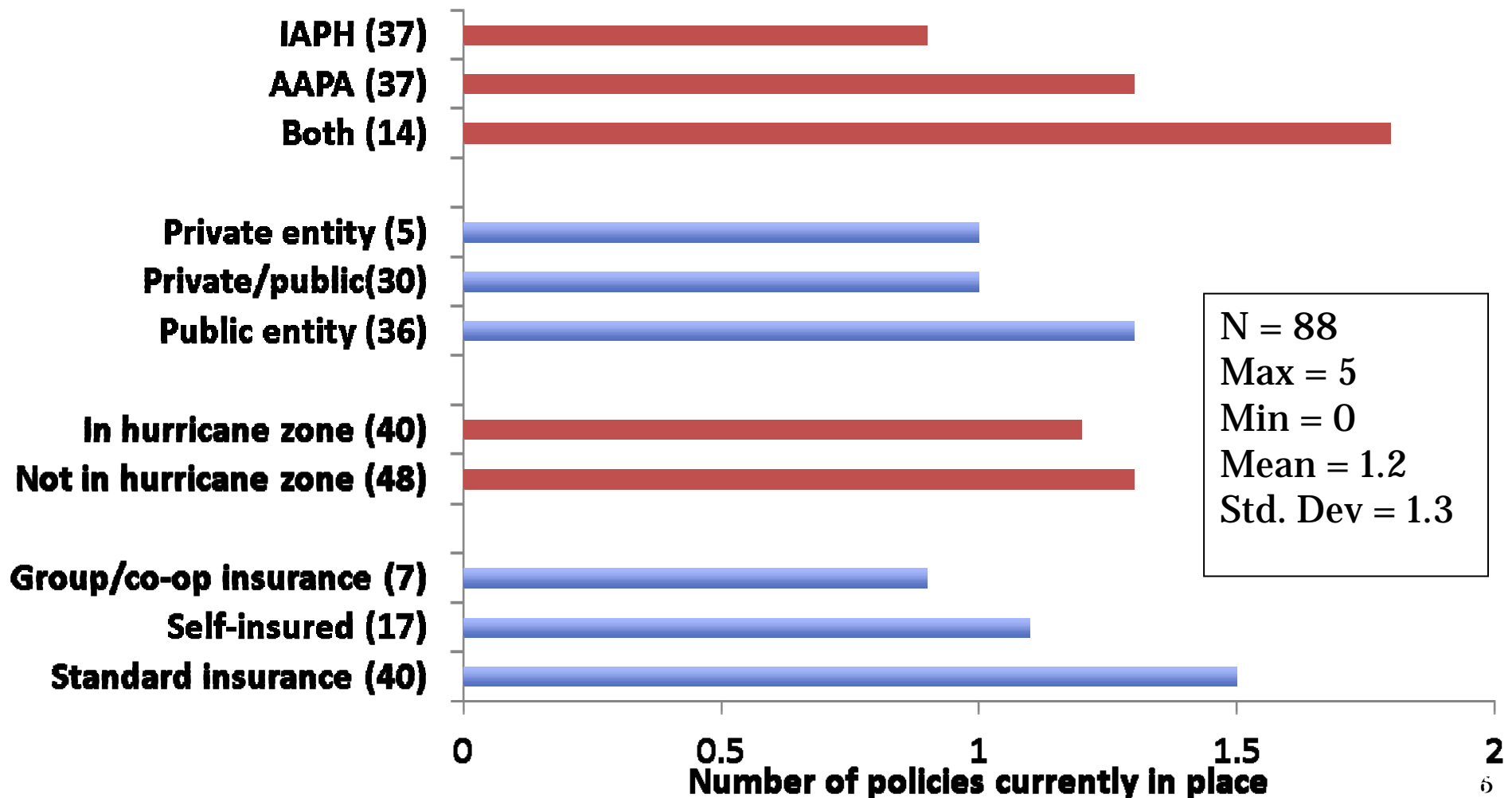
# Finding 2: How much sea level rise would be a problem at your port?



