The Price of **Not** Investing in the Texas Coastal Spine System

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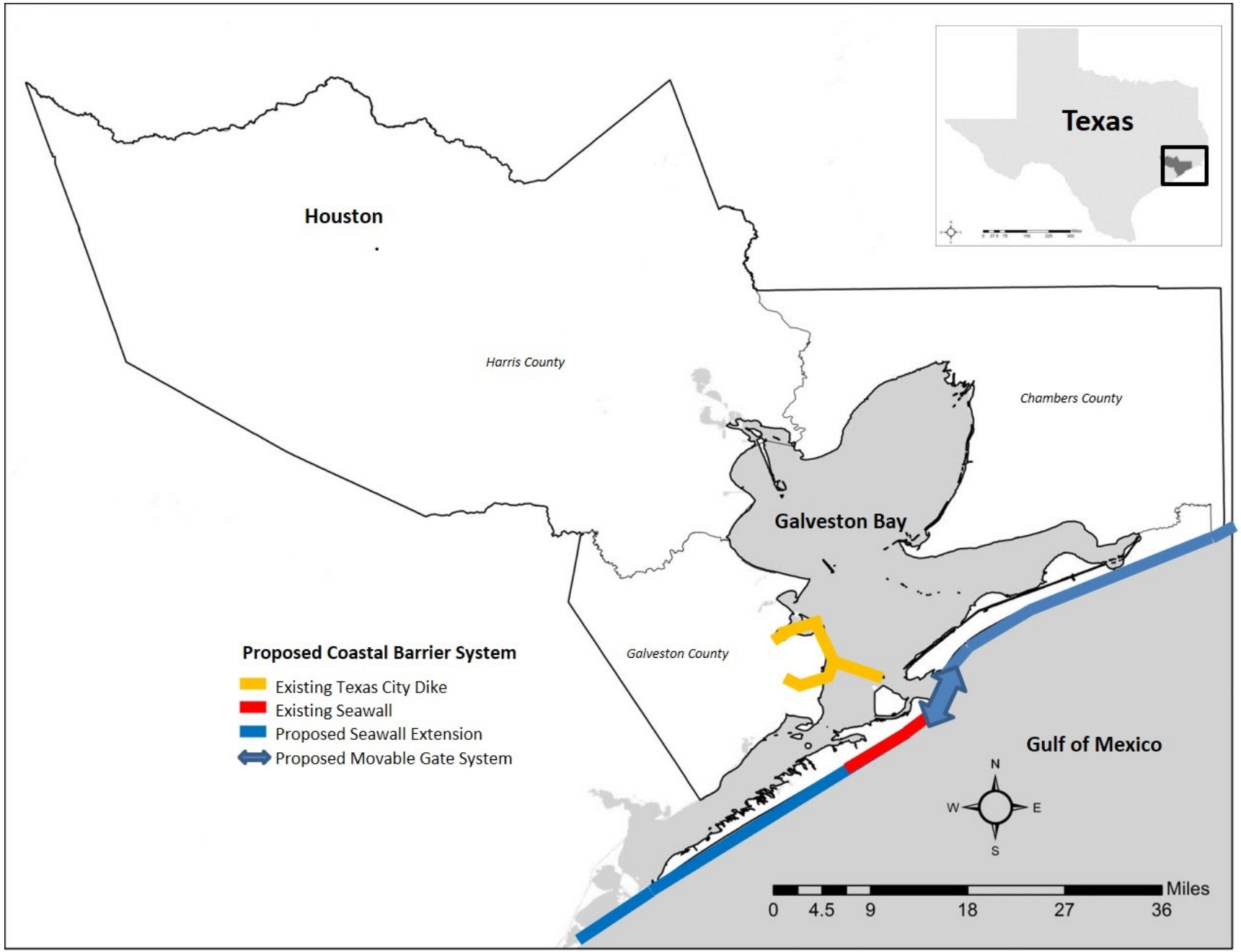
Overview of the problem

- Tropical cylone-induced storm surges, while rare, unarguably represent the most devastating aspect of tropical cyclones and are a concern for many low-lying areas in the US, with the East and Gulf coastal communities at particularly greater risk of impacts (Balaguru et al. 2016).
  - Estimate asset losses due to storm surge and sea level rise (SLR) in the U.S. could reach $990 billion by 2100 (Neumann et al. 2015)

- Recent studies indicate that the heights of storm surge currently associated with a 100-year recurrence interval could become as frequent as one in every four years, as a result of SLR creating a higher “launch point” for future storm surges (Frumhoff et al. 2007).

