Climate Change and Sea Level Rise: Impacts on Pavement and Road Design

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With generous support from the National Science Foundation

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Infrastructure and Climate Network (ICNet)

Develop a collaborative network of climate scientists and research/practicing engineers

Accelerate new research in climate change impacts and adaptation to transportation infrastructure

Future Sea Level Rise

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Sea Level Adaptation Options for New Castle Causeway

Source: Steve Miller

UNH SENIOR PROJECT DESIGN TEAM:

MICHAEL FIGUEROA

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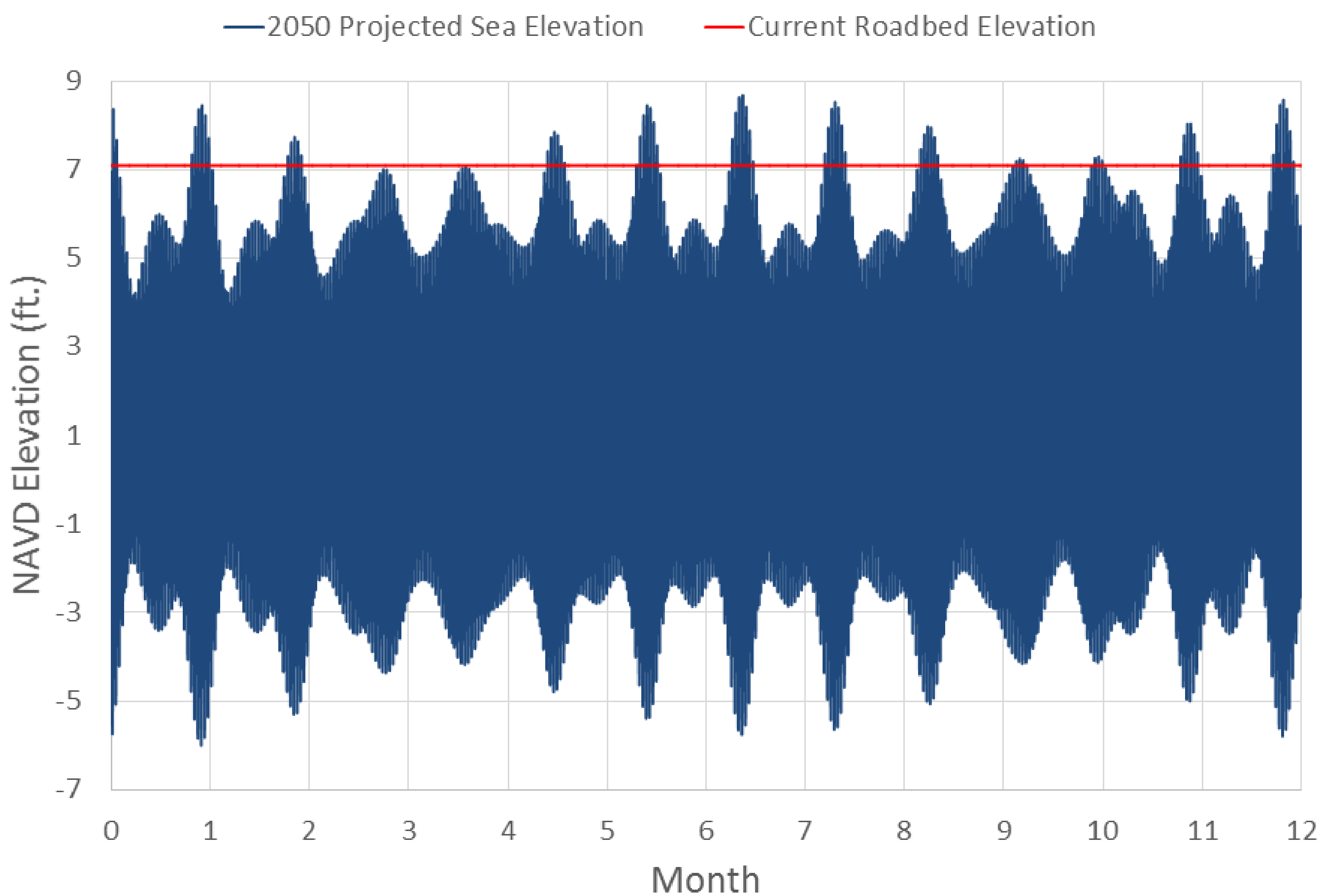
SONJA PAPE

