CLIMATE CHANGE Vulnerability Assessment & Pilot Project

Photo: Caltrans

Prepared for:

Caltrans

Del Norte Local Transportation Commission

Humboldt County Association of Governments

LAKE APC

MCOG

Prepared by:

ESA PWA

GHD

1.0 Why Study Climate Change Impacts on Transportation?

Lead Authors: Robert C. Hyman, Joanne R. Potter, Michael J. Savonis, Virginia R. Burkett, and Jessica E. T

Transportation is such
consider its importanc
transit, rail, marine, ar
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Transportation pr
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Four key

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4. H

menu NBC NEWS HOME LATEST SEARCH

ENVIRONMENT

Scientists More Certain Than Ever on Climate Change, Report Says

BY JOHN ROACH

The world is not on track to meet the target agreed [upon] by governments to limit the long-term rise in the average global temperature to 2° Celsius. Global greenhouse emissions are increasing rapidly and, in May 2013, carbon-dioxide levels in the atmosphere exceeded 400 parts per million for the first time in several hundred millennia.

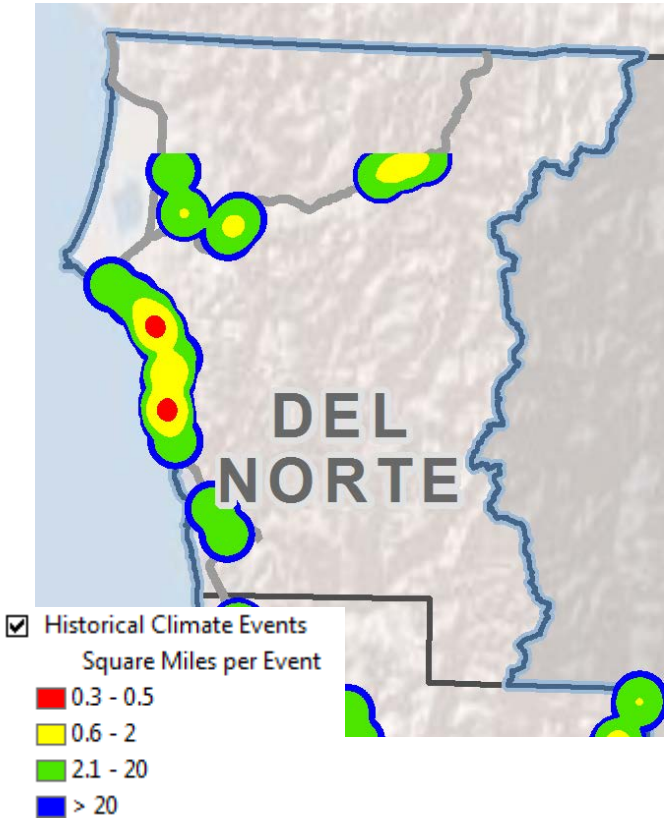
—Executive Summary
Redrawing the Energy-Climate Map
International Energy Agency
June 2013

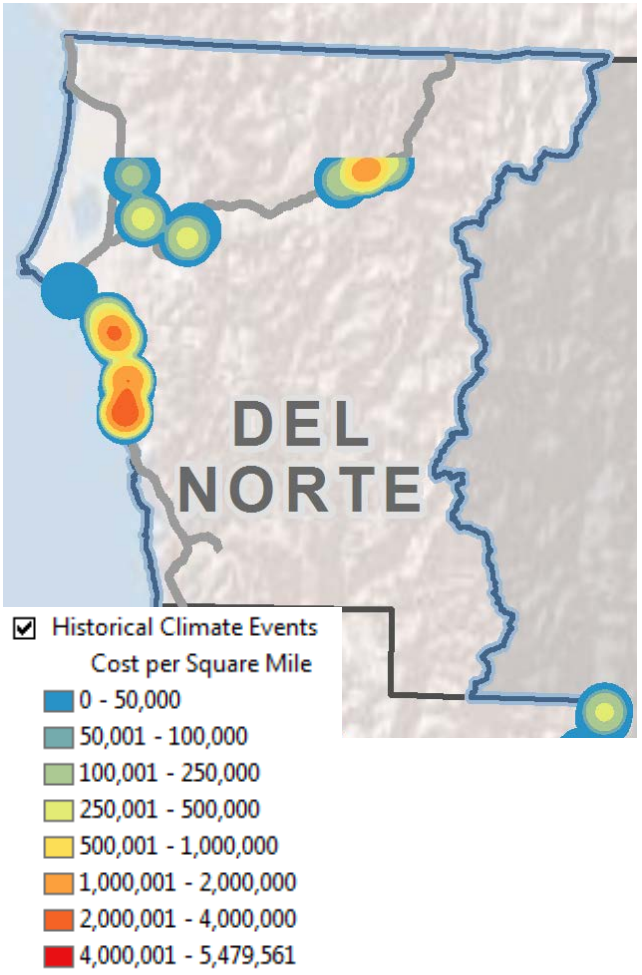

Courtesy of CALTRANS

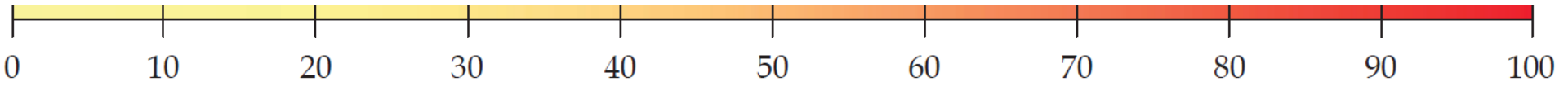
Photo: Brian Birke, Creative Commons Attribution License

Photo: laffy4k, Creative Commons Attribution License

Historic Maintenance Events



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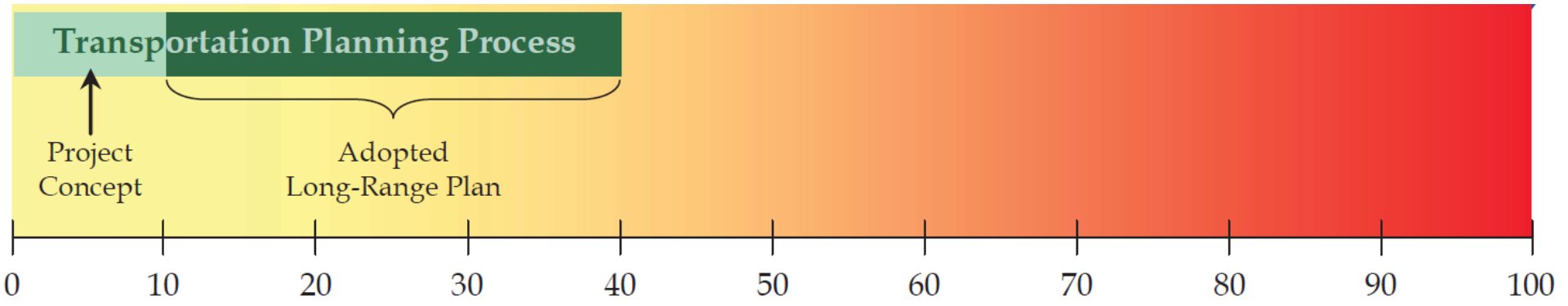
Transportation Planning Process
Project Concept
Adopted Long-Range Plan
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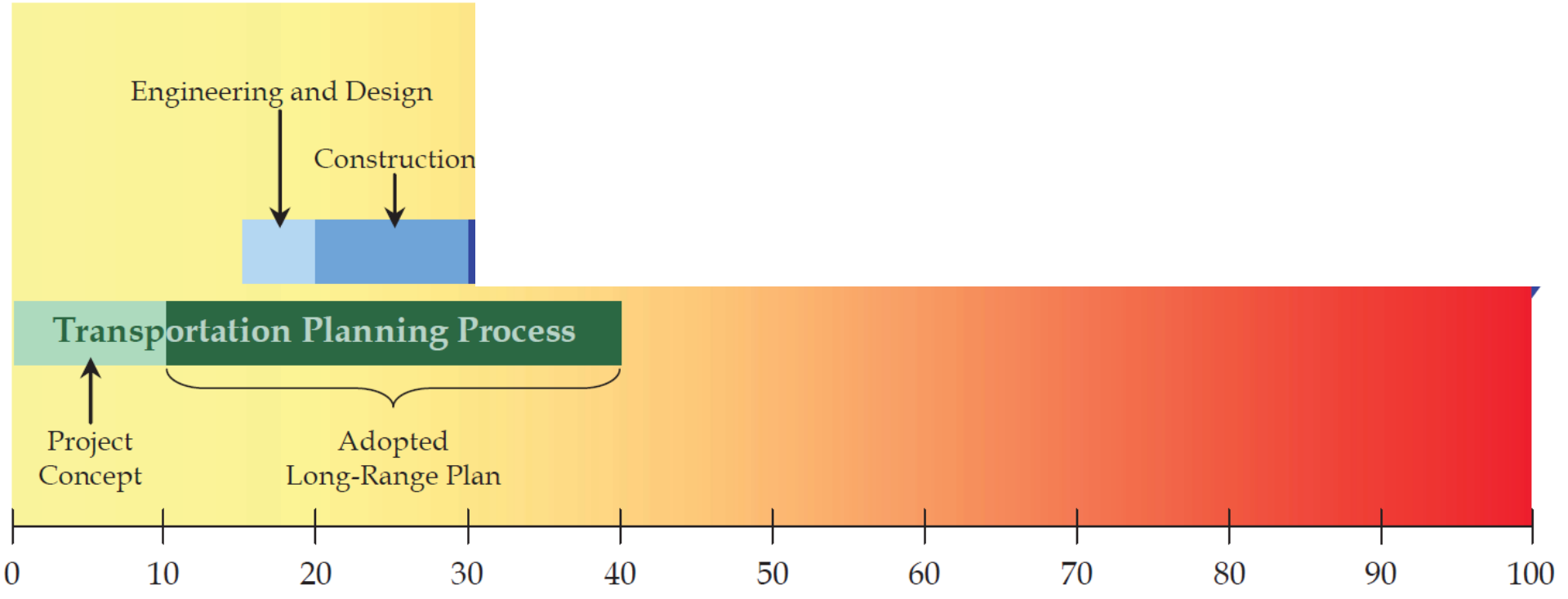
Engineering and Design
Construction
Transportation Planning Process
Project Concept
Adopted Long-Range Plan
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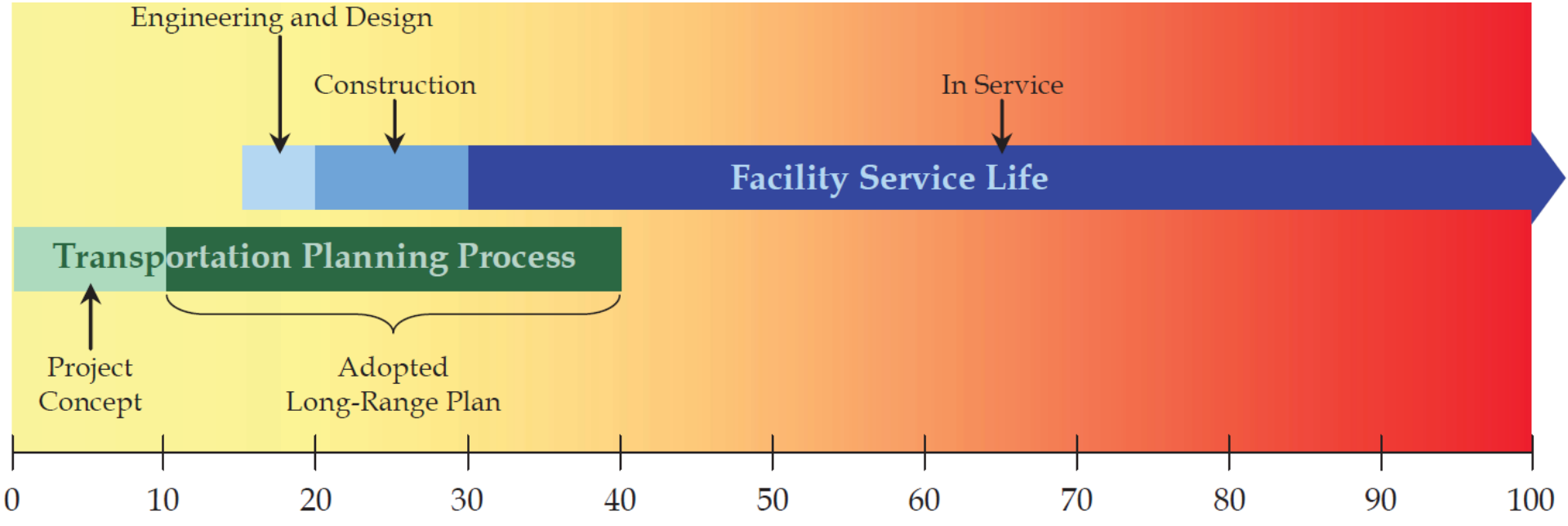
Engineering and Design
Construction
In Service
Facility Service Life
Transportation Planning Process
Project Concept
Adopted Long-Range Plan
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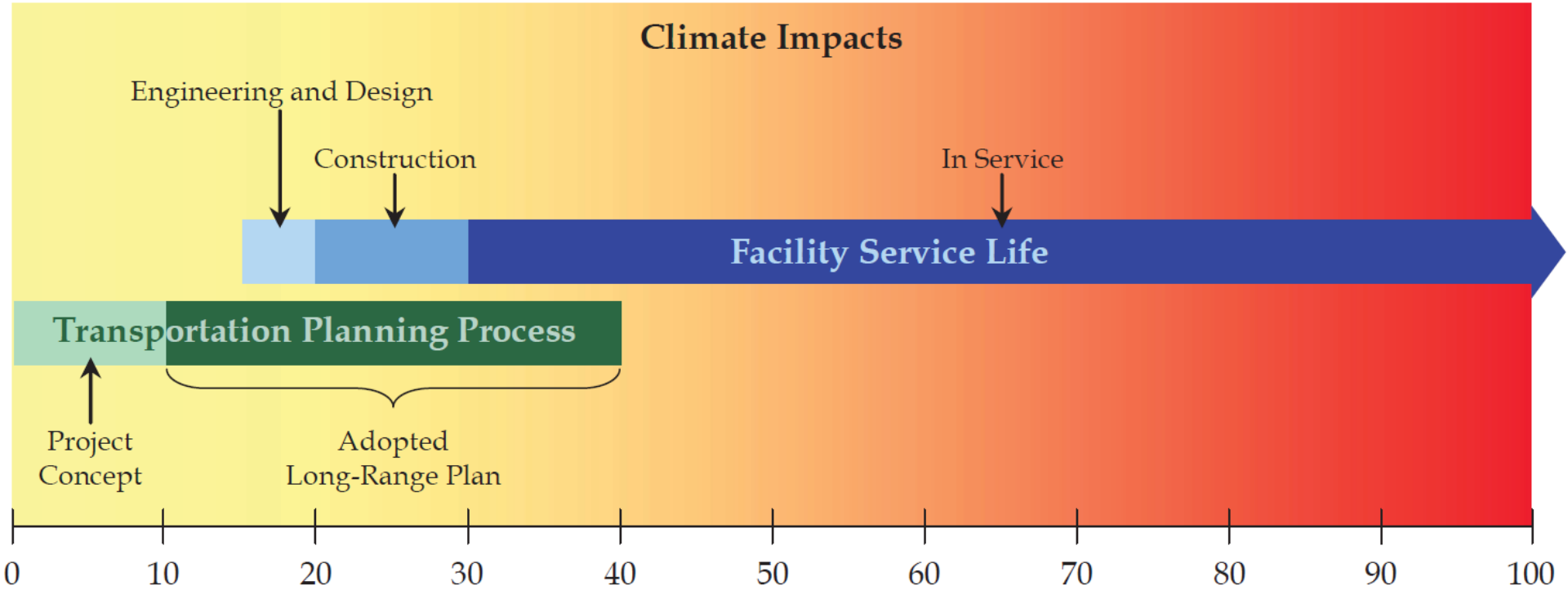
Climate Impacts
Engineering and Design
Construction
In Service
Facility Service Life
Transportation Planning Process
Project Concept
Adopted Long-Range Plan
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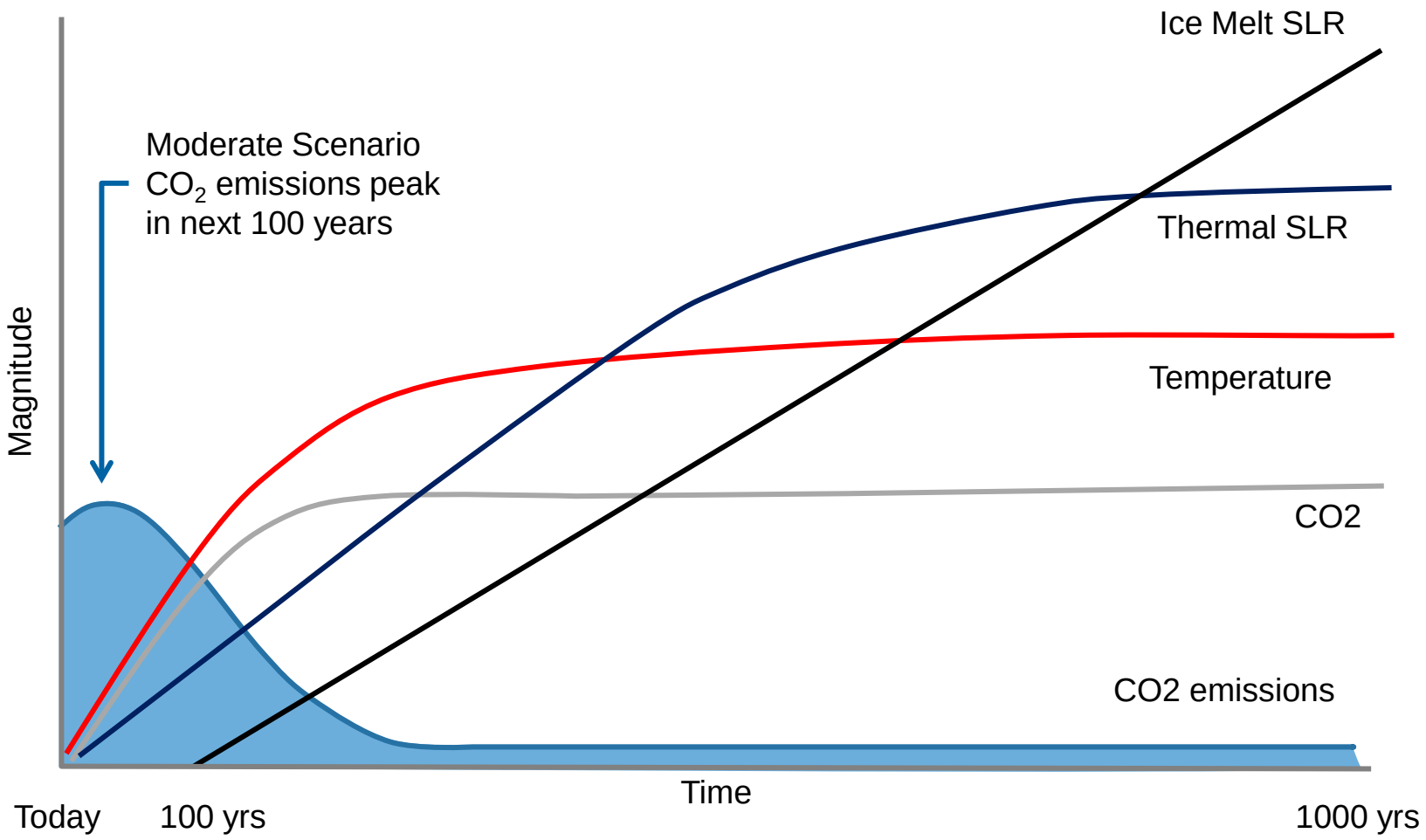
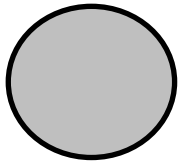
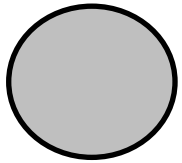