Houston-Galveston Area (HGA)

- Home to approximately 4.42 million people (U.S. Census, 2010)
- Projected to surpass 6.3 million people by 2040 (Houston Galveston Area Council 2017).
- Hub of some of the nation's largest refineries, petrochemical manufacturing facilities, and critical infrastructure (the largest port in the US imports and export tonnage).
- HGA generated over 341 billion of GDP, contributing a quarter of the entire Texas State economy, and employed more than 62% of the state's total population (year 2012)
- The combined output value from the chemical manufacturing, mining, oil, and gas extraction sectors was estimated above 294 billion dollars in 2012 (MIG 2012).


Texas
Houston
Harris County
Chambers County
Galveston Bay
Galveston County
Gulf of Mexico
Proposed Coastal Barrier System
Existing Texas City Dike
Existing Seawall
Proposed Seawall Extension
Proposed Movable Gate System
N
W
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Miles
0
4.5
9
18
27
36

Impacts of Storm Surge

- **Direct Impacts** (i.e. surge sensitive sectors):
  - Residential housing (dwelling)
    - **FEMA HAZUS** model → estimates property damage
  - Petroleum and Chemical manufacturing → reducing Total Factor Productivity (TFP)
    - **Chemplant database** → daily value of production output→ derive the output loss due to plant shutdown (18, 26, 33 days of shutdown duration)

- **Indirect Impacts**
  - **General equilibrium effects:** the surge impacts on housing and petro/chemical sectors affect
    - Prices of production inputs (i.e. capital, labor, materials, and other) facing producers in other sectors.
    - Output prices received by producers in another sector.
    - The price changes (both outputs and inputs) stimulate substitution away from higher-priced goods and toward lower-priced goods.
  - **Multiplier effects:**
    - Changes in input prices lead changes in personal income → additional rounds of indirect effects through the changes in personal income

Economic Scenarios & Impacts

Economy without the storm surge (Business as Usual)

- Simulated forward in time (50-years) based on projections in population, working age population, saving rates, depreciation rates, government taxes, productivity growth rates, rates of improvement in capital and labor quality

Economy with the storm surge

- The economy is simulated with changes in selected parameters:
  - Housing sector capital endowment is reduced by the amount of estimated property damages (HAZUS)
  - TFP growth rates in petroleum and chemical sectors are adjusted until sector output losses solved in the model matches the estimated losses that correspond to the different shut-down days

Economic Impacts of surge

- Economics indicators (with the surge) - Economics indicators (BAU)