Problem and Approach

- Flooding due to tides and storms – Raise road
- Narrow shoulders for pedestrians – Widen road
- Design life 2020 to 2050
- New road elevation must account for future sea level increase

2050 +1.7 ft Tidal Projection

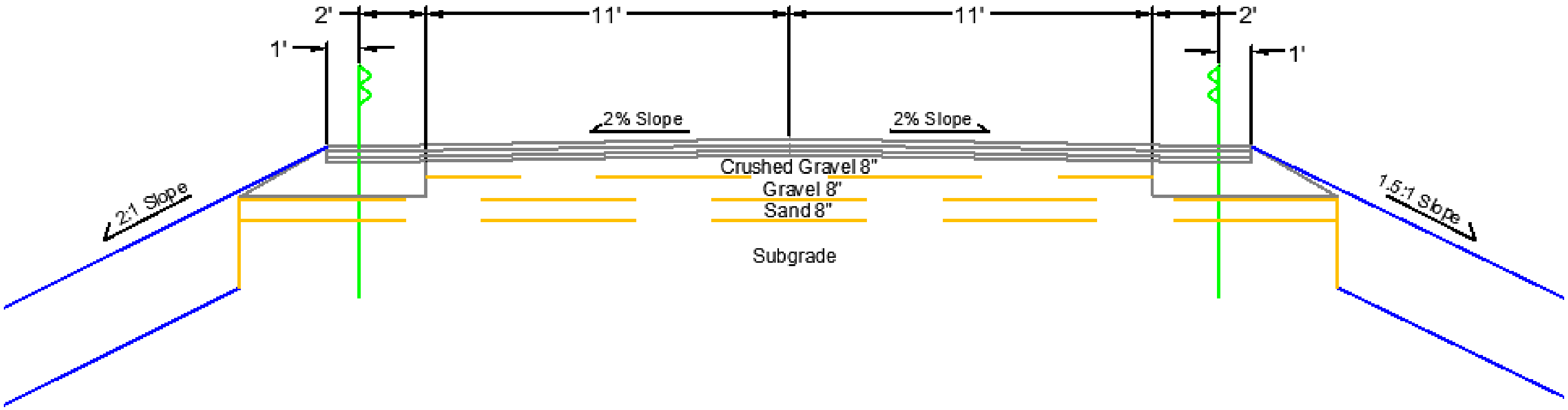


Design Options for 2020 – 2050 Use a +3' Roadway

- **Do Nothing**