Ice Melt SLR
Moderate Scenario
CO_2 emissions peak
in next 100 years
Thermal SLR
Temperature
CO2
CO2 emissions
Magnitude
Time
Today
100 yrs
1000 yrs

Climate Change Scenarios

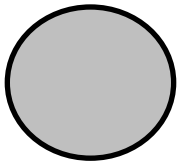
2050

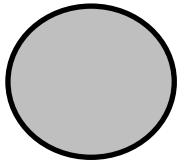
Extreme Climate Change Models

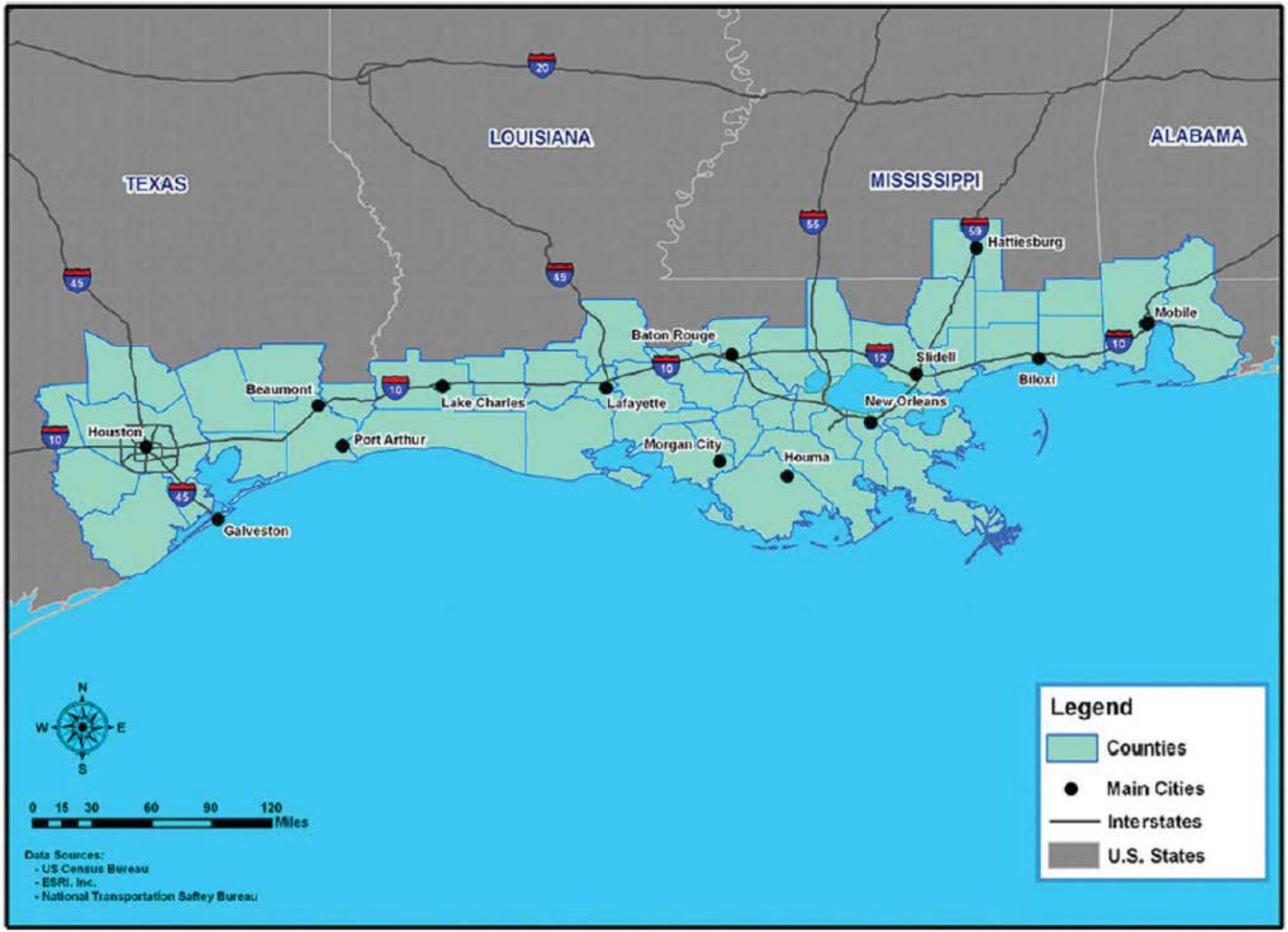




Moderate Climate Change Models






TEXAS
LOUISIANA
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ALABAMA
Hattiesburg
Mobile
Baton Rouge
Slidell
Biloxi
Beaumont
Lake Charles
Lafayette
New Orleans
Houston
Port Arthur
Morgan City
Houma
Galveston
N
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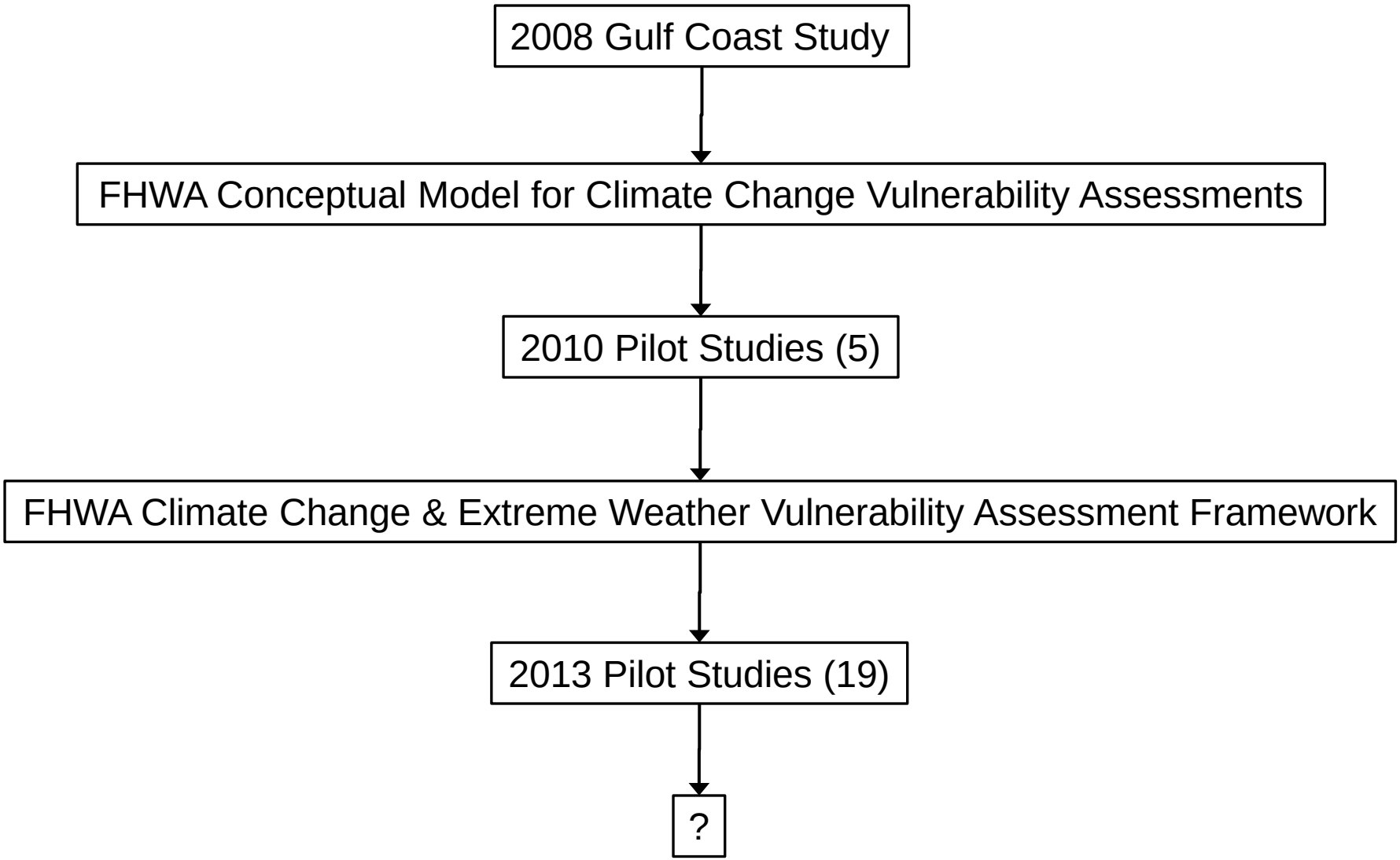
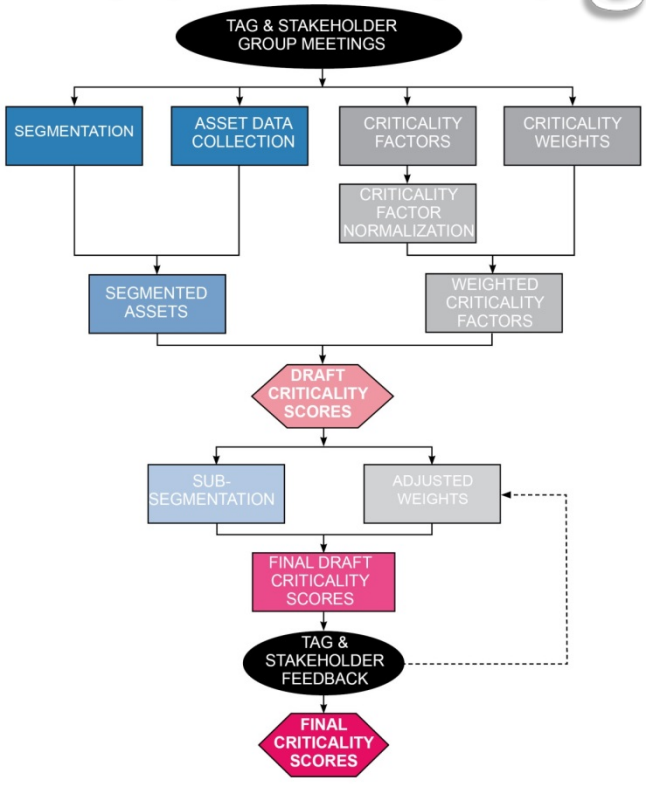
E
S
0 15 30 60 90 120
Miles
Data Sources:
- US Census Bureau
- ESRI, Inc.
- National Transportation Saftey Bureau
Legend
Counties
Main Cities
Interstates
U.S. States

