

Table of Contents

Executive Summary	ES-1
1.0 Why Study Climate Change Impacts on Transportation?	1-1
1.1 The Climate is Changing.....	1-2
1.2 How Will Changes in Climate Affect Transportation?.....	1-4
1.2.1 What are the Challenges to Research?.....	1-5
1.3 State of Science Regarding Climate Change Impacts on Transportation	1-6
1.3.1 Overview of State of Practice	1-7
1.3.2 Major Sponsors Conducting Related Research	1-8
1.3.3 State of Technical Analysis	1-9
1.3.4 Impacts, Assessment, and Adaptation	1-11
1.3.5 Direct Climate Impacts on Transportation Addressed in Existing Literature	1-12
1.3.6 Indirect Climate Impacts on Transportation Addressed in Existing Literature	1-15
1.3.7 Decision-Making Processes and Tools	1-17
1.4 Conclusions Drawn from Current Literature on the State of Research	1-20
1.5 Gulf Coast Study Selection, Objectives, and Organization	1-23
1.5.1 Study Selection	1-23
1.5.2 Gulf Coast Study Objectives and Three Phases.....	1-24
1.5.3 Study Organization and Oversight.....	1-25
1.5.4 Characterizing Uncertainty	1-25
1.6 References	1-26
2.0 Why the Gulf Coast?	2-1
2.1 Overview of the Study Region.....	2-1
2.1.1 Regional and National Significance	2-1
2.1.2 Study Area Boundaries	2-2
2.1.3 Structure of This Chapter.....	2-3
2.2 The Transportation System in the Gulf Coast Region	2-3
2.2.1 Overview of the Intermodal Transportation System in the Gulf Coast Region.....	2-3
2.2.2 Modal Characteristics	2-6
2.3 Gulf Coast Physical Setting and Natural Environment.....	2-16
2.3.1 Geomorphology	2-16
2.3.2 Current Elevation and Subsidence.....	2-18
2.3.3 Sediment Erosion, Accretion, and Transport.....	2-19
2.3.4 Land Use and Land Cover	2-20
2.4 Social and Economic Setting	2-21
2.4.1 Population and Development Trends.....	2-22
2.4.2 Employment, Businesses, and Economic Drivers	2-23

2.4.3 Societal Vulnerability	2-25
2.5 2.5 Conclusions	2-27
2.6 References	2-28
3.0 How is the Gulf Coast Climate Changing?.....	3-1
3.1 Temperature, Precipitation, and Runoff.....	3-3
3.1.1 Historical Data Sources	3-3
3.1.2 GCM Applications for the Study Area	3-4
3.1.3 Water-Balance Model.....	3-5
3.1.4 Temperature and Runoff Trends.....	3-6
3.1.5 GCM Results and Future Climate Scenarios	3-7
3.1.6 Changes in Daily Temperature	3-8
3.1.7 Changes in Specific Temperature Maxima Affecting Transportation	3-10
3.1.8 Increasing Daily Precipitation Extremes	3-12
3.2 Hurricanes and Less Intense Tropical Storms.....	3-12
3.2.1 Assessing Trends in Historical Hurricane Frequency and Intensity...	3-13
3.2.2 Gulf Coast Hurricane History	3-15
3.2.3 HURASIM: Model Application.....	3-15
3.2.4 Historical Storm Frequency across the Northern Gulf Coast Study Region.....	3-15
3.2.5 Temporal and Spatial Analysis of Hurricane Landfall	3-16
3.2.6 Hurricane Wind Direction Patterns.....	3-17
3.2.7 Modeling Climate Change Effects on Tropical Cyclones into the 21 st Century.....	3-18
3.3 Sea Level Rise and Subsidence.....	3-18
3.3.1 Historic and Projected Global Sea Level Trends.....	3-19
3.3.2 Tide Records, Sea Level Trends, and Subsidence Rates along the Central Gulf Coast	3-20
3.3.3 Sea Level Rise Scenarios for the Central Gulf Coast Region.....	3-21
3.4 Storm Surge.....	3-23
3.4.1 Predicting Storm Surge with the SLOSH Model.....	3-23
3.4.2 Future Sea Level Rise and Storm Surge Height	3-25
3.5 Other Aspects of Climate Change with Implications for Gulf Coast Transportation	3-26
3.5.1 Wind and Wave Regime	3-26
3.5.2 Humidity and Cloudiness.....	3-27
3.5.3 Convective Activity	3-27
3.6 Conclusions	3-28
3.7 References	3-32
4.0 What are the Implications of Climate Change and Variability for Gulf Coast Transportation?	4-1
4.1 Climate Drivers and their Impacts on the Transportation System.....	4-2
4.1.1 Effects of Warming Temperatures.....	4-2
4.1.2 Effects of Precipitation Levels and Patterns	4-3
4.1.3 Relative Sea Level Rise	4-4

4.1.4 Storm Activity.....	4-6
4.1.5 Climate Impacts on Freight Transport.....	4-9
4.2 Climate Impacts on Transportation Modes.....	4-10
4.2.1 Highways.....	4-10
4.2.2 Transit.....	4-15
4.2.3 Freight and Passenger Rail.....	4-18
4.2.4 Marine Facilities and Waterways.....	4-25
4.2.5 Aviation.....	4-30
4.2.6 Pipelines.....	4-37
4.2.7 Implications for Transportation Emergency Management.....	4-43
4.3 Impacts and Adaptation: Case Examples in the Study Region.....	4-49
4.3.1 Impacts of Hurricane Katrina on Transportation Infrastructure.....	4-49
4.3.2 Evacuation during Hurricane Rita.....	4-54
4.3.3 Elevating Highway 1.....	4-55
4.4 Conclusions.....	4-56
4.5 References.....	4-58
5.0 How Can Transportation Professionals Incorporate Climate Change in Transportation Decisions?	5-1
5.1 Considering Climate Change in Long-Range Planning and Investment	5-2
5.1.1 Overview of the Federal Surface Transportation Planning and Investment Process	5-2
5.1.2 Coordination in Transportation Planning	5-5
5.1.3 Current State of Practice in Incorporating Climate Change Considerations	5-7
5.1.4 Interviews with Transportation Representatives in the Gulf Coast	5-10
5.1.5 Challenges and Opportunities to Integrating Climate Information	5-14
5.2 Conceptual Framework for Assessing Potential Impacts on Transportation	5-17
5.2.1 Factors of Concern: Exposure, Vulnerability, Resilience, and Adaptation.....	5-17
5.2.2 Framework for Assessing Local Climate Change Impacts on Transportation.....	5-22
5.3 Conclusions.....	5-26
5.4 References.....	5-27
6.0 What are the Key Conclusions of this Study?	6-1
6.1 Trends in Climate and Coastal Change.....	6-2
6.2 Transportation Impacts.....	6-4
6.3 Implications for Planning.....	6-6
6.4 Future Needs.....	6-7
6.5 References.....	6-9

Appendix A: Gulf Coast Study GIS Datasets.....	A-1
Appendix B: Additional Data on Social and Economic Setting.....	B-1
Appendix C: Additional Rail Data.....	C-1
Appendix D: Water Balance Model Procedures.....	D-1
Appendix E: HURASIM Model Description.....	E-1
Appendix F: Projecting Future Sea Level Rise with the SLRRP Model.....	F-1

List of Acronyms

Glossary of Terms