- **Bridge**
- **Raise and Widen**
- **Raise and Reinforce**

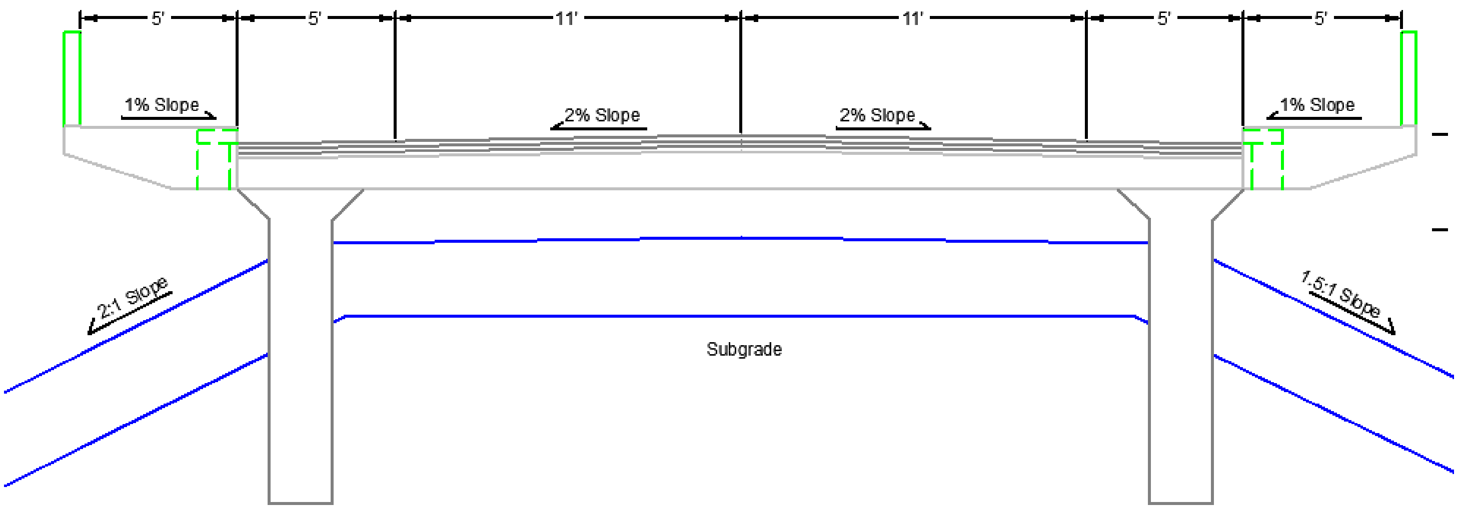
Source: Brad Sullivan, CMA Engineers

Do Nothing



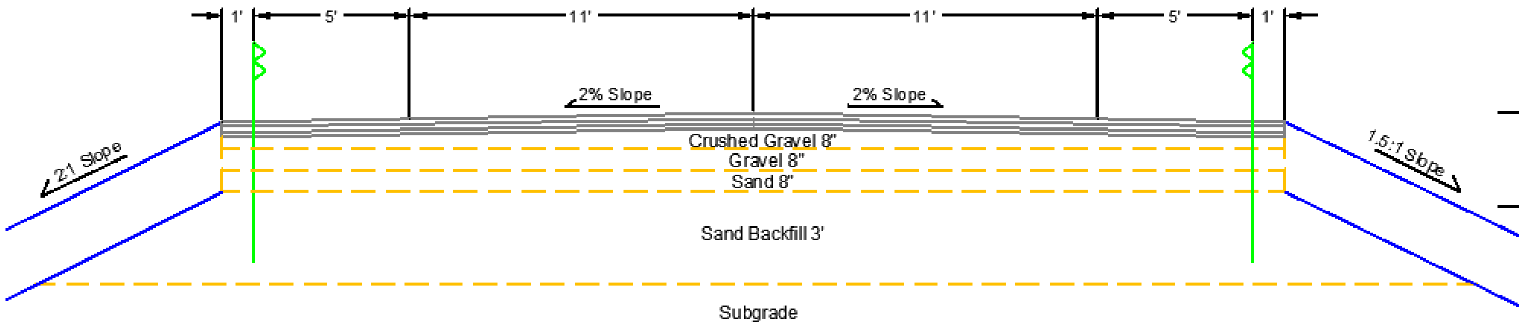
- Pavement structure is the concern, due to water
- Current system is not sufficient for 2050
- Would need 12" asphalt over 36" gravel by 2050