# *Finding 3: Most ports have few (if any) climate-adaptation policies in place*



**Category (# of ports)**



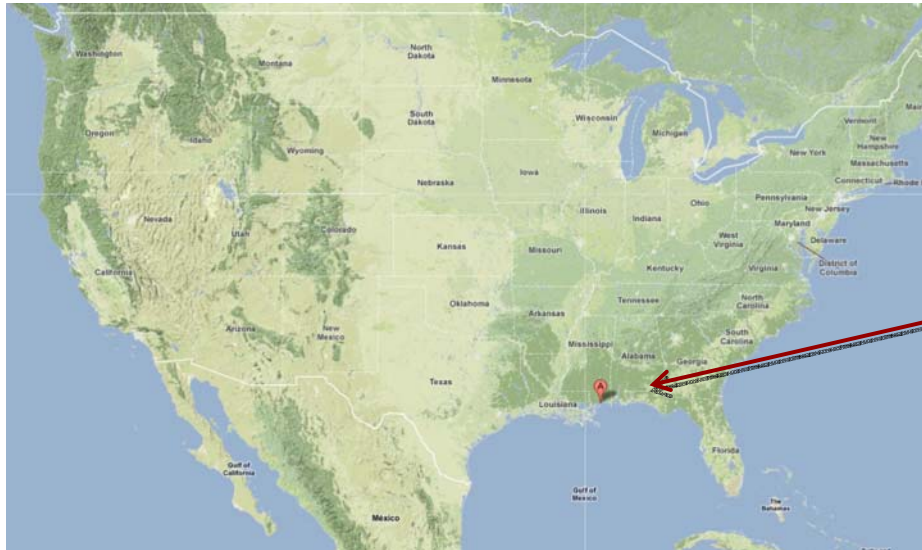
# Problem - Ports have not yet begun to address this issue



- What can be learned from ports that are addressing the *kinds of problems* that climate change will create?



# Part II. Case study of Gulfport's plan to elevate to 25 feet (7.6 meters)



## Port of Gulfport Mississippi State Port Authority

### 2008 Revenues

Business: \$183m

Local Purchases: \$15m

State/Local Taxes: \$27m

Federal taxes: \$51m

*2010: 208,000 TEUs*

*Primary Freight: Containers, bulk freight*

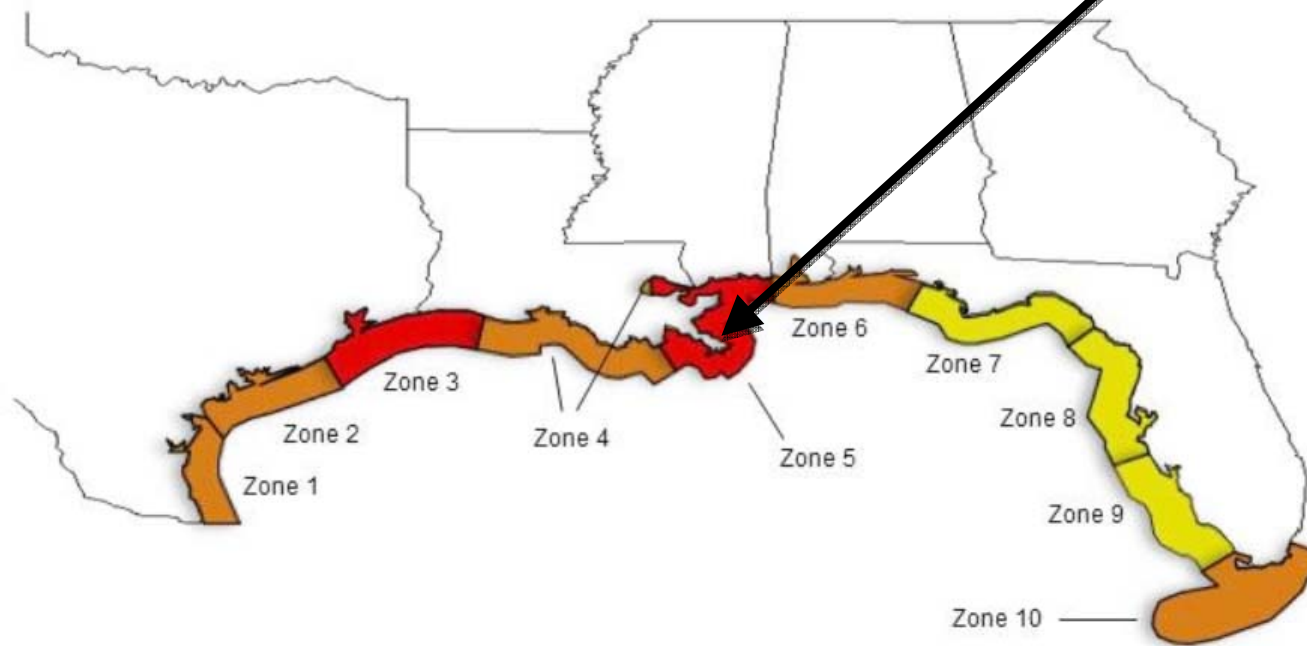
*Imports: Fresh fruit, raw materials, garments, ore, lumber*