PROJECT HISTORY



D1CCPS Project: Process vs. Product

Methodology

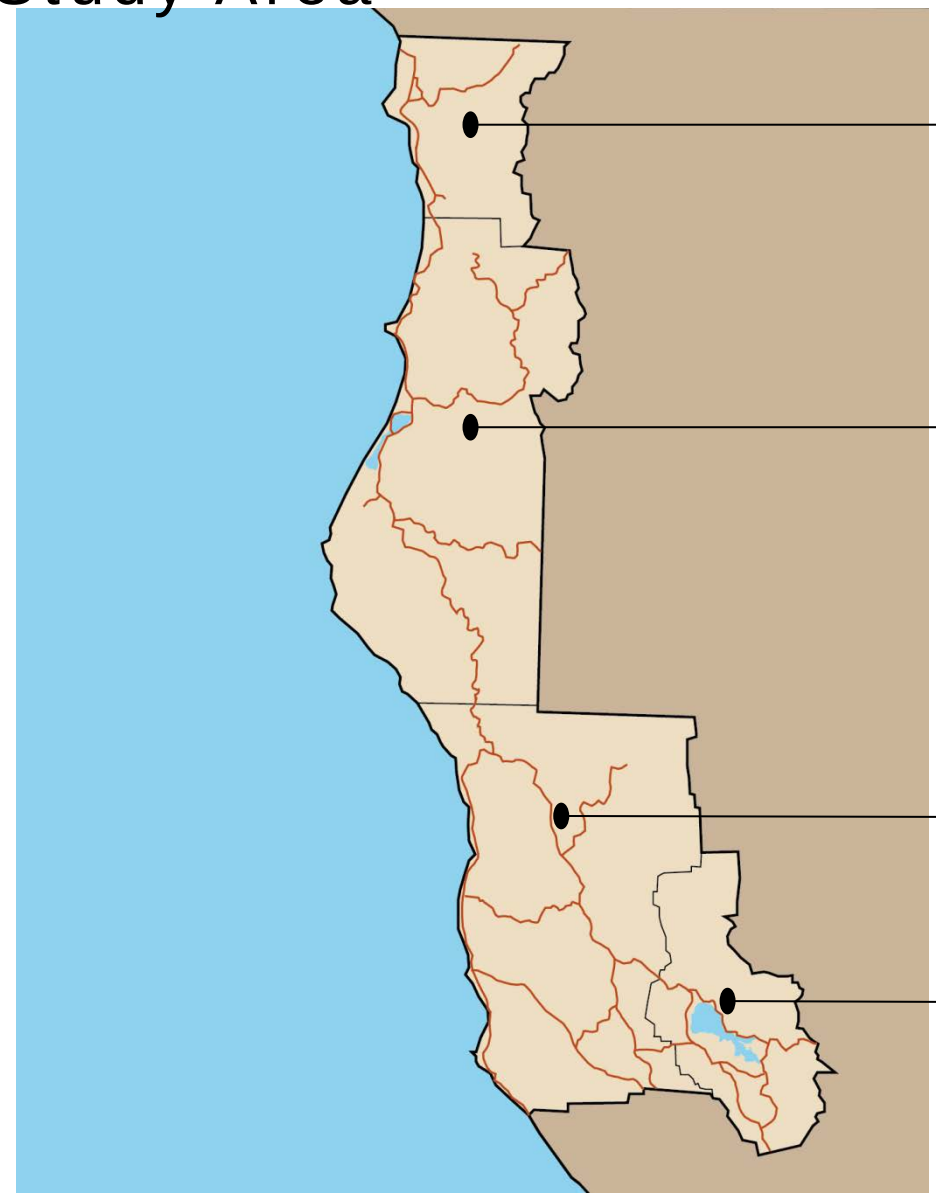


Project Objectives

1. Identify **Vulnerabilities**

2. Analyze **Adaptation Options**

Study Area



Identify vulnerabilities

What is *vulnerability?*

Exposure

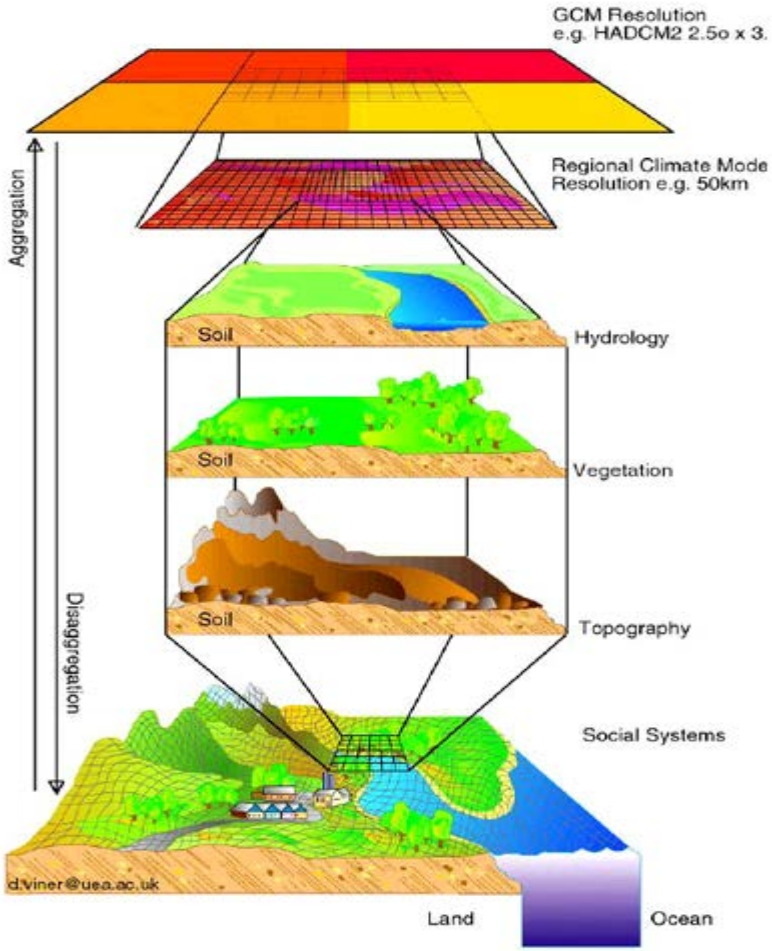
Climate Change Effects

- Temperature
- Precipitation
- Runoff
- Sea level rise
- Coastal erosion hazards
- Wildfire

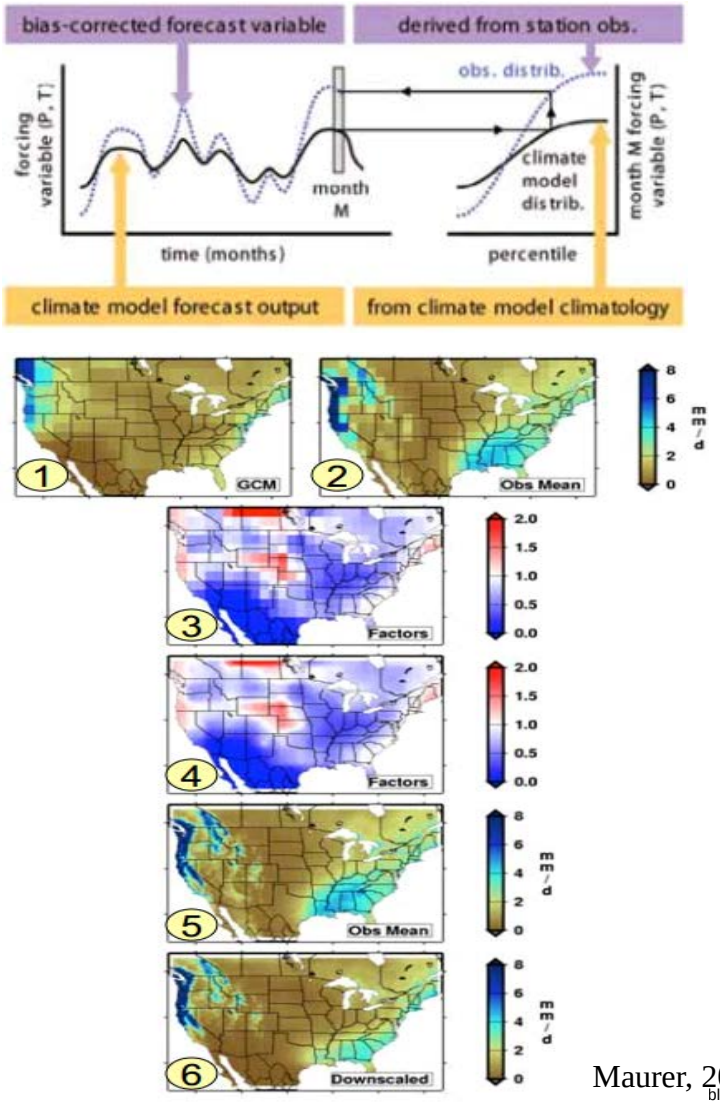
Moderate & Extreme changes at 2050 and 2100

How do we know?

Dynamical



Statistical



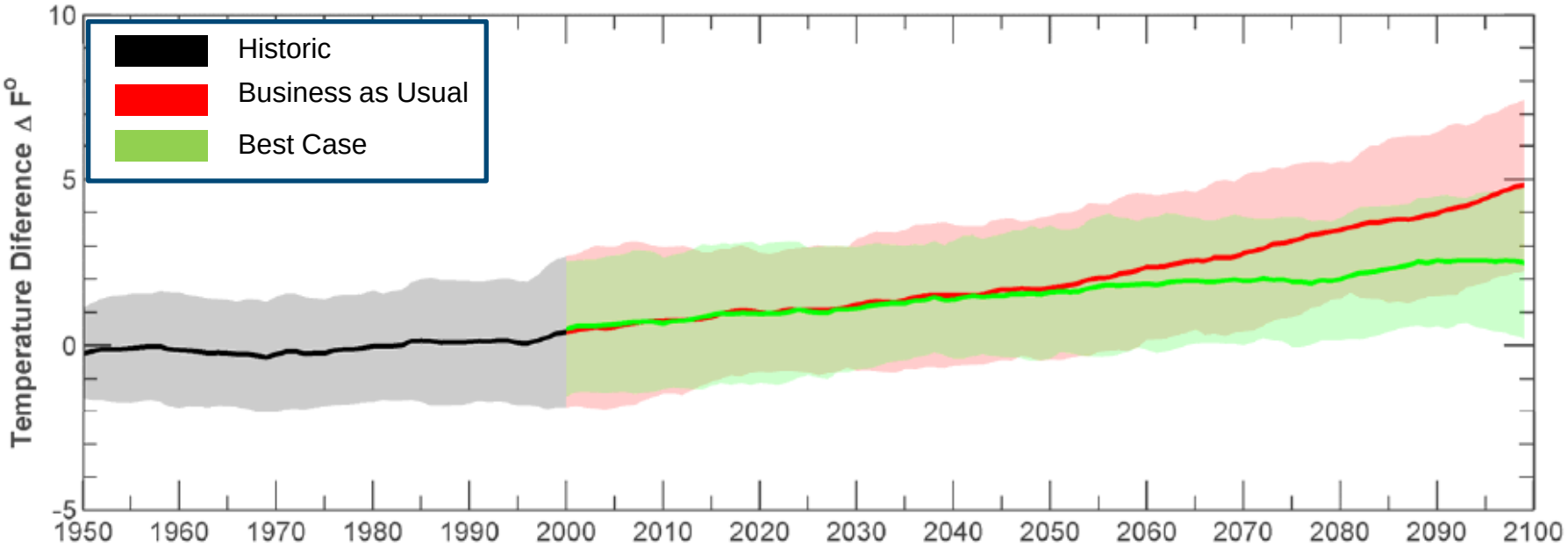
David Viner, Climatic Research Unit, University of East Anglia, UK