Surge and Policy Scenarios

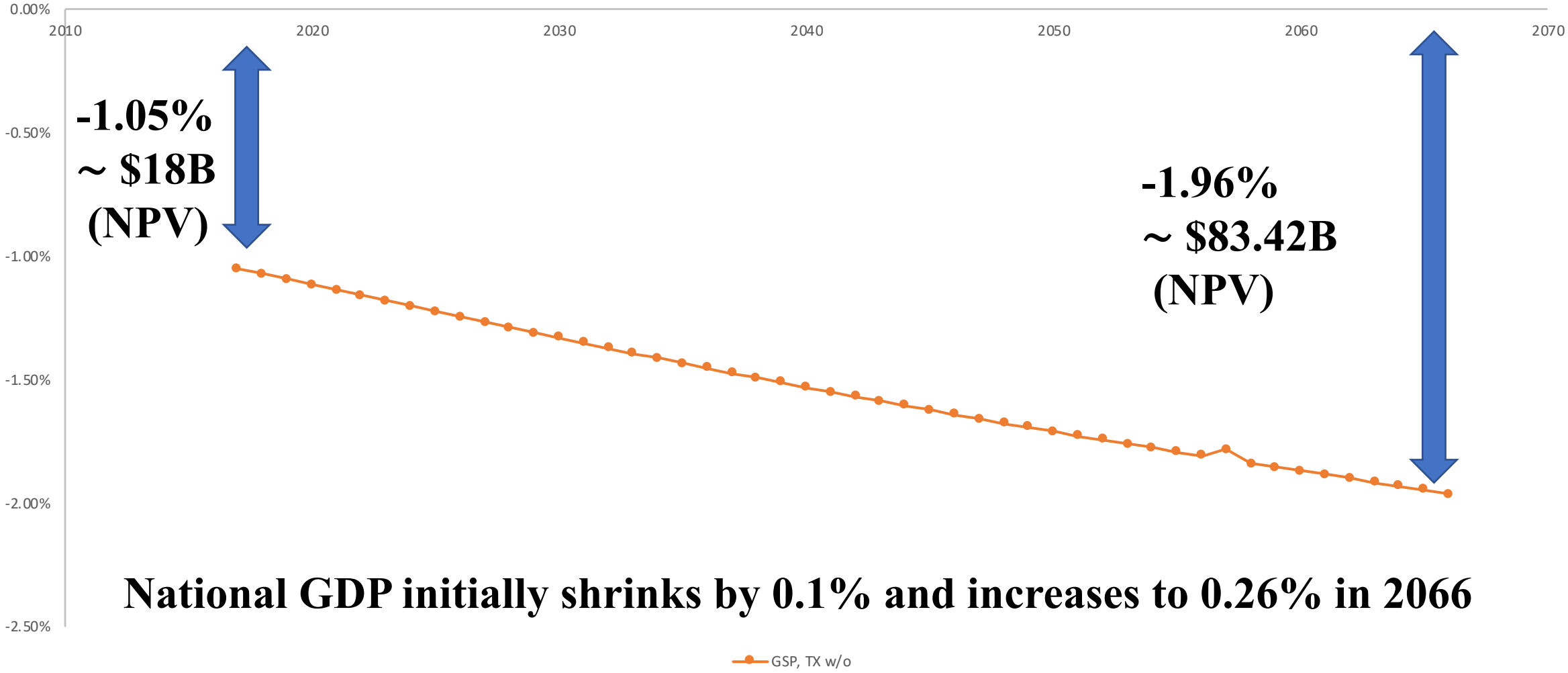
Synthetic storms based on ADCIRC model

- 500-yr storm, annual probability of 0.2%, → most intense and destructive
- 100-year storm surge → annual probability 1%
- 10-year (10%) → annual probability 10%
- Ike-like storm surge, a category 2 hurricane that struck Southeast coast of Texas in 2008.

Direct Losses in 2016 prices, $ mln

	Property Losses	Output losses (33 days shut down)	Total
500-year	8,496	7,899.56	**16,395.56**
100-year	4,609	2,006.92	**6,615.92**
10-year	559	55.75	**614.75**
Ike-like	3,149	611.81	**3,760.81**

Impact of 500-yr storm surge on Economy Conservative Estimates (Gross State Product)



National GDP initially shrinks by 0.1% and increases to 0.26% in 2066

Overall Economic Impact relative to BAU

	Per capita Income	GSP	Total consumption	Total investment	Total Government consumption	Net export	Welfare
2017	-0.94%	-1.05%	-2.02%	1.16%	0.28%	-19.22%	-1.25%
2026	-1.11%	-1.25%	-2.23%	1.02%	0.27%	-6.80%	-1.41%
2036	-1.28%	-1.45%	-2.42%	0.90%	0.28%	-5.07%	-1.56%
2046	-1.42%	-1.46%	-2.52%	0.85%	0.32%	-4.47%	-1.67%
2056	-1.54%	-1.81%	-2.57%	0.83%	0.38%	-4.77%	-1.77%
2066	-1.67%	-1.96%	-2.62%	0.77%	0.46%	-4.78%	-1.87%