*Exports: Products primarily to South and Central America*      Over 2m tons of cargo



# 100-year Storm Surge Heights

**Gulfport = 25.2' (7.7m) surge zone**



Zone #	1	2	3	4	5	6	7	8	9	10
Height (ft)	18.1	18.7	20.7	15.2	25.2	19.9	11.6	10.9	12.9	18.9

Surge Color Code

10-15 feet

15-20 feet

20+ feet



How did decision makers choose and  
implement a resilience strategy in  
Gulfport?

# Research Methodology



Outstanding questions:

- What are the impacts of a major hurricane at the port?
- What strategies can help build port resilience?
- How did the decision system choose and implement the elevation plan?

“Grounded theory” approach

- Interviewed 28 Gulfport decision makers in 2010 and 2011
- Examined plans, articles, reports, environmental assessments, and other secondary materials

1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011



Mississippi State Port Authority (MSPA) decides to expand port by 84 acres in anticipation of Panama Canal expansion project

Key actors: MSPA and Mississippi Development Authority (MDA)

1998 1999 2000 2001 2002 **2003** 2004 2005 2006 2007 2008 2009 2010 2011

Master Plan completed and seaward expansion begins  
*(plan does NOT include storm resilience component)*

Key actors: MSPA, MDA, AECOM Engineering, Governor Barbour

## Hurricane Katrina Destroys Port of Gulfport



- ~1m square feet of warehouses, laydown, fill, and structures destroyed
- Tenants lost
- Contents of port washed throughout City
- \$51m (US) in direct damages

1998 1999 2000 2001 2002 2003 2004 2005 **2006** 2007 2008 2009 2010 2011



Master Plan is updated to reflect restoration and new resilience strategy of **EVACUATION PLAN** for port

Federal funding sought and obtained  
\$600m through Housing and Urban Development (HUD)  
Additional funds from Federal Emergency Management Agency (FEMA) and from insurance companies

Key actors: MSPA, MDA, AECOM Engineering, FEMA, Governor Barbour



1998 1999 2000 2001 2002 2003 2004 2005 2006 **2007** 2008 2009 2010 2011

MSPA hires CH2M Hill to review and implement the revised 2007 Port Master Plan

2007 Master Plan Updated, evacuation strategy rejected and **new 25' elevation strategy proposed**

MSPA begins additional additional “Expansion Program” component be completed in conjunction with the “Restoration Program”

Key actors: MSPA, CH2M Hill Engineering, MDA, Governor Barbour

1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 **2010** 2011



MSPA and MDA conduct Environmental Assessment  
for **Restoration Program**

MSPA and MDA conduct Environmental Impact Statement for  
**Expansion Program**

Key actors: MSPA, MDA, Dept. of Housing and Urban Development  
(HUD)