Maurer, 2008

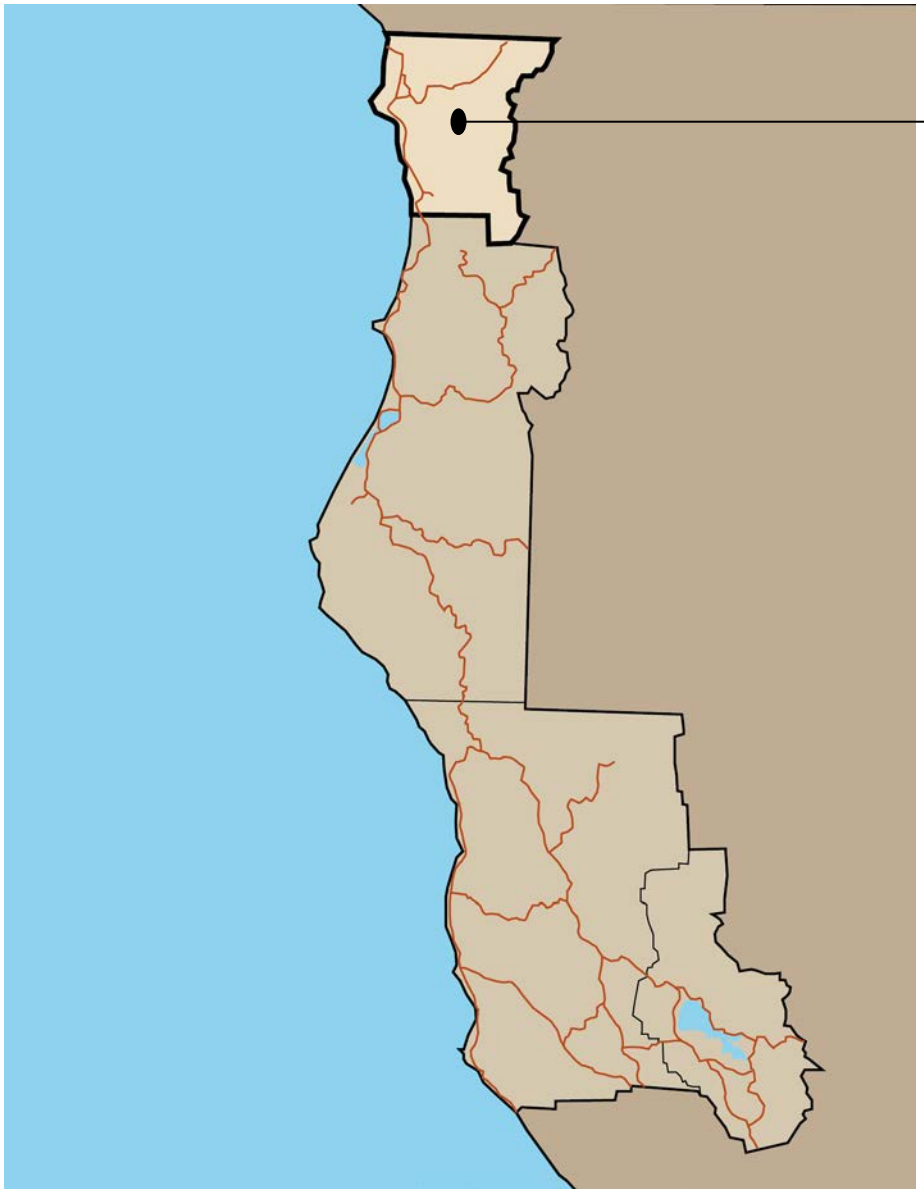
RESULTS OF EXPOSURE ANALYSIS

Climate Change Effects

Changes in Average Daily Maximum Temperature



Del Norte County



DEL NORTE

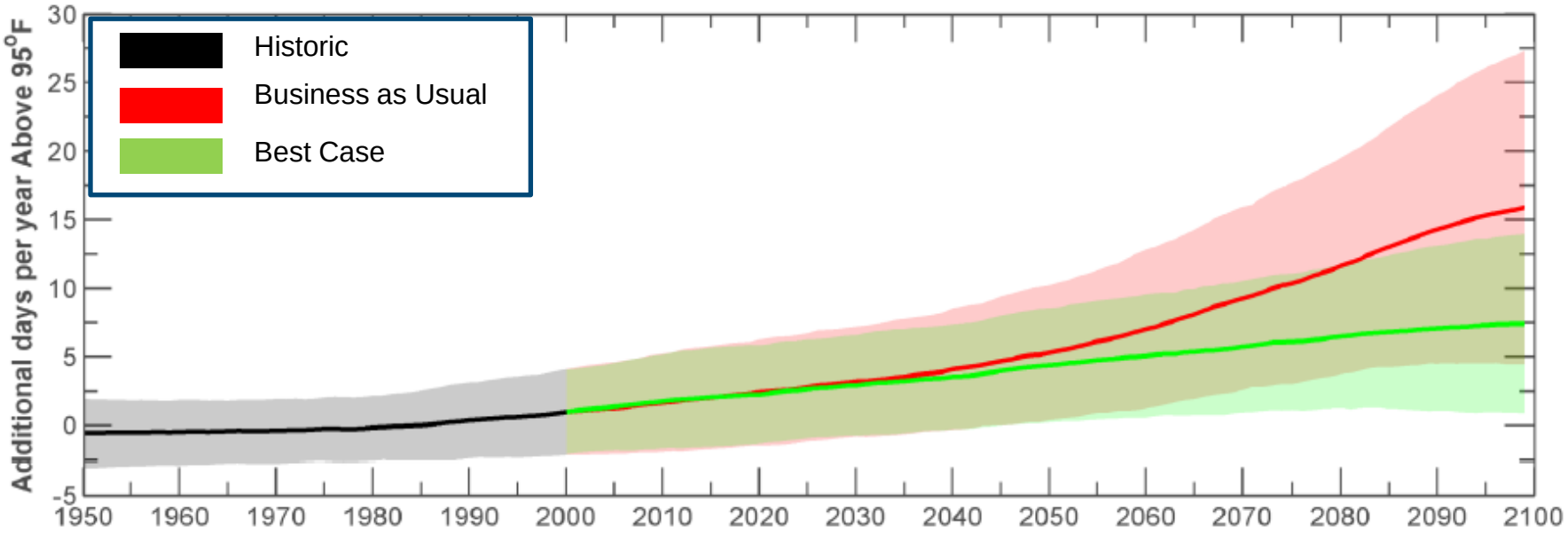
+2.8 to 3.2°F - 2050

+4.0 to 6.7°F - 2100

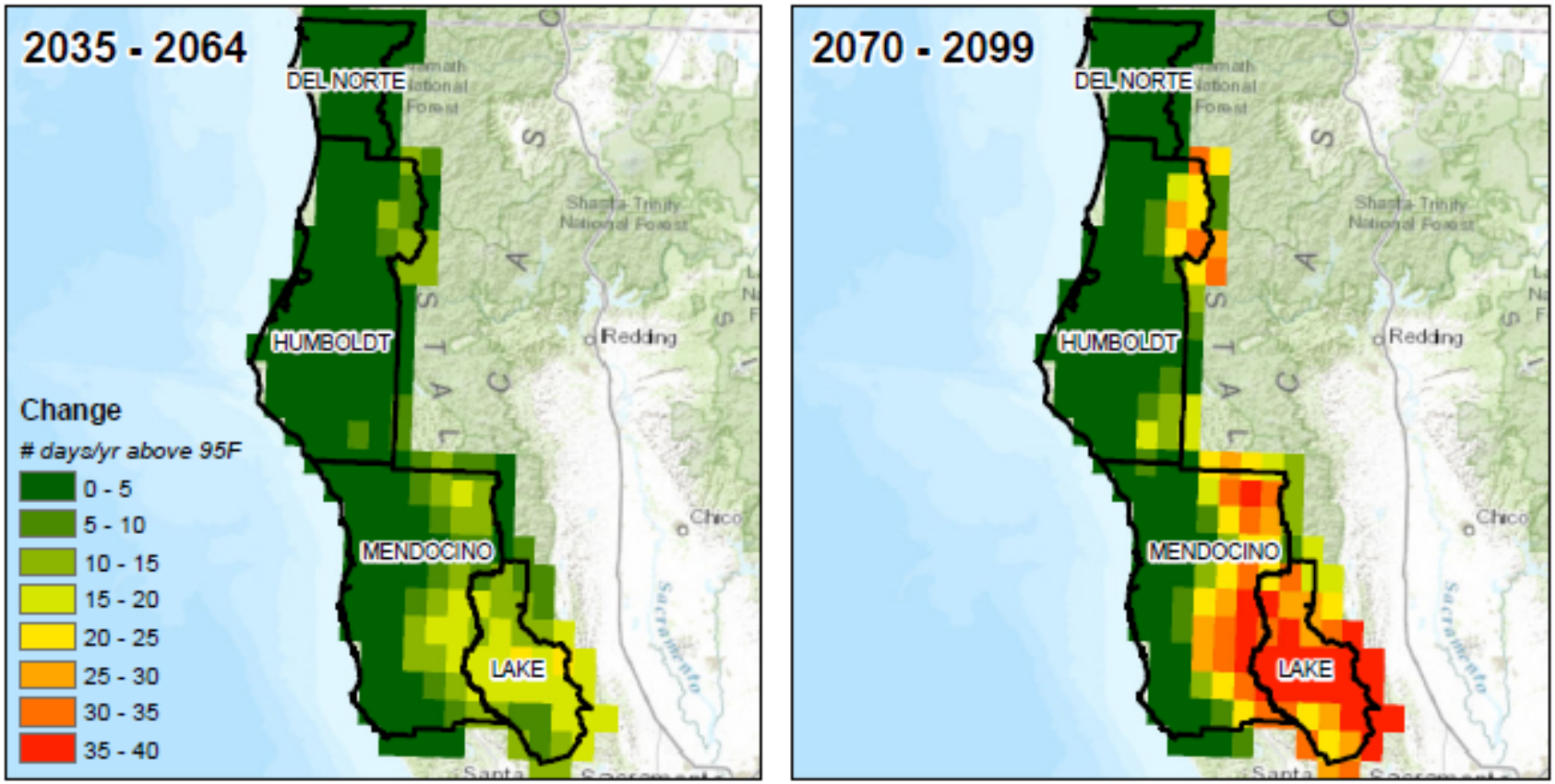
Increased average temperature

Climate Change Effects

Extreme Temperature (additional days above 95F)



Extreme Temperatures



Increased days above 95°F.

Sea Level Rise

King Tides Rising

Sea Level Rise

2000 0 in

2050

12-14 in

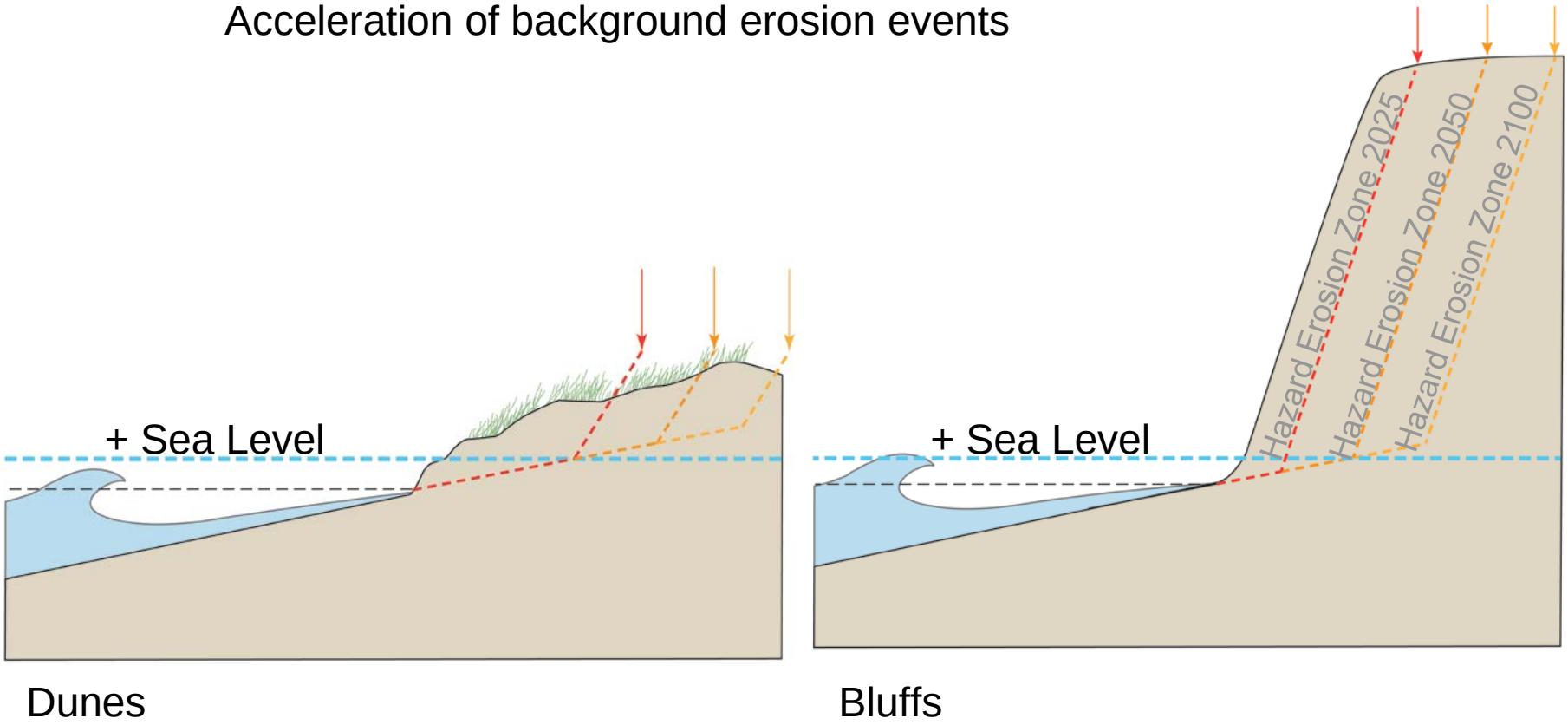
2100

36-55 in

2100+ ?? in

Coastal Erosion

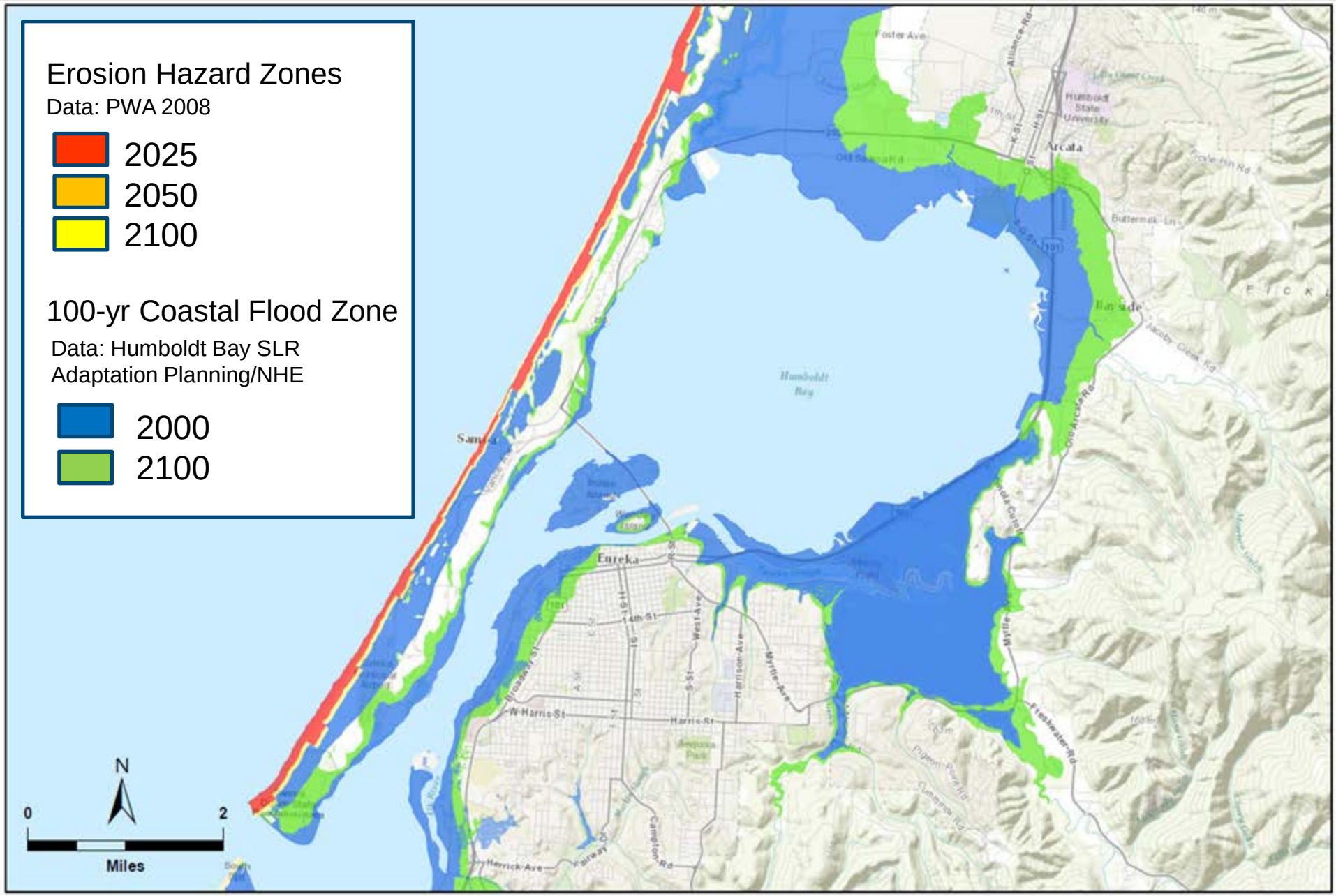
Erosion is episodic
Acceleration of background erosion events