Bridge



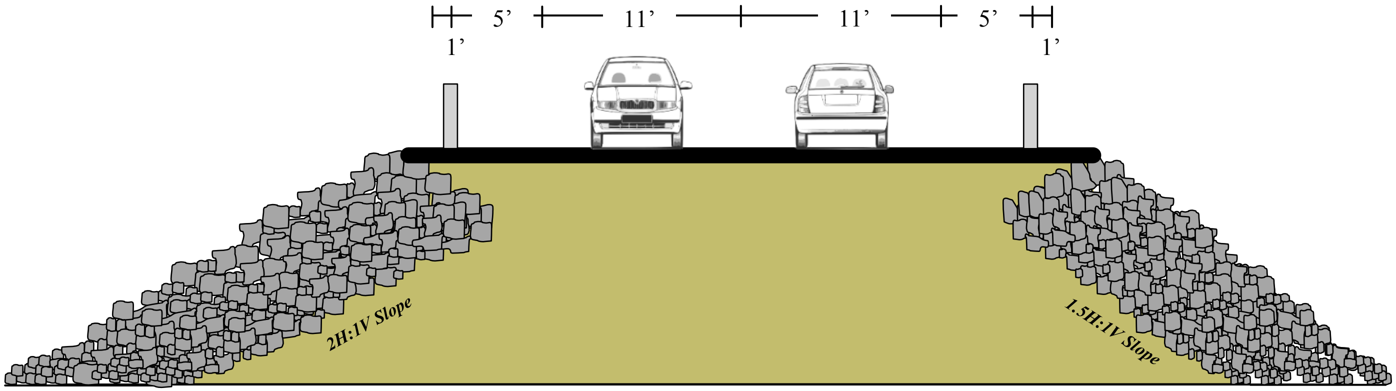
- 1000 ft. bridge with five 200 ft. spans
- 42 ft. wide
- Expensive

Raise & Widen



- Raise road to new height with sand backfill
- 11 ft. lanes with 5 ft. multi-use shoulders
- Additional layer of riprap

4) Pave, Complete

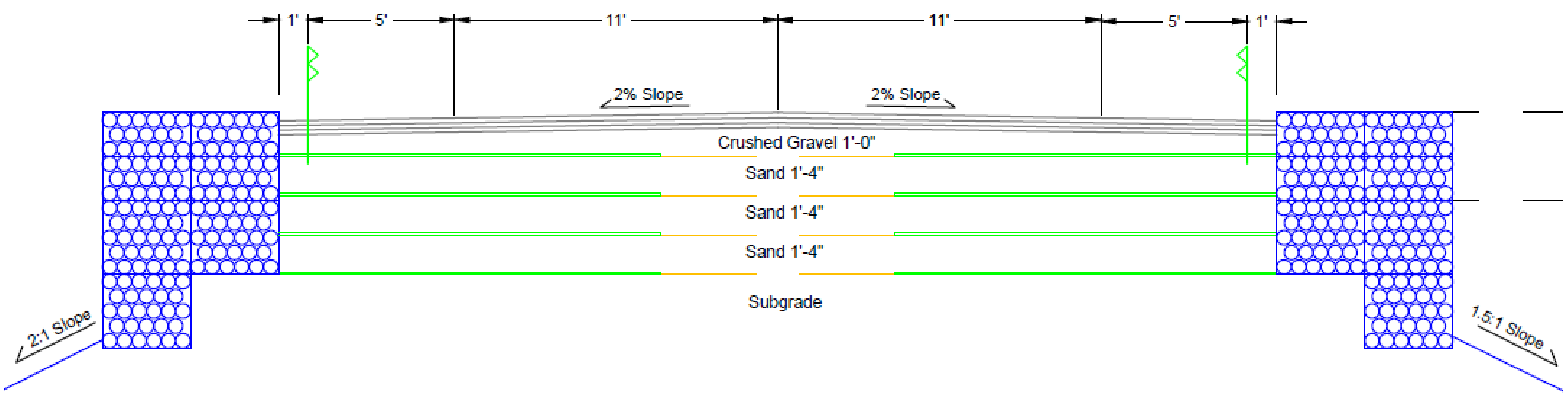


Pros: Cost-effective
Easy to build

Cons Wider footprint
Environmental impacts
Two challenging DES permits
Not adaptable

Raise & Reinforce

- Goals: Raise road to new height w/o widening footprint
- Site Limitations:
  - Riprap slopes
  - Water level