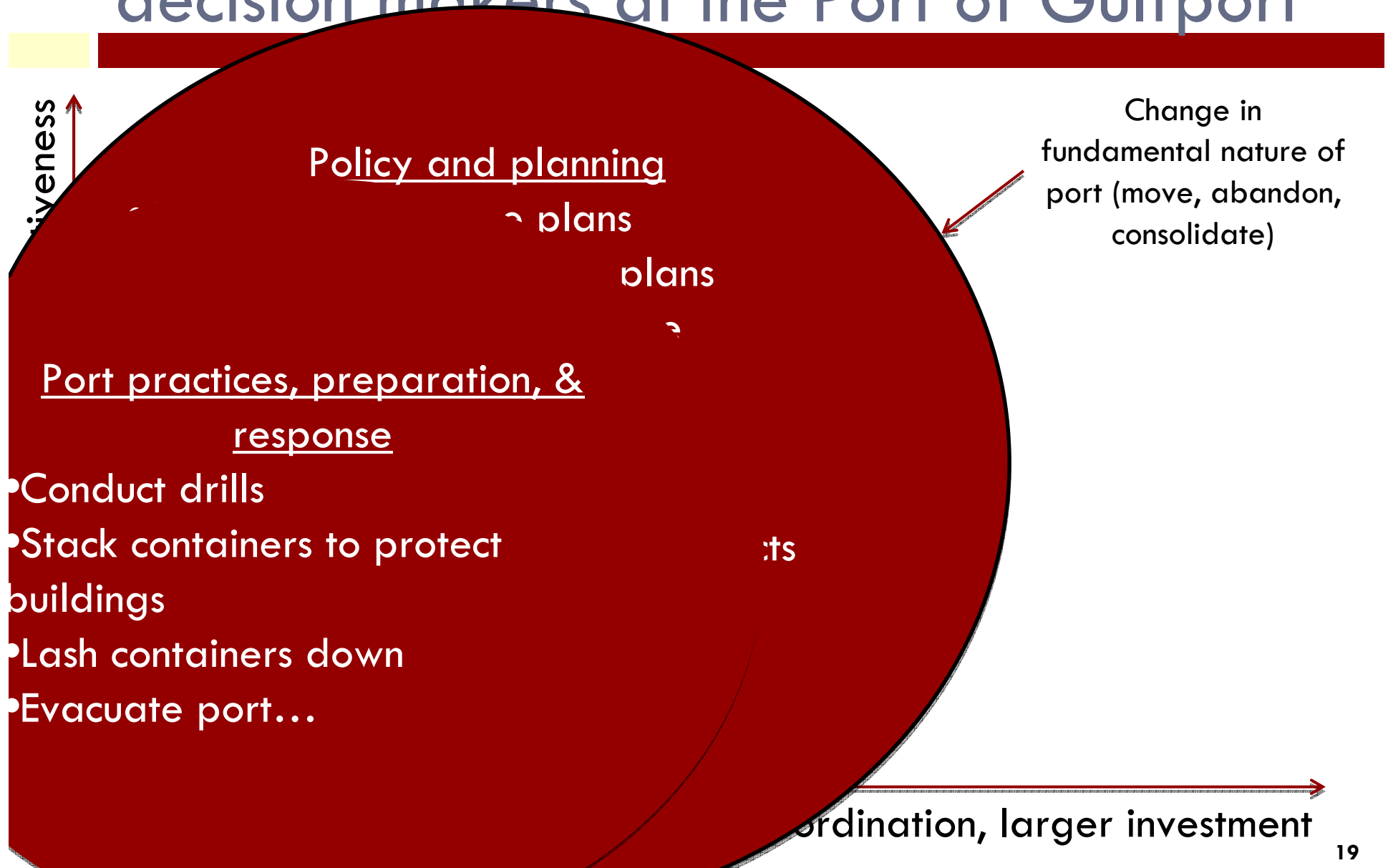
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 **2011**



