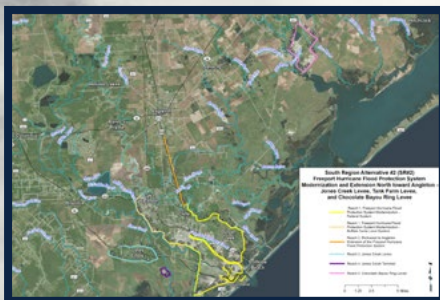
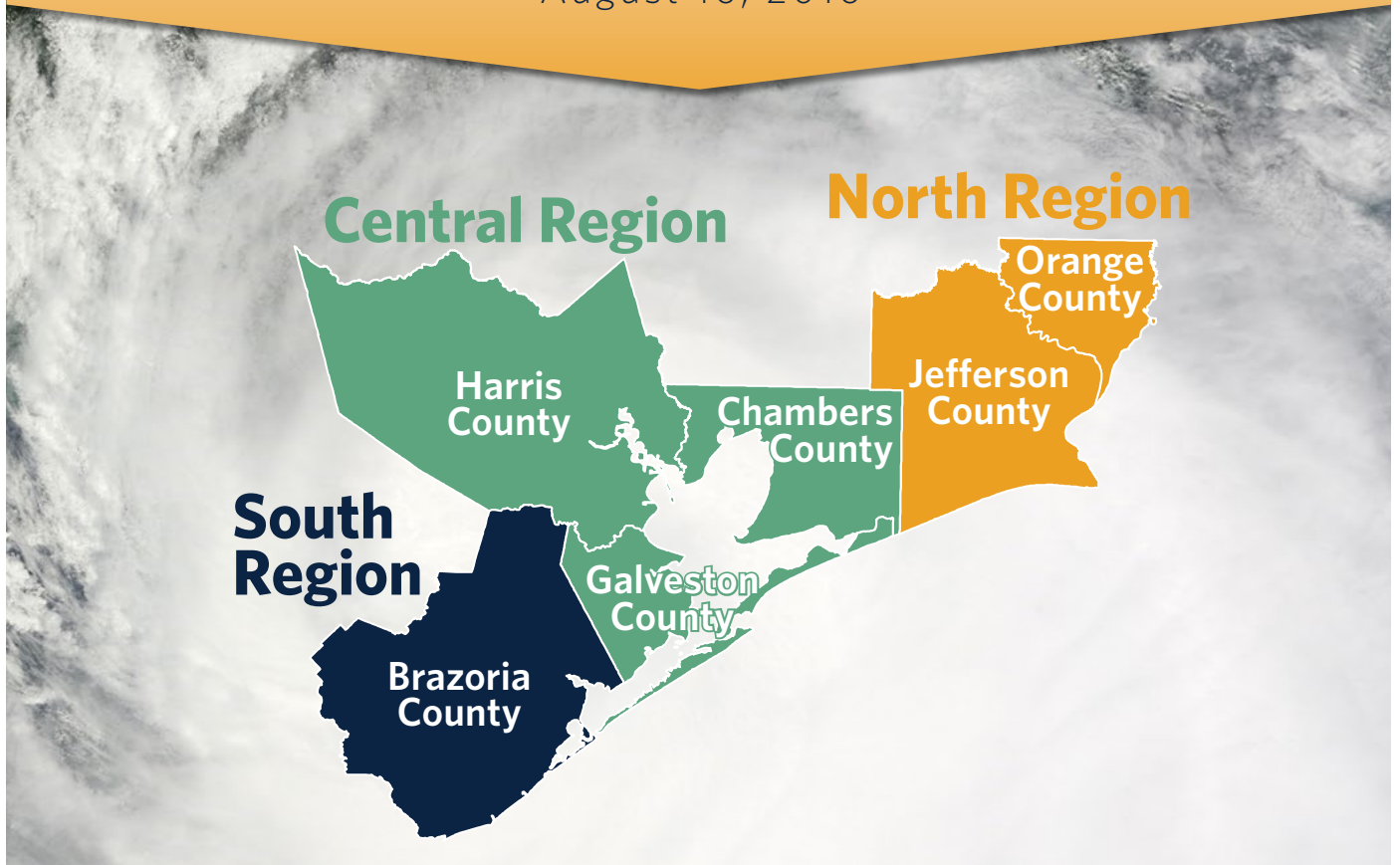




STORM SURGE SUPPRESSION STUDY SUPPLEMENT TO THE PHASE 3 REPORT: EXTENDED ECONOMIC BENEFITS

August 16, 2016



Extended Economic Benefits: National Economic Impacts

This information is a supplement to the Phase 3: Recommended Actions report

The Gulf Coast Community Protection and Recovery District's Phase 3: Recommended Actions report contained an economic analysis prepared using the U.S. Army Corps of Engineers' (USACE) Hydrologic Engineering Center Flood Damage Analysis Model (HEC-FDA) to compute damages. The analysis estimated the *direct damages attributable to storms* and the direct benefits achieved through the implementation of the recommended project alternatives. These direct benefits include the reduction of potential damages caused by the inundation of public and private property and the associated avoided debris removal costs.

The direct damages from a storm represent only the initial impacts which affect the national economy. There are also additional indirect storm damages that will ripple through the local and national economy. The ripple effects are ultimately manifested as a disruption to the production of goods and services in a variety of industries. Examples of the ripple effect can be directly related to workers being displaced and downtime for industries recovering from the initial storm effects. By implementing storm risk reduction measures, this otherwise lost production is preserved, and indirect economic impacts are also mitigated.