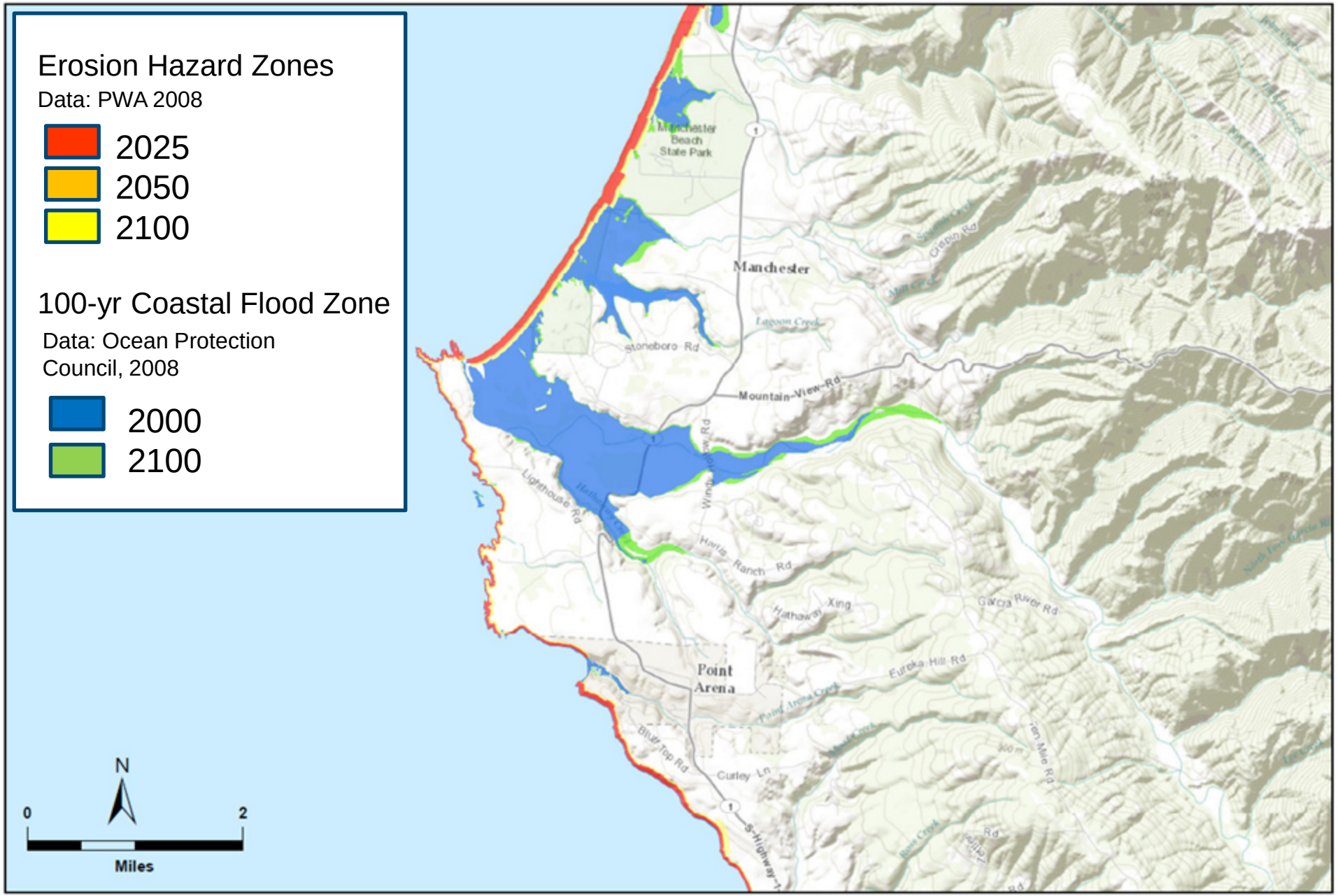
Dunes

Bluffs

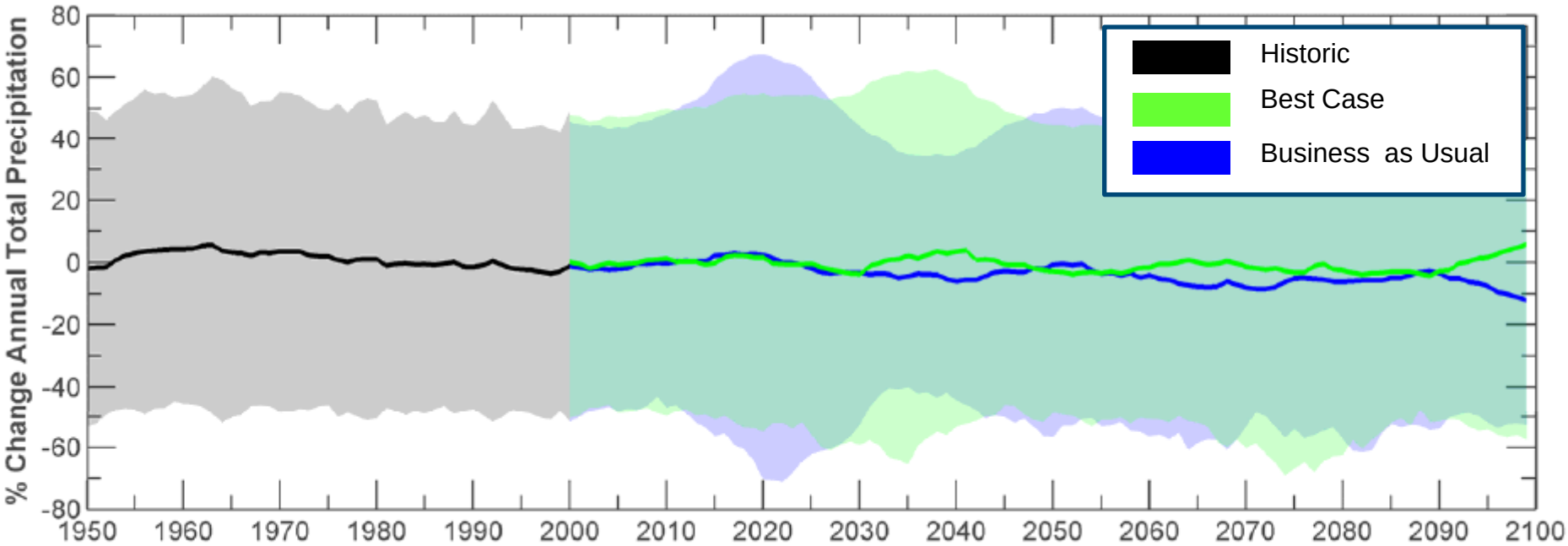
Coastal Hazards



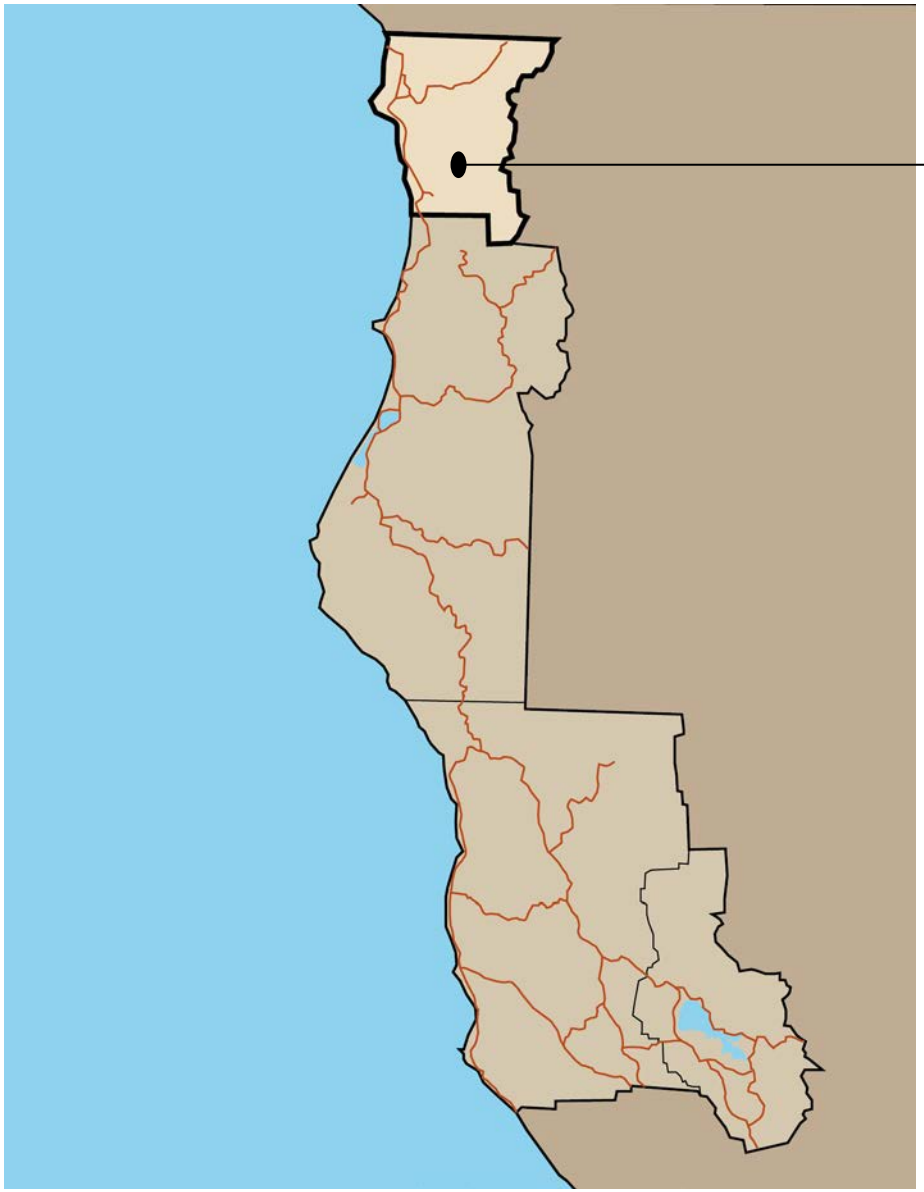
Coastal Hazards



Rainfall change



Del Norte County



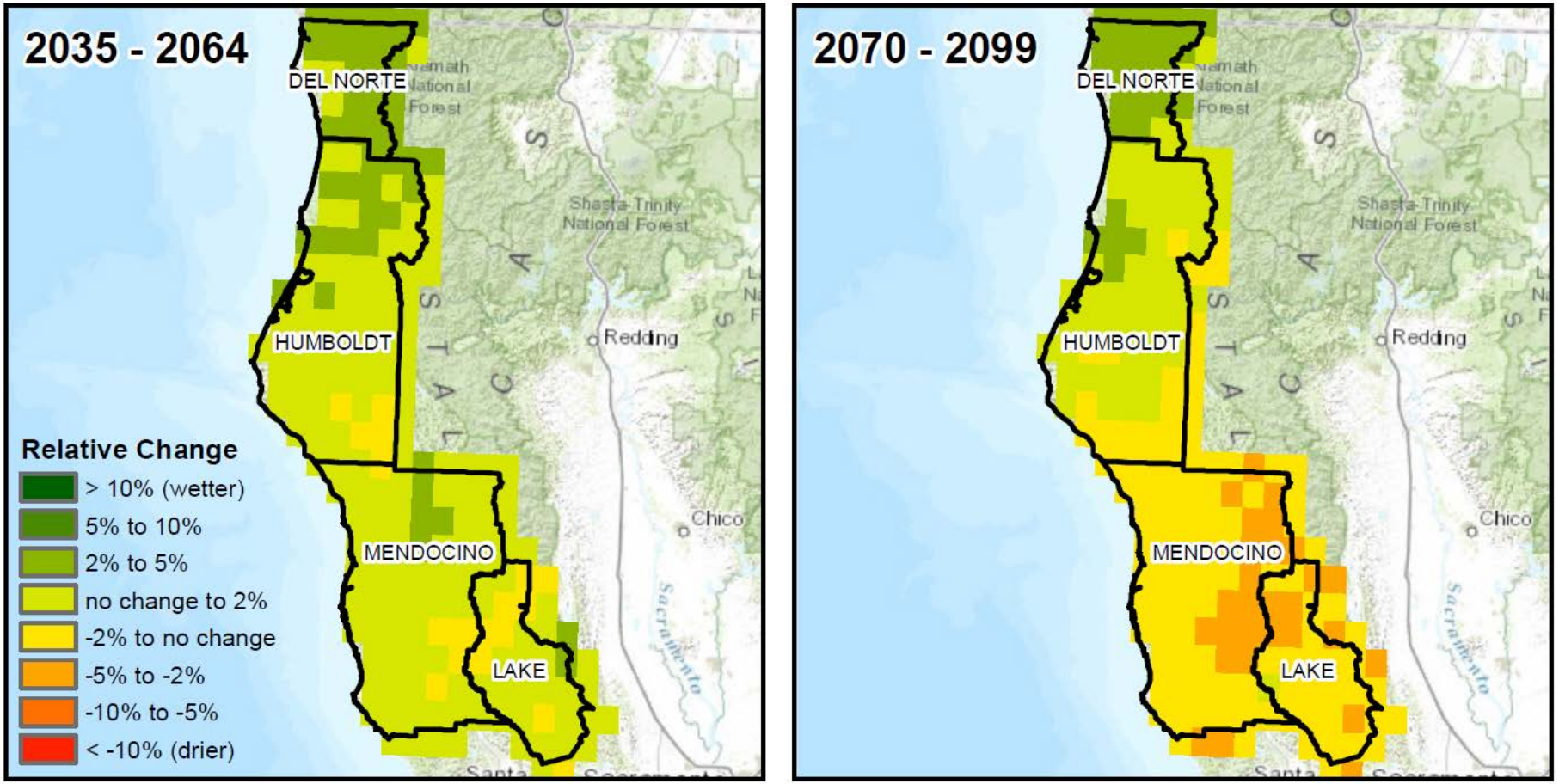
DEL NORTE

-3% to 0%	2050
-5.6 to 0.6%	2100

Changes in average rainfall

Extreme Precipitation

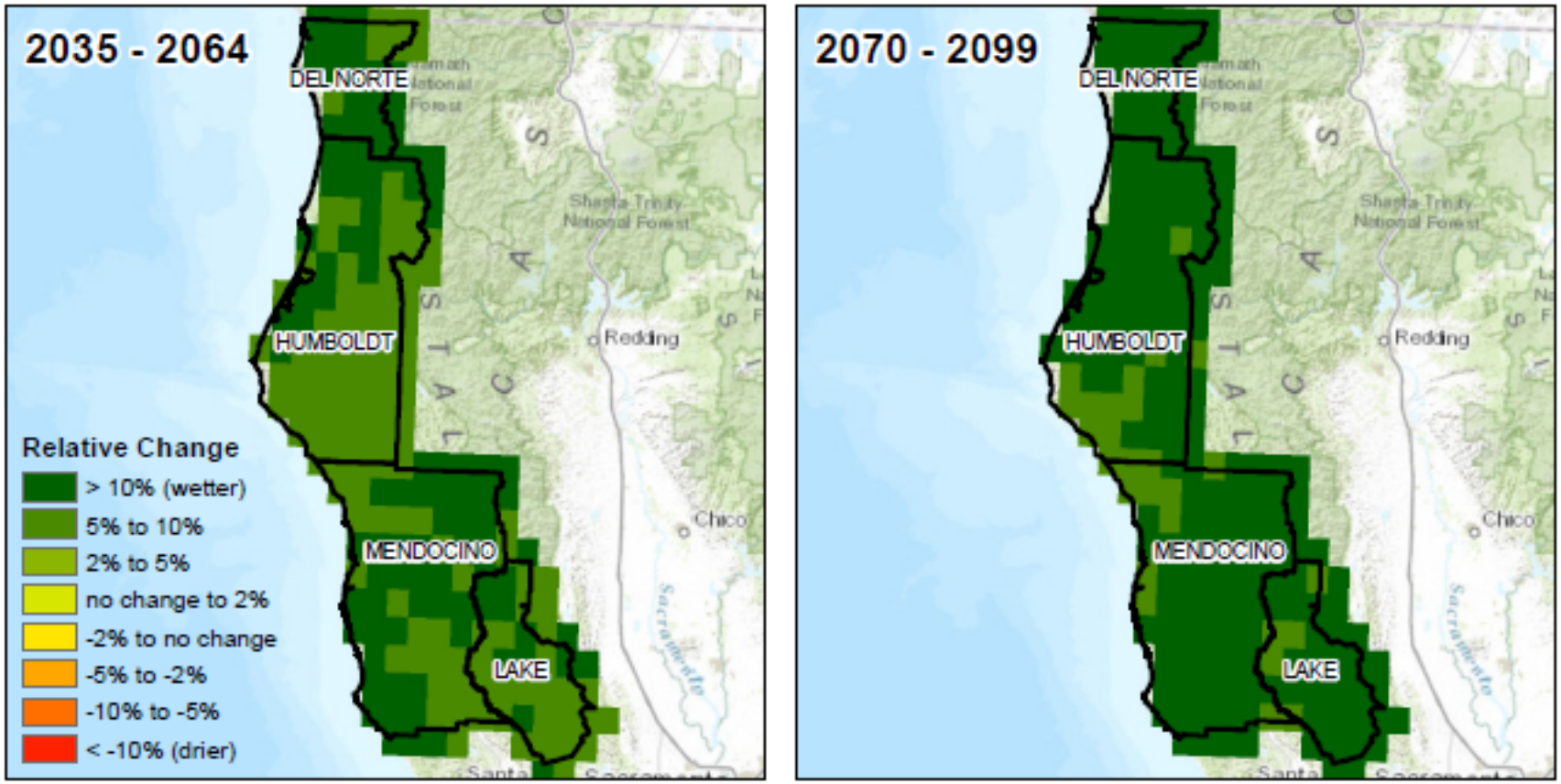
Moderate Scenario



Changes in extreme rainfall

Extreme Precipitation

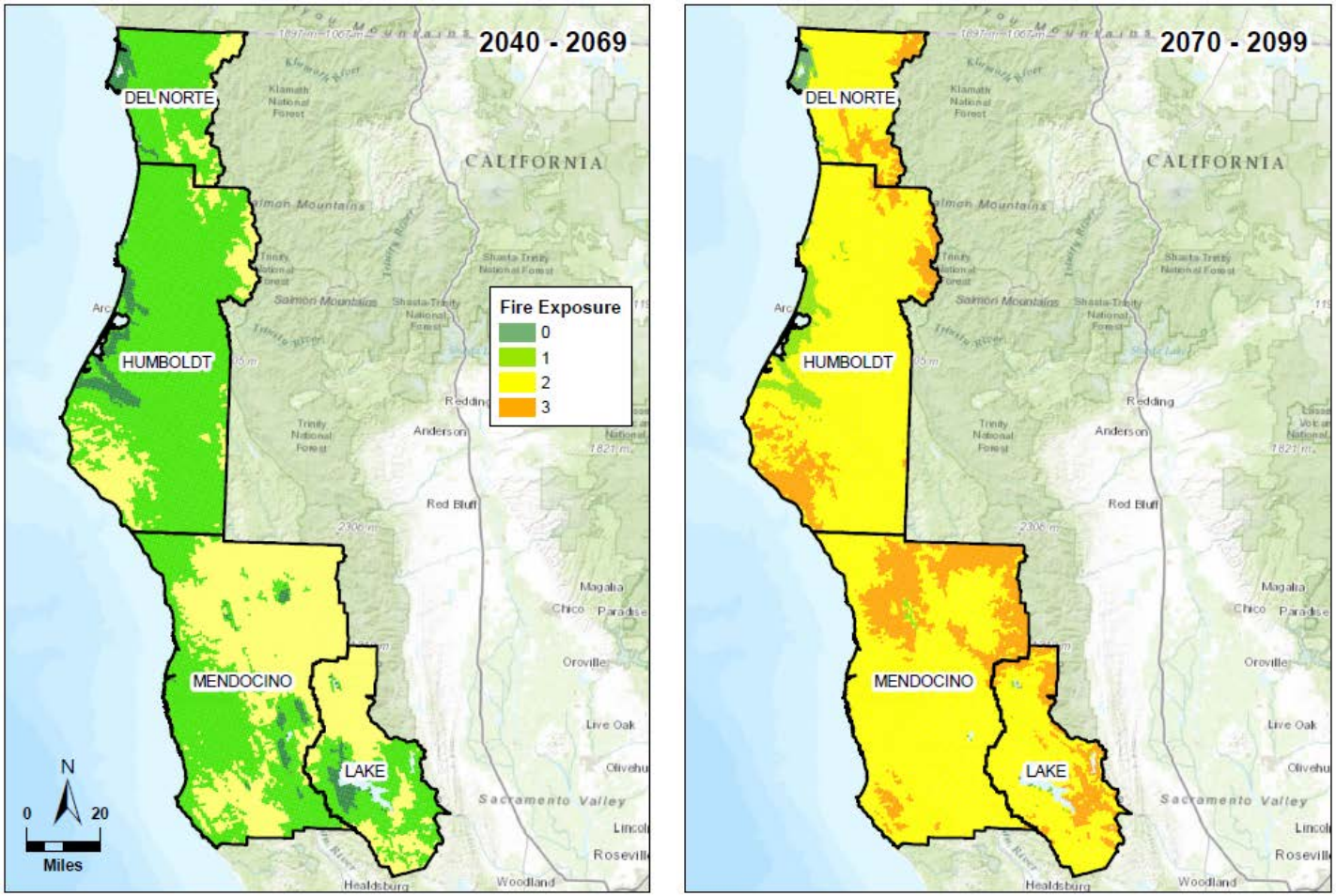
Wet scenario



Changes in extreme rainfall

Wildfire Exposure

Moderate Scenario



Data: DWR, 2014

Changes wildfire risk

What is “Potential for Impact”