60 acres fill project completed, 24 acres additional fill underway,  
elevation to 25' underway

Key actors: MSPA

# Resilience strategies identified by 28 decision makers at the Port of Gulfport



# Decision-maker roles for Gulfport

## **Informants**

*United States Army Corps of Engineers, Mississippi Dept. of Environmental Quality, Dept. of Marine Resources, Community groups, Port tenants, Insurance agency, etc. (some 20 in all)*

## **Funding agents**

*Federal Emergency Management Agency (FEMA), Federal Department of Housing and Urban Development*

## **Funding liaisons**

*Mississippi Development Authority*

## **Regulators**

*FEMA*

## **Project drivers**

*MSPA and Governor Barbour of Mississippi*

# Lessons from the decision to elevate

- \$140m (US) for the filling alone (%110 of pre-Katrina asset value)
- Strongly tied to economic development and port expansion
- Funded by federal government
- Driven primarily by the Governor and the port authority, but many actors involved in the process
- ***What if every port decided to do this???***

# Part III. “Upper-bound estimates” to protect the world’s ports

**What if every coastal port had to protect itself against climate change?**

Options considered:  
**Elevate or Dike**

- 180 ports – Top 100 by throughput and all ports in city with >1m people
- Heads-up digitized port infrastructure
- Assumed 2-meter rise in sea levels
- Modeled “minimum-criteria dike” structure for each port





# Buenos Aires

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/ Inav/Geosistemas SRL

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

0, 2010

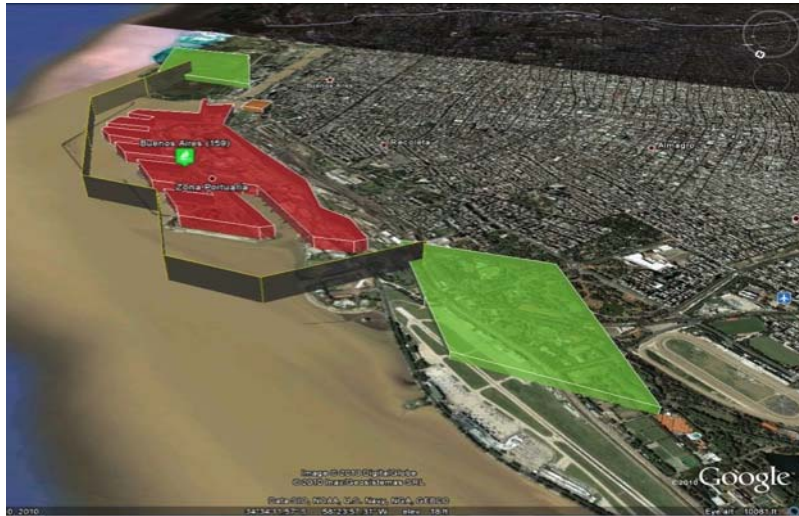
34°34'11.57" S 58°23'57.31" W elev 18 ft

© 2010 Google

Eye alt 10081 ft



# *Preliminary finding 1: Concrete required to dike top 155 ports*



Dike all 155 ports = 528 million m<sup>3</sup> of concrete\*

Three Gorges Dam = 26 million m<sup>3</sup> of concrete

**Equivalent of 20 Three Gorges Dams!**



\*Or equivalent to a typical sidewalk wrapping around the equator 93 times!

*Preliminary finding 2:  
Material to elevate top 155 ports 4.6 meters*

**10.7 billion m<sup>3</sup> of fill material**

**At ~\$247 million/km<sup>2</sup>,  
that's  
\$1.7 trillion (US)**

Asia

63

0

10

20

30

40

50

60

70

*"Three Gorges Dam" moved 106.2 million m<sup>3</sup> of earth*

# Conclusion



## **Many Questions...**

- How will nations prioritize port resilience projects?
- Which ports are at highest risk?
- What are the barriers to implementing major resilience enhancements?

**What are yours?**

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