The study team used the REMI model, developed by Regional Economic Models Inc., to analyze the impacts of indirect storm damages to the six-county region, the rest of Texas and the national economy. The REMI model was used by the USACE after Hurricane Katrina in New Orleans to help assess the full impact of the storm on the national economy. REMI is a dynamic regional input-output model that incorporates the economic links and interdependencies between regions of the economy by accounting for regional production and trade between regions. With this capability, the model can estimate the geographic redistribution of production (some current production will shift to other regions as a consequence of storm damages) and the net changes in national output associated with storm damage. The model is also able to account for population relocations due to storm events to make estimates of net employment impacts.

Tables 1 and 2 summarize the additional benefits by project alternative for the six-county region, the rest of Texas, and the rest of the U.S. in terms of Gross Domestic Product (GDP) and employment losses prevented. The GDP is a measure of the value of final goods and services within the economy. Employment losses in Table 2 represent an estimate of full-time jobs. Indirect benefits attributable to project implementation are avoiding GDP decline and employment loss.

Table 1: GDP benefits

REMI Estimated Impacts				
Impact	Alternative			
	NR#2	CR#1	SR#2	NR#2 + CR#1 + SR#2
GDP Loss Prevented: Total U.S. in 2035 (\$ mil)	15.8	473.4	82.6	559
GDP Loss Prevented: Total U.S. in 2085 (\$ mil)	32.1	805.6	4.4	950.9
GDP Loss Prevented: Total U.S. Average Annual @ 3.125% (\$ mil)	21.9	597.6	99.9	705.6
GDP Loss Prevented: 6-Counties 50-Yr Period Total 2035-2085 (\$ mil)	4,167.5	34,772.9	6,735.0	42,720.0
GDP Loss Prevented: Rest of TX 50-Yr Period Total 2035-2085 (\$ mil)	-2,427.5	-5,018.6	-1,387.5	-6,412.5
GDP Prevented: Rest of U.S. 50-Yr Period Total 2035-2085 (\$ mil)	-542.5	1,410.2	-62.5	1,440.0
Net GDP Loss Prevented: Total U.S. 50-Yr Period Total 2035-2085 (\$ mil)	1,197.5	31,164.5	5,285.0	37,747.5

Table 2: Employment Benefits

REMI Estimated Impacts				
Impact	Alternative			
	NR#2	CR#1	SR#2	NR#2 + CR#1 + SR#2
Employment Loss Prevented: Total U.S. in 2035 (# Jobs)	60	2,270	560	2,930
Employment Loss Prevented: Total U.S. in 2085 (# Jobs)	160	2,340	690	3,130
Employment Loss Prevented: 6-Counties 50-Yr Period Total 2035-2085 (# Jobs)	26,700	147,900	43,700	192,300
Employment Loss Prevented: Rest of TX 50-Yr Period Total 2035-2085 (# Jobs)	-17,800	-37,100	-11,500	-45,200
Employment Loss Prevented: Rest of U.S. 50-Yr Period Total 2035-2085 (# Jobs)	-3,500	4,400	-900	4,400
Net Employment Loss Prevented: Total U.S. 50-Yr Period Total 2035-2085 (# Jobs)	5,400	115,200	31,300	151,500

The GDP and employment impacts are the result of the annual expected value damages prevented for each project alternative. As such, the impacts represent the weighted-average consequences of all storm events. The impacts of individual storms will vary significantly from the presented results as the damages of those storms vary from the annual expected value damage.

The REMI model accounts for productivity gains over time within the economy. The significance of this model characteristic is that future output can be produced with a lesser labor input compared to current

production. Consequently, the REMI-estimated employment impacts for the year 2035 and beyond are lower than if the impacted output were produced today.

In Tables 1 and 2, the year 2035 represents the assumed first year of project alternative operation, while 2085 represents the final year of the 50-year project life. For GDP estimates, average annual values are presented in addition to the estimates for the two individual model years. Average annual values represent the annualized stream of total present value over the period 2035 to 2085.

GDP and employment losses prevented are also summarized for the six-county region, the rest of Texas, and the rest of the U.S. for the 50-year life of the project. The losses prevented are generated by comparing the with-project and without-project conditions. The negative numbers (indicating a with-project induced loss) that appear within the table reflect the displacement of without-project production that would occur post storm. Some of the without-project production and employment losses in the six-county area would shift to other regions within the state and the nation and represent without-project increases to those other regions, offsetting some of the six-county losses. Under with-project conditions, a portion of these other-region production shifts would be prevented, resulting in a negative production or employment impact when the with-project and without-project values are compared.

The ripple effect through the national economy of the proposed region system-wide project implementation is substantial. Over the 2035 to 2085 project life at the project interest rate of 3.125 percent, system-wide project implementation would preserve over \$700 million **annually** of GDP. This represents an increase of over 50 percent in direct economic benefits. The inclusion of the avoided GDP losses would result in an increase of the benefit-cost ratio from 2.03 to 3.14 (Table 3). Total employment impact over the 50-year project life for system-wide project implementation would be more than 151,000 jobs for the nation.

Table 3: Benefit-Cost Ratios

Impact	REMI Estimated Impacts			Alternative	
	NR#2	CR#1	SR#2	NR#2 + CR#1 + SR#2	
Benefit - Cost Ratio without GDP Impacts (3.125% Interest Rate)	0.80	3.22	1.47	2.03	
Benefit - Cost Ratio with GDP Impacts (3.125% Interest Rate)	0.92	5.09	2.18	3.14	