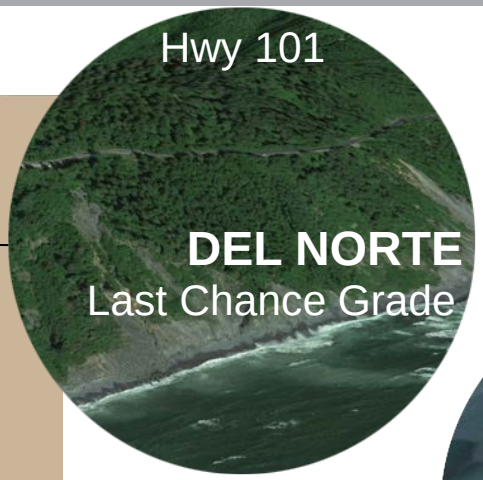
Delay

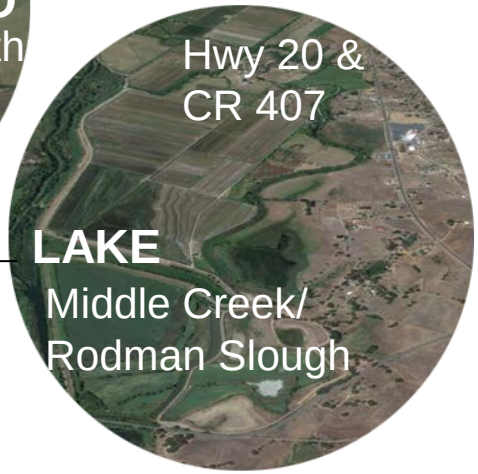
Temporary Closure – Damage

Failure

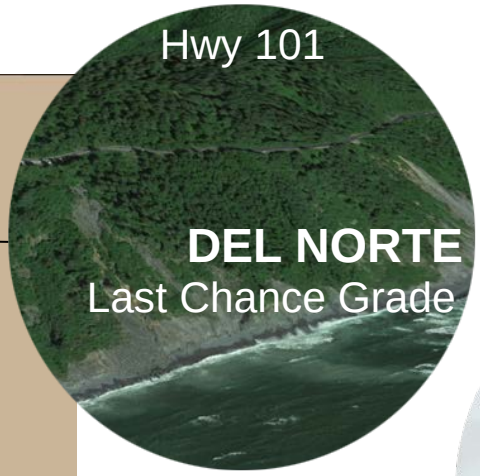
ADAPTATION Prototype Sites

ADAPTATION Sites





ADAPTATION Sites

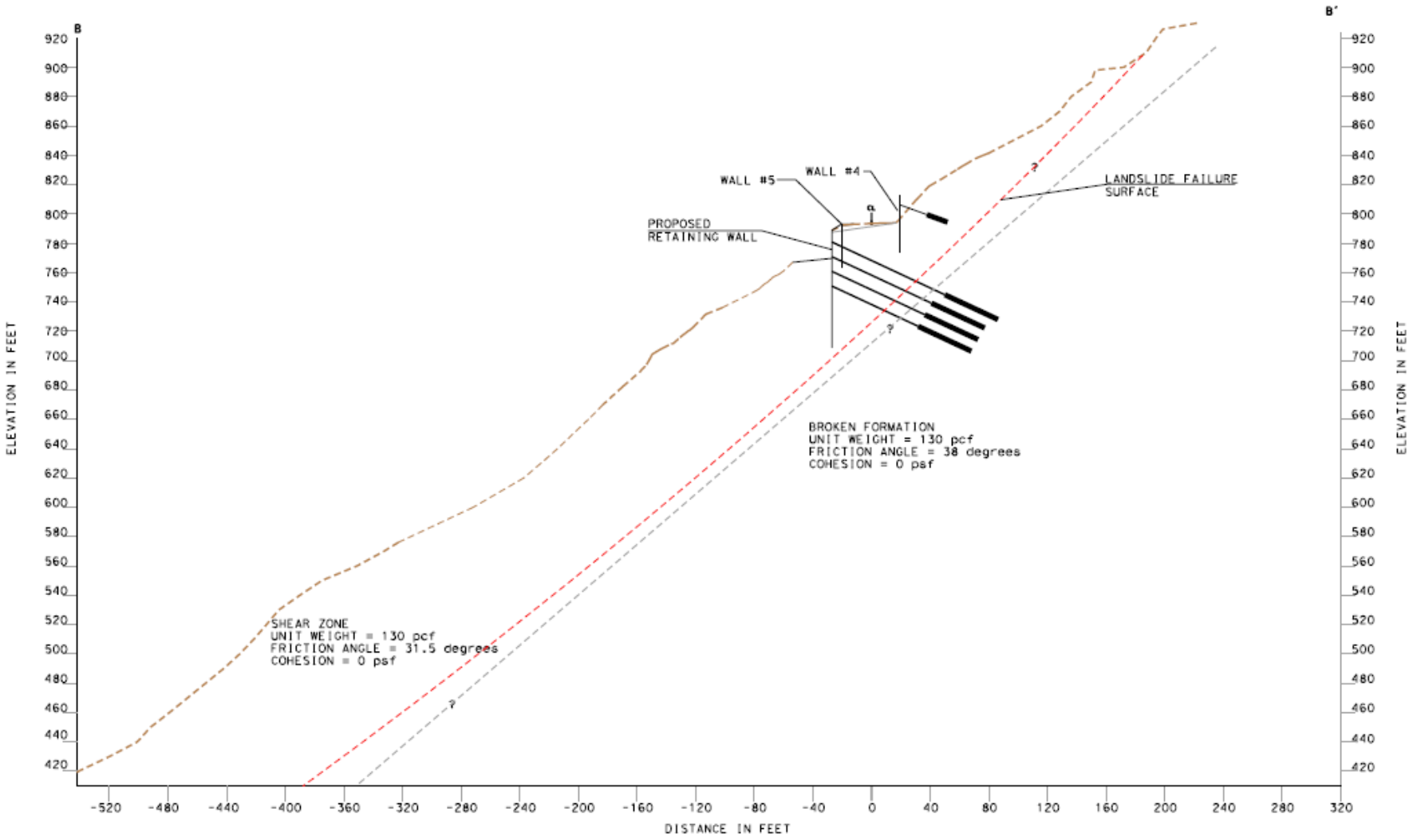


Del Norte County

Last Chance Grade

Del Norte County

Last Chance Grade



The ELB wall design attempted to go behind the presumed slide plane.

Del Norte County

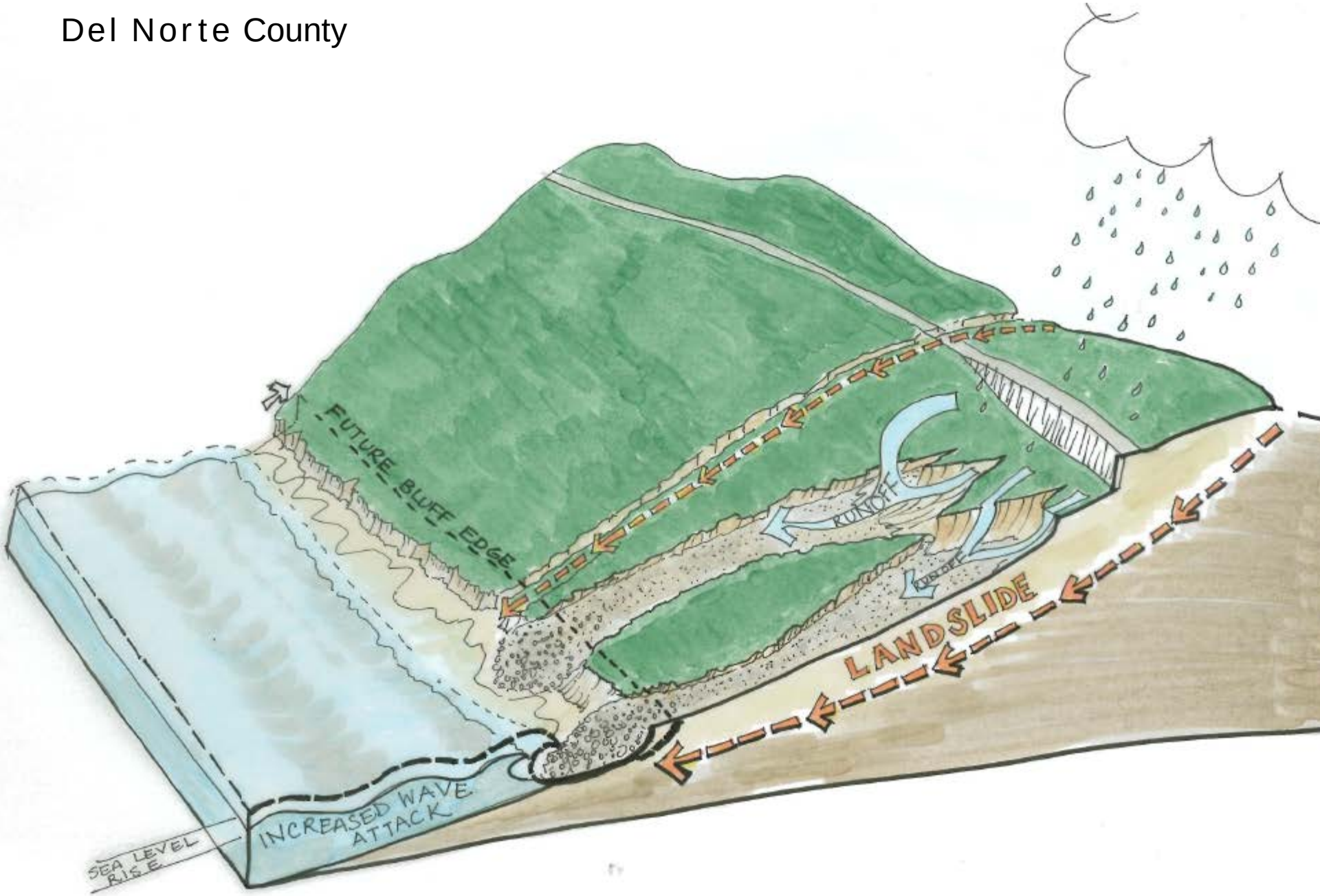
2100
Legend

SYMBOL

- SLOPE MOVEMENT
- DRAINAGE
- SEA LEVEL
- Prototype Location
- Roadways
- 100-year Coastal Flooding
- Coastal Cliff Erosion Hazard Zone