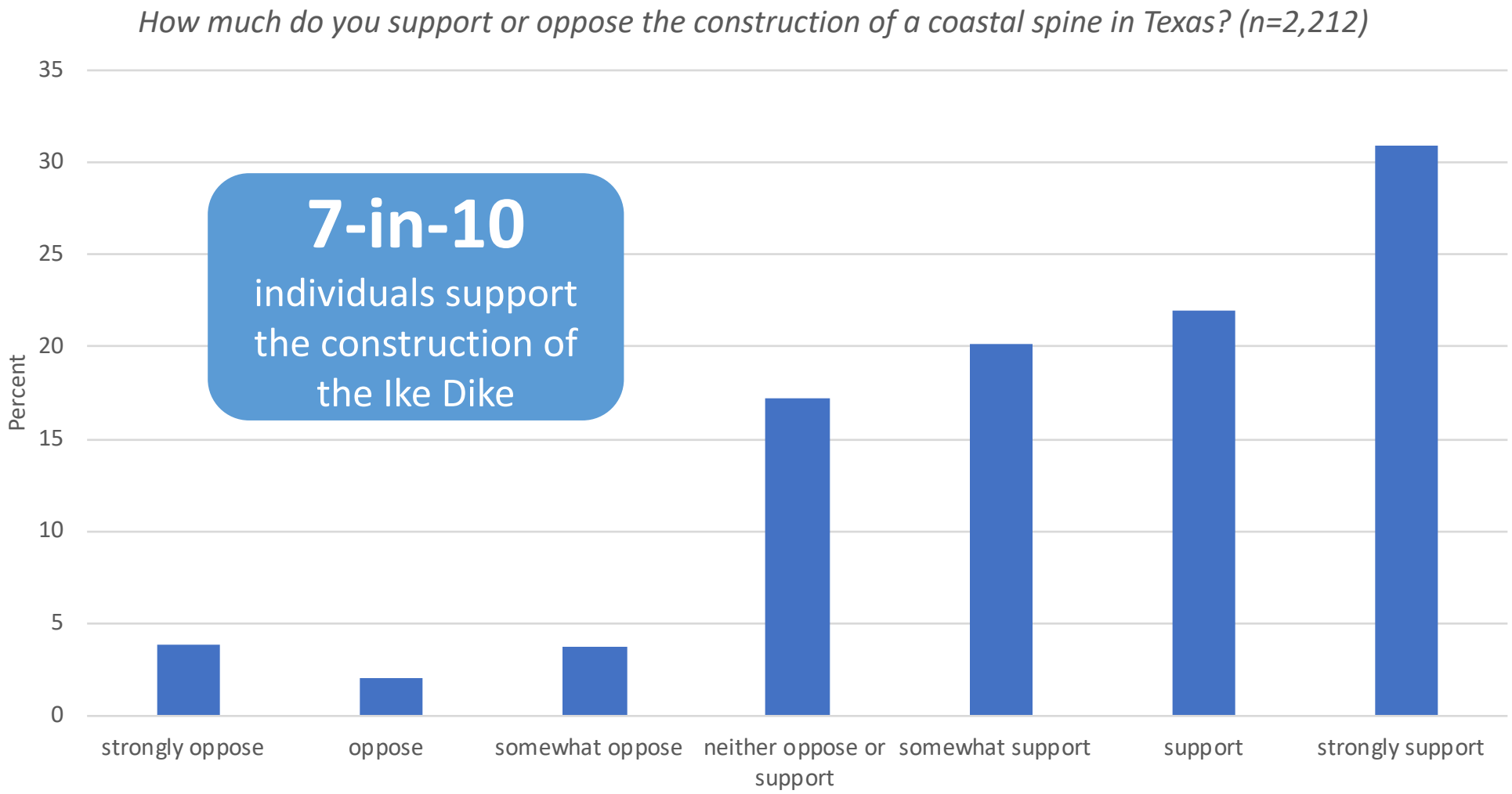
Expected Annualized Impacts (%)

	Income	GDP	Investment	Total Consumption	Gov. Consumption	Net export
TX	-0.040	-0.047	-0.049	0.036	-0.080	0.008
USA	-0.005	-0.007	-0.006	0.006	-0.010	0.000