Approach: Mechanically Stabilized Earth (MSE) and Gabion Walls

MSE and Gabion Walls

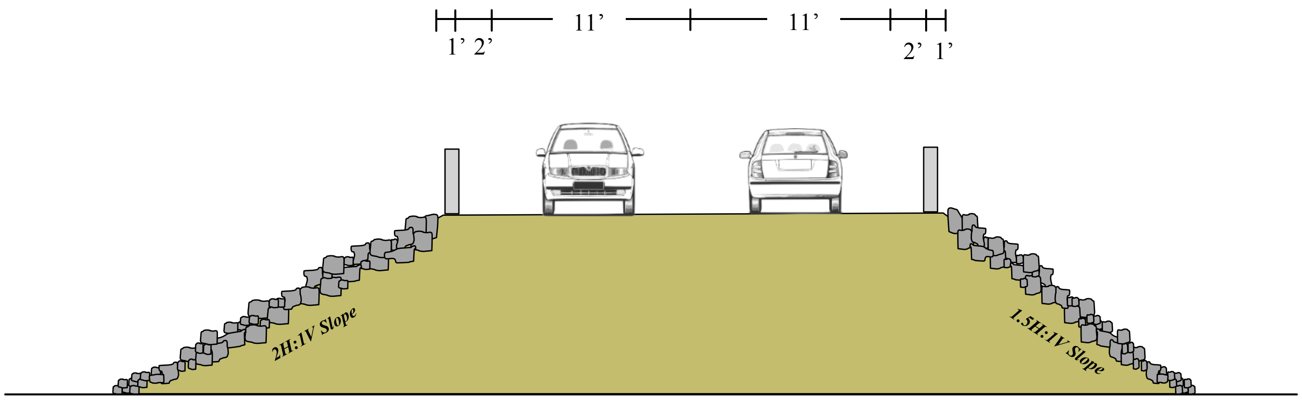
- MSE Wall
  - Mechanically Stabilized Earth (MSE)
  - Layers of geotextile reinforcement

Source: http://www.snapedge.ca/products/hardscape-accessories/geotextile/miragrid/

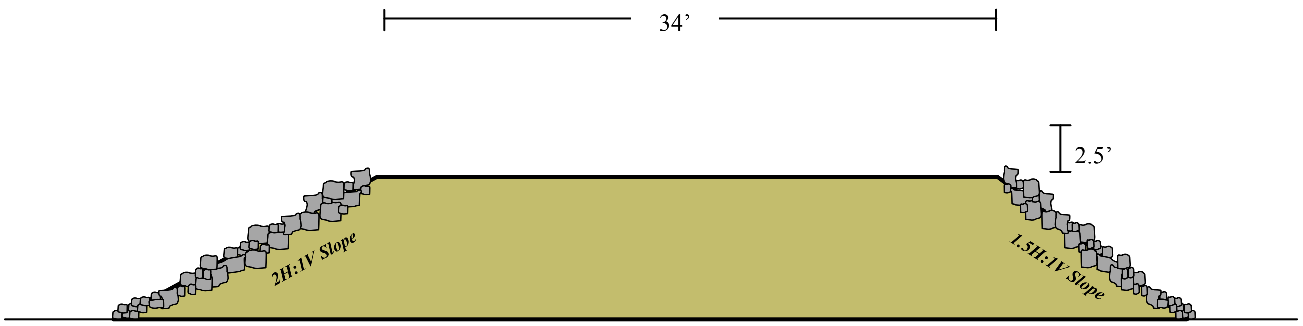
- Gabion Wall
  - Face of the MSE Wall
  - PVC-coated baskets for water application
  - Allow for fill soil to be placed