Last Chance Grade

Del Norte County



Last Chance Grade

Del Norte County

Del Norte County

Del Norte County

Del Norte County

Del Norte County

Del Norte County

Del Norte County

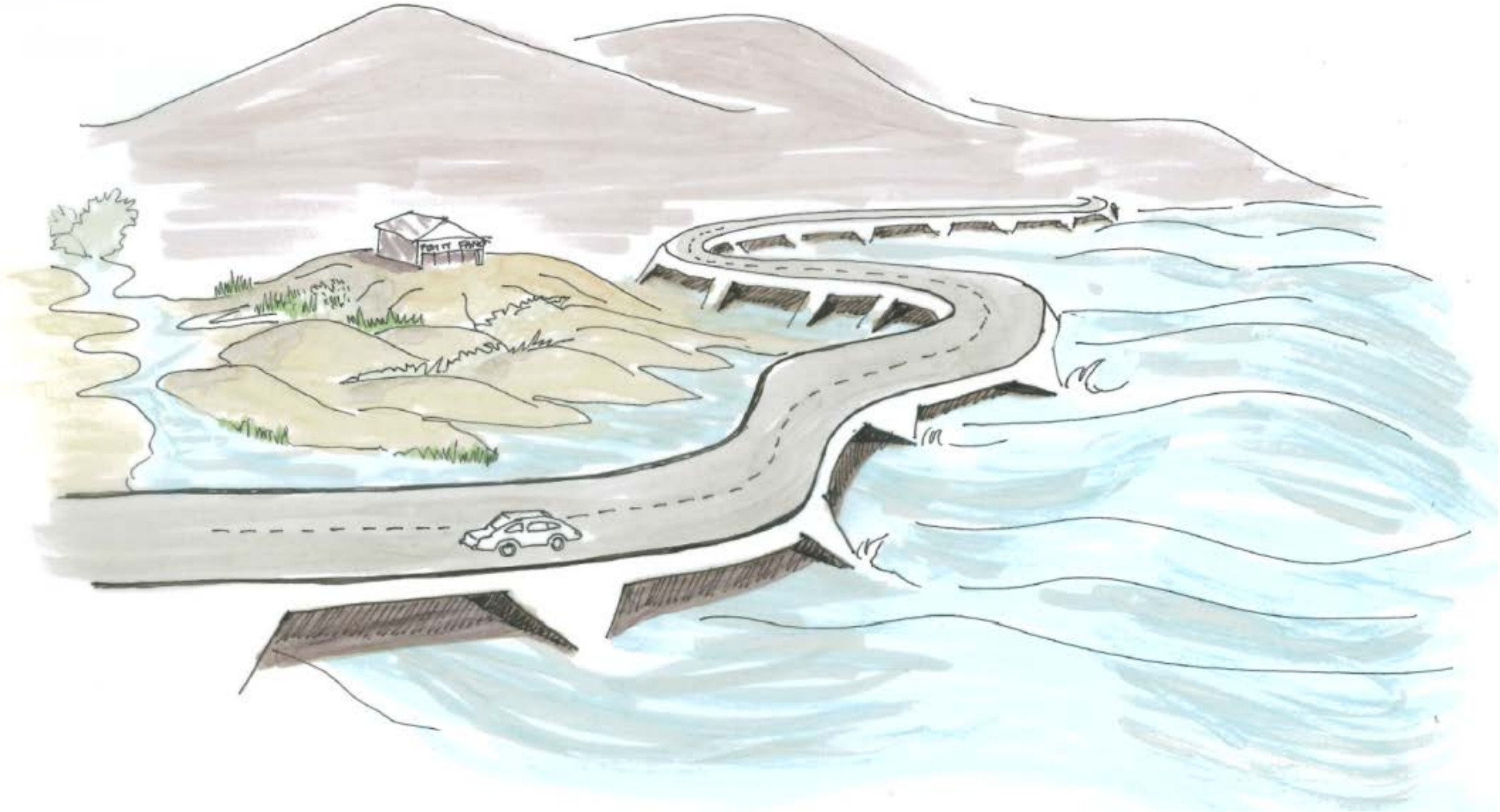
ADAPTATION Options

Adaptation approaches

Existing

Adaptation approaches

Defend



Adaptation approaches

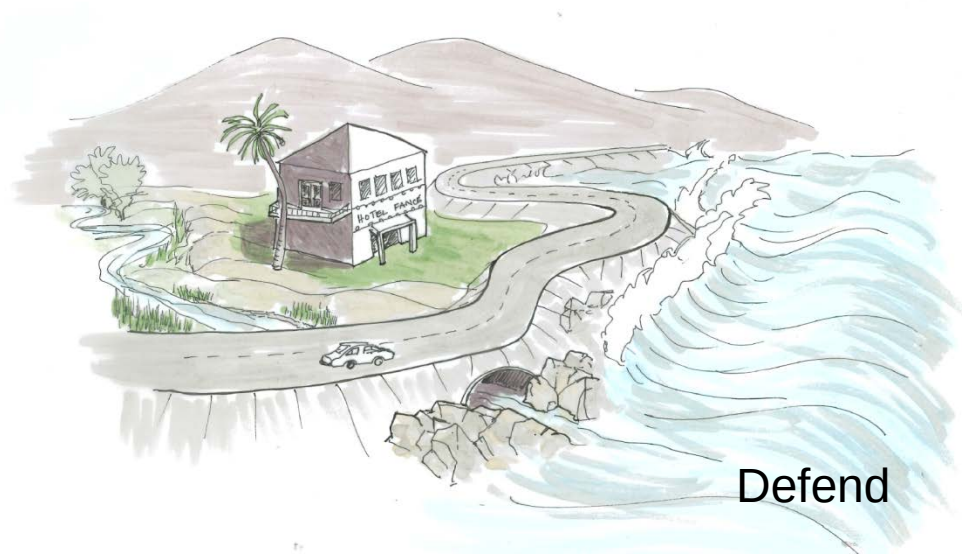
Adapt

Adaptation approaches

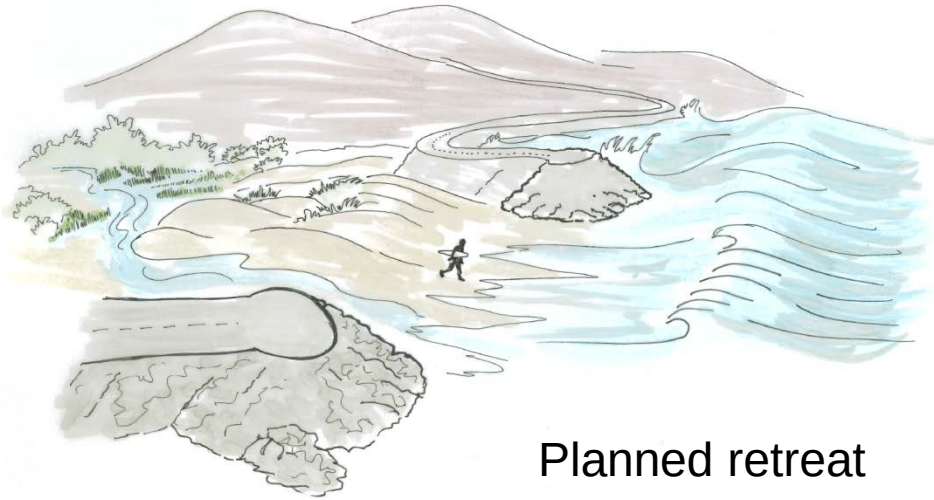
Planned Retreat

Adaptation approaches

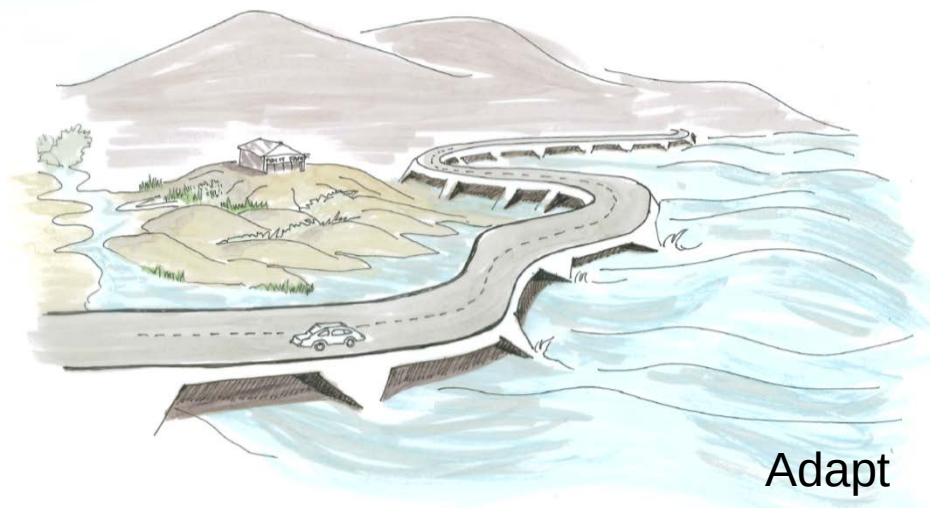
Forced Retreat



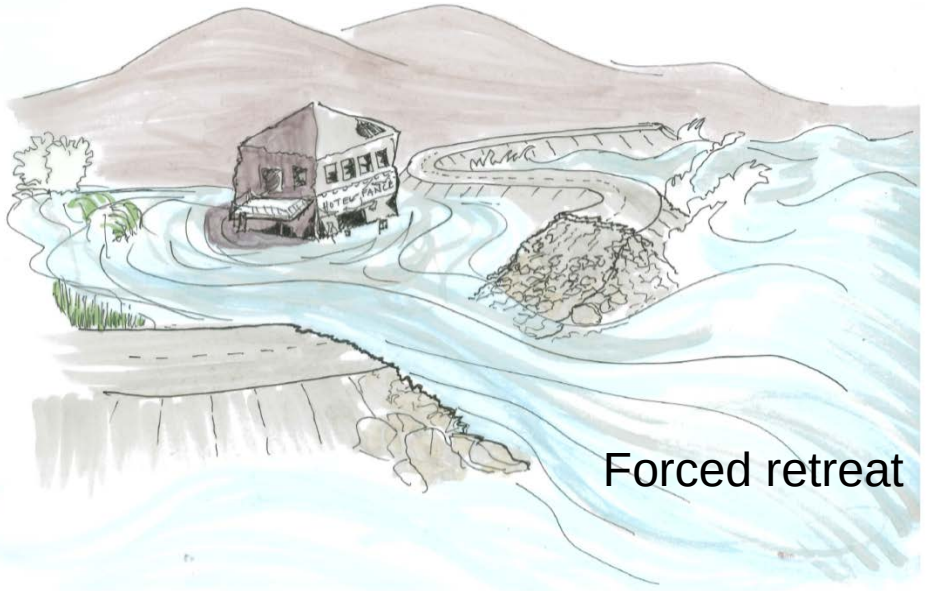
Defend



Planned retreat



Adapt



Forced retreat

Adaptation approaches

Adaptation approaches

Defend

Adaptation approaches

Flood Walls
Sea Walls
Levees
Dikes

Living shoreline

Photo: GoogleEarth

Adaptation approaches

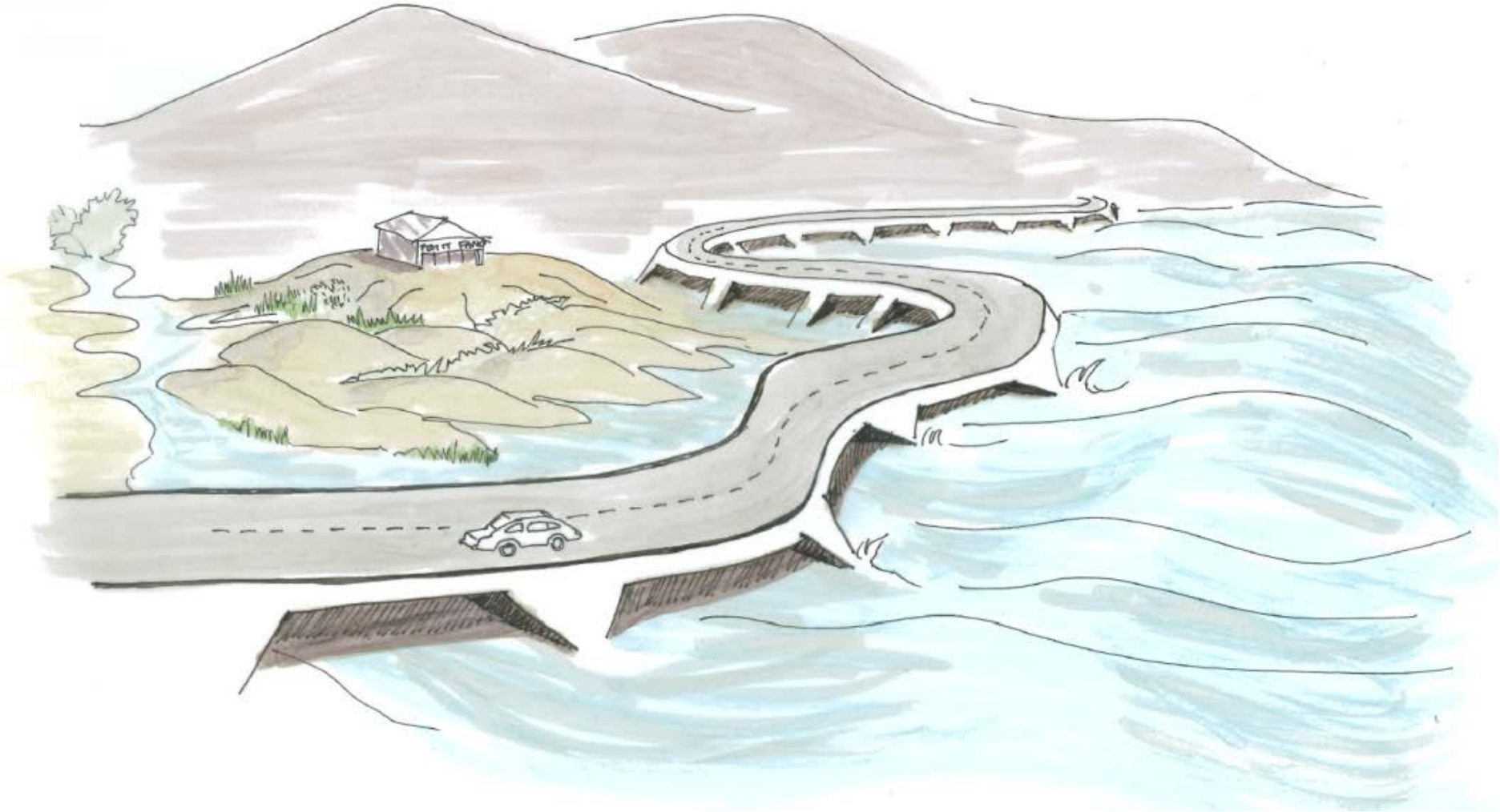
Soil nails

&

Retaining walls

Photos: Google Earth

Structural modification until failure



Adaptation approaches

Adapt

Causeways

Photo: California Coastal Records Project

Floodable Bridges

Photo: Google Earth

Adaptation approaches

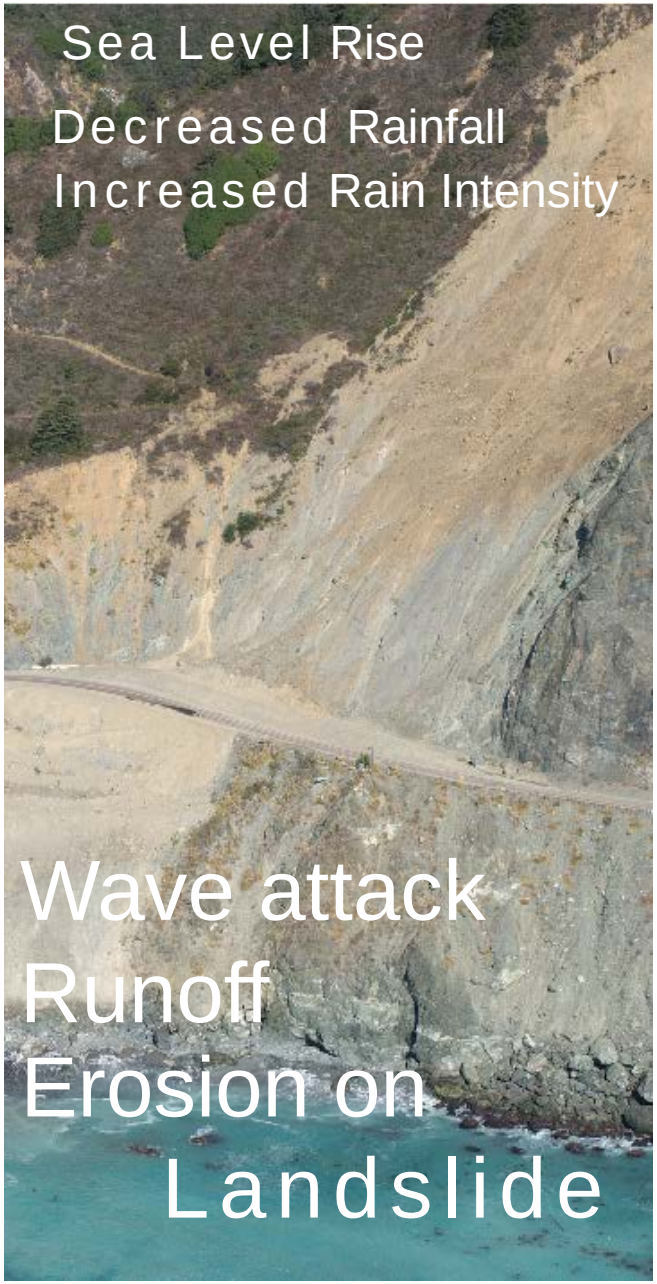
Adaptation approaches

Raise bridges & roads

Photos: Peter Dobbins/Friends of the Garcia River (FrOG)

Armor roads

Photo: MoBikeFed, , Creative Commons Attribution License



Bridge over

Tunnel under

Photos: California Coastal Records Project

Adaptation approaches

Adaptation approaches

Planned Retreat

Adaptation approaches

Photo: Google Earth

Image: Ocean Beach Master Plan

Re-route & Retreat

Adaptation approaches

Photo: Google Earth

Re-route / Planned Retreat

Adaptation approaches

Forced Retreat

Sea Level Rise

Decreased Rainfall
Increased Rain Intensity

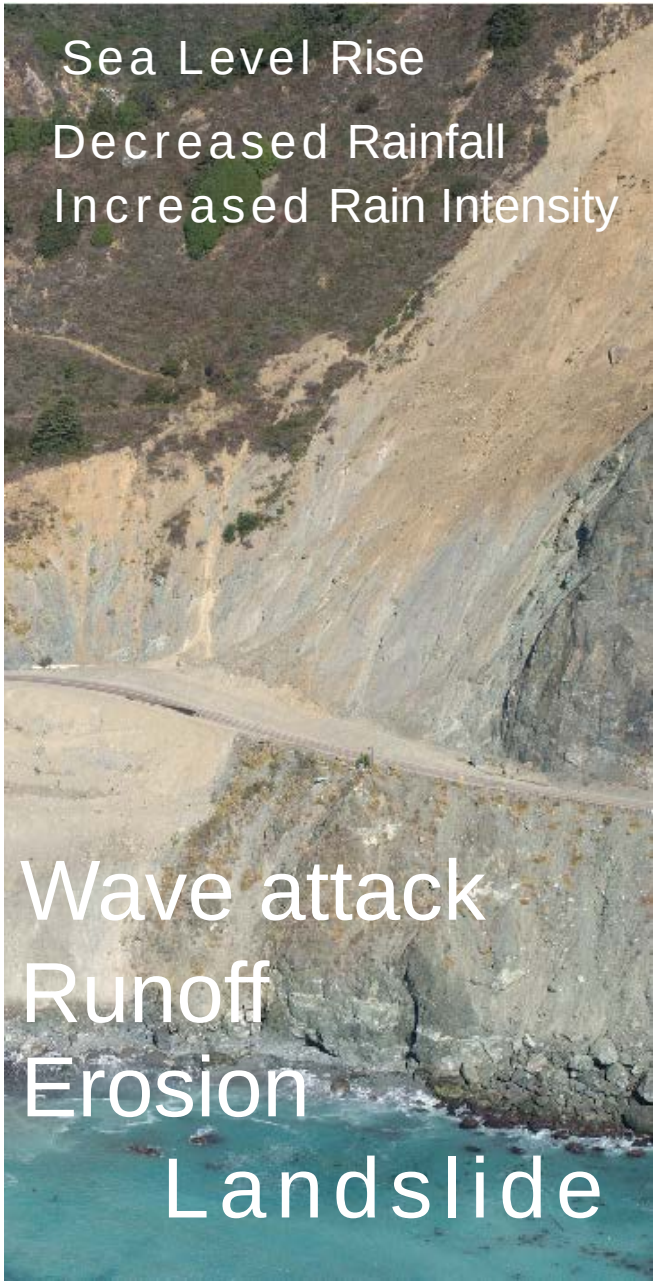
Coastal & Flash Flooding

Coastal Erosion

Adaptation approaches

No Action:

Flooding & Road Closures



Adaptation approaches

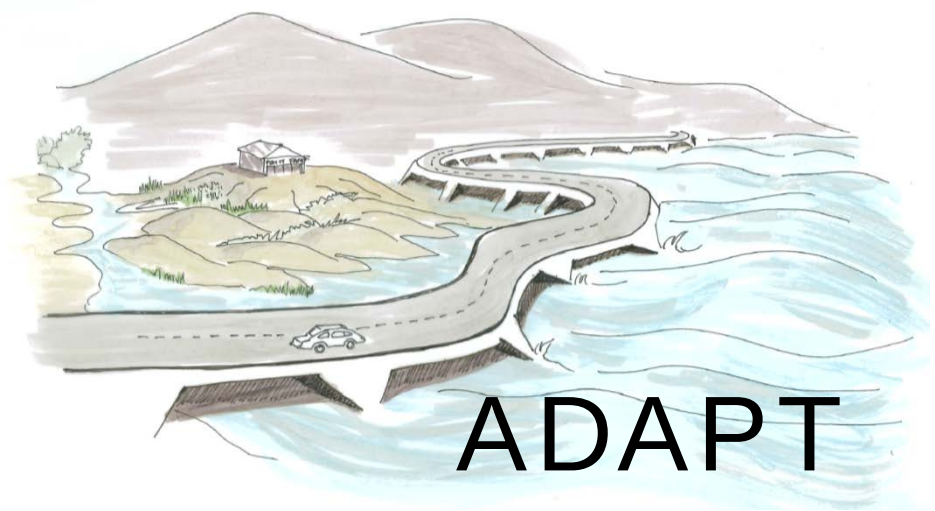
No Action:

Landslides
&
Road
Closures

Images: Wikipedia

DEFEND

planned
RETREAT



ADAPT

forced
RETREAT

Adaptation approaches

Adaptation Assessment Criteria