Mitigation strategies

- Coastal spine → mitigates 80-90% of impacts
  - Costly but construction can also boost economic activities in the construction and related sectors (estimated construction time period 10-15 years)
- Ecosystem restoration (e.g., marshes, wetlands, dunes)
- Beach nourishment
- Coastal retreat → autonomous vs. managed retreat
  - Fiscal constraint → loss of tax base for smaller communities
  - Conflicting policy incentives → subsidized insurance vs. retreat
- Estimated total cost ~**$26.17B** (US Army Corps of Engineers [USACE], 2020) and 1.96 of Benefits to Cost Ration (BCR)

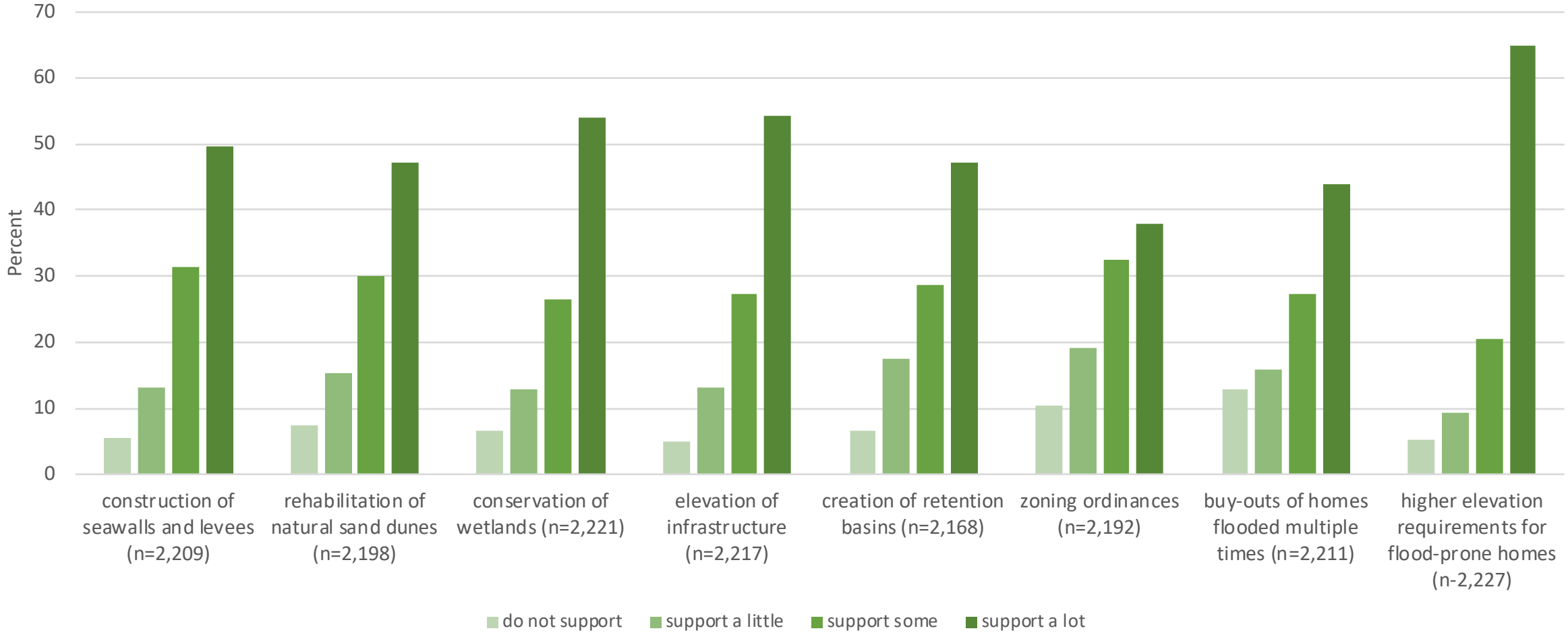
Public support for a coastal spine



Note: Weighted tabulations reported. Responses collected in a phone and online survey fielded May-July 2018 to residents in Chambers, Galveston, and Harris Counties. Research supported by a grant from the Texas General Land Office. ;
Source: Ross et al. (2020)

Public support for various mitigation strategies

I'm going to list ways that coastal communities can manage the risk posed by natural hazards.
For each one, how much do you support it?



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Thank you!
Questions?