Source: http://www.terraaqua.com/gravity-retain.php

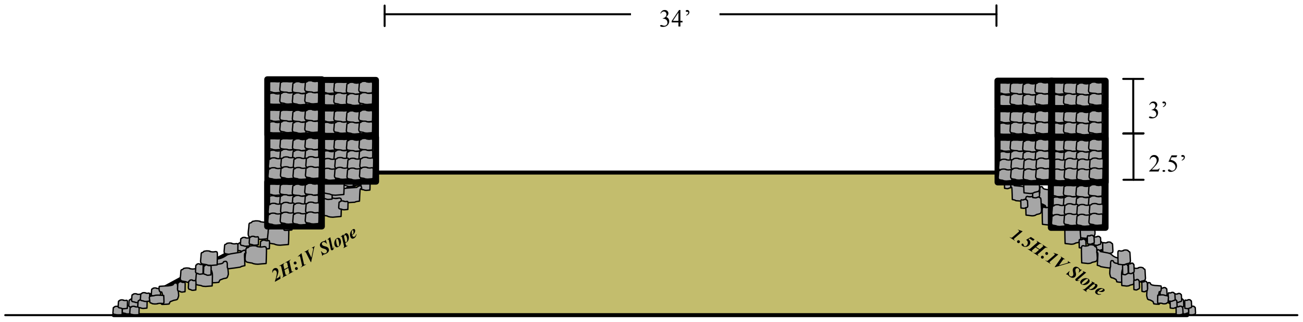
Existing Causeway



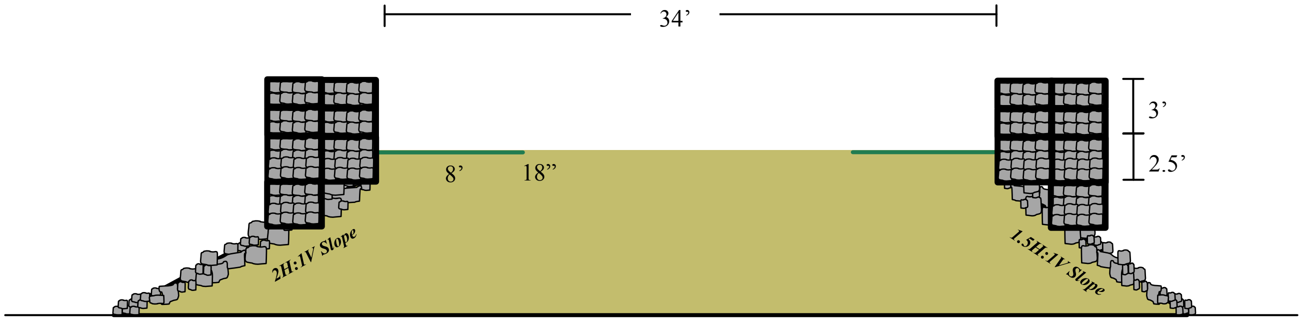
1) Excavate to Subgrade



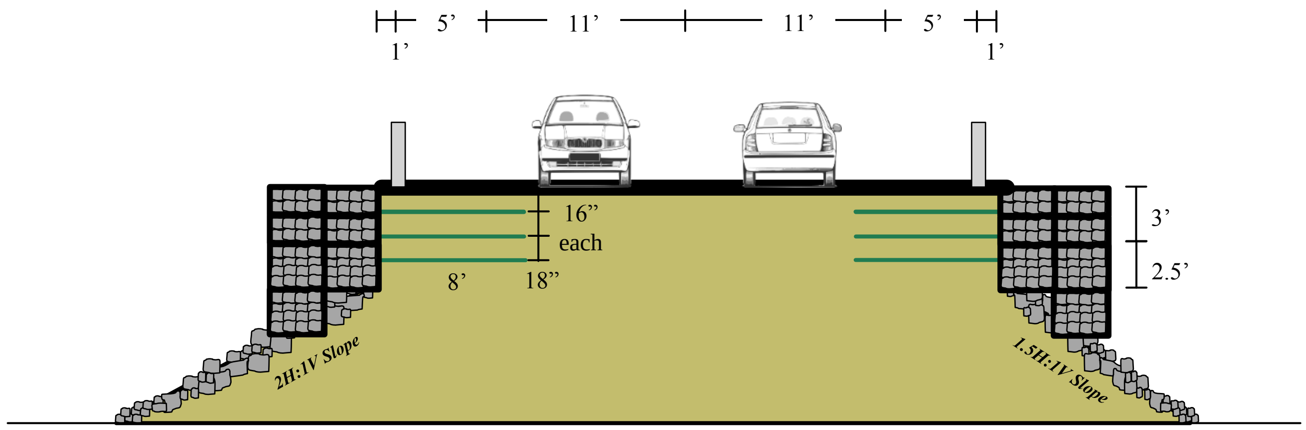
2) Place Gabion Walls



3) Fill, Place Bottom Layer of MSE Reinforcement



4) Repeat, then Pave, Complete



Pros	Footprint is not widened, minimizing permits required Cost-effective Adaptable in future by adding geotextile layers
Cons	Limited design options for reinforcement Gabion walls will need to be replaced

Preliminary Design Comparison

Approach	Performance	Adaptive	Cost	Permits	Total
Do Nothing	1	1	3	5	**10**
Bridge	5	1	1	3	**10**
Raise & Widen	4	3	3	2	**12**
Raise & Reinforce	4	4	3	5	**16**

Point Scale – 1 (Poor) to 5 (Excellent)

Engineering Focused Webinars

INFRASTRUCTURE & CLIMATE NETWORK (ICNet)

WEBINARS

Fall 2013 - Wednesday 2-3 EST

ICNet will present a series of webinars this Fall on topics related to climate change and infrastructure. The first two webinars in this series will provide fundamental and current climate change model and output information targeted to infrastructure researchers and practitioners. The third webinar will showcase research on pavement performance in the future using climate model output and standard engineering tools and techniques.

Wednesday September 18th
2-3 pm EST

"High-resolution climate projections: Where do they come from and what can we do with them?"

Katharine Hayhoe
Texas Tech University

Wednesday October 9th
2-3 pm EST

"Climate Change in the Northeast US: Past, Present, and Future"

Cameron Wake
University of New Hampshire

Wednesday October 30th
2-3 pm EST

"Climatic change impacts on future pavement performance and maintenance costs: Case Studies in New England"

Jo Daniel
University of New Hampshire

Rajib Mallick
Worcester Polytechnic Institute

ICNet Webinar Instructions

1. Link to GoToMeeting https://global.gotomeeting.com/meeting/join/938431661