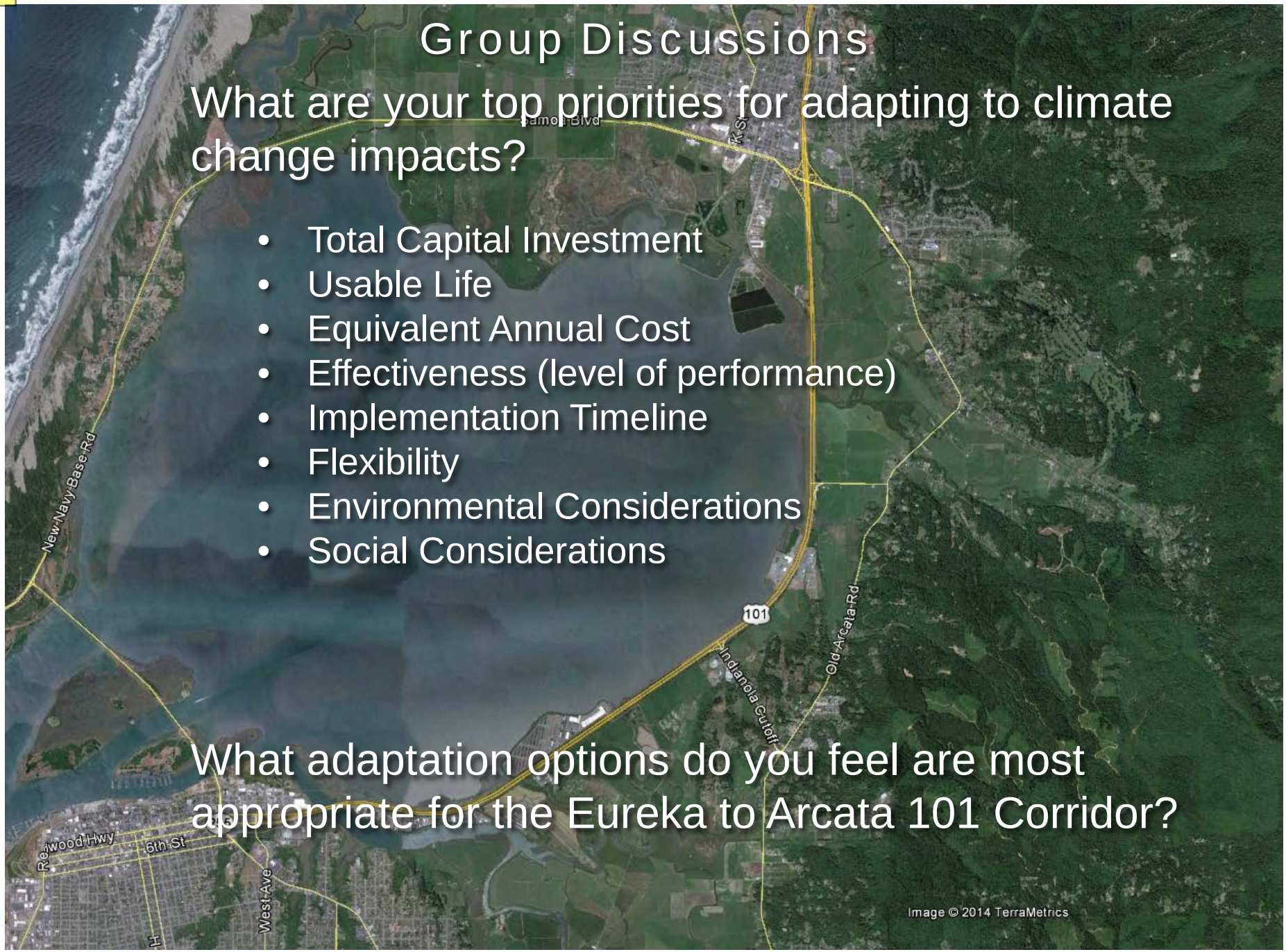
- Total Capital Investment
- Usable Life
- Equivalent Annual Cost
- Effectiveness (level of performance)
- Implementation Timeline
- Flexibility
- Environmental Considerations
- Social Considerations

Group Discussions

What are your top priorities for adapting to climate change impacts?

- Total Capital Investment
- Usable Life
- Equivalent Annual Cost
- Effectiveness (level of performance)
- Implementation Timeline
- Flexibility
- Environmental Considerations
- Social Considerations

What adaptation options do you feel are most appropriate for the Eureka to Arcata 101 Corridor?



Last Change Grade Adaptation Options

Defend: Structural modification and maintenance

Re-route / Planned Retreat

Project website

http://www.northcoastclimatechange.com

DISTRICT ONE CLIMATE CHANGE PILOT STUDY

CLIMATE CHANGE ADAPTATION PILOT STRATEGY FOR CRITICALLY VULNERABLE ASSETS IN A NORTHWEST CALIFORNIA PROJECT

RELATED LINKS

- CalTrans District One

DISTRICT ONE – CLIMATE CHANGE – PILOT STUDY – (D1CCPS)

Project Background

The planning department of Caltrans District 1 applied for and received a grant from the Federal Highway Administration to study the potential vulnerabilities of transportation assets to climate change throughout District 1 (Del Norte, Humboldt, Mendocino, and Lake Counties), and to identify and evaluate a range of adaption options to address the identified vulnerabilities at four prototype locations.

The study will begin with an inventory of transportation assets in District 1 and a subsequent analysis to determine which assets are critically vulnerable. Following this task, four pilot sites ("prototype locations") will be selected for further analysis during the "adaptation assessment" phase of the project. The adaptation assessment will identify options for adapting Caltrans infrastructure to the various climate change factors and will evaluate the level of protection, flexibility, relative costs, acceptability, constraints, and benefits of those adaptation options. The adaptation methodology will include criteria