2. Use your microphone and speakers (VoIP) to listen. Or, call in using your telephone. (213) 493-0606
3. Access Code: 938-431-661

Audio PIN: Shown after joining the meeting
Meeting ID: 938-431-661

Additional information and instructions are available on http://theICNet.org

If you are not on the ICNet webinar distribution list, consider becoming an ICNet Associate to receive updates on future webinars and other activities. Contact Lee Friess (ICNET@theicnet.org) for more information.

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WEBINARS

Spring 2014 - Wednesday 2-3 ET

ICNet continues its Spring webinar series on topics related to infrastructure and climate change. The March webinar will focus on the planning and practice of MaineDOT from a climate change perspective. April's webinar will provide an update on the latest status of infrastructure engineering and climate science. The May presentation will focus on risk modeling for storm surge and coastal engineering adaptations.

Wednesday March 26th
2-3 pm ET

"Coping with Climate Change at MaineDOT: Practice, Planning and Policy"

Charlie Hebson and Judy Gates, Maine Department of Transportation/ Environmental Office

Wednesday April 30th
2-3 pm ET

"The Current State of Infrastructure Engineering and Climate Science"

Jennifer Jacobs,
University of New Hampshire

Wednesday May 28th
2-3 pm ET

"Storm Surge Risk Modeling and Coastal Engineering Adaptations in a Changing Climate"

Kirk Bosma,
Woods Hole Group

ICNet Webinar Instructions

Please register for ICNet Webinar Series at:
https://attendee.gotowebinar.com/register/8569217950163609089

After registering, you will receive a confirmation email containing information about joining the webinar.

If you are not on the ICNet webinar distribution list, consider becoming an ICNet Associate to receive updates on future webinars and other activities. Contact Lee Friess (ICNet@theicnet.org) for more information.

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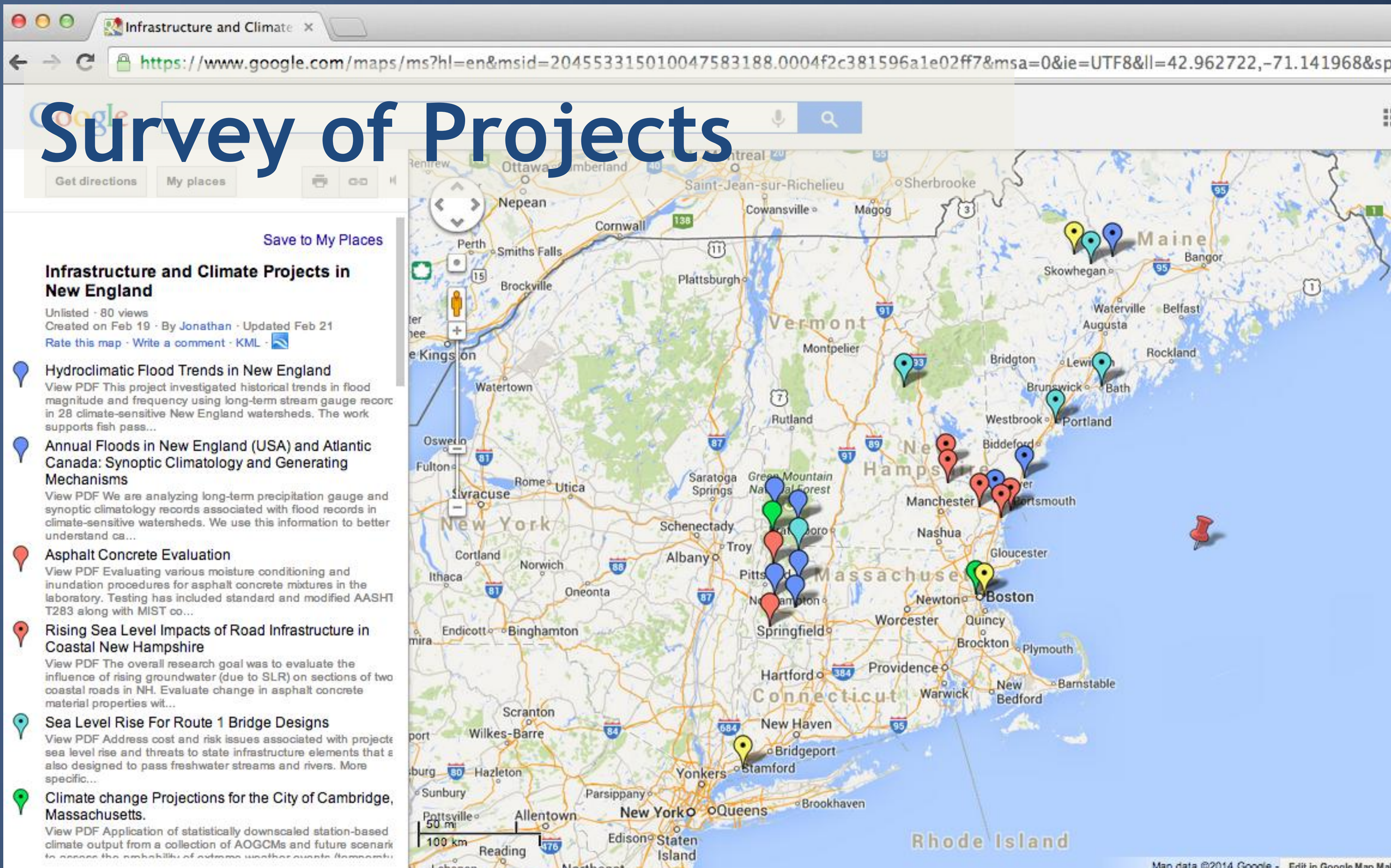
Survey of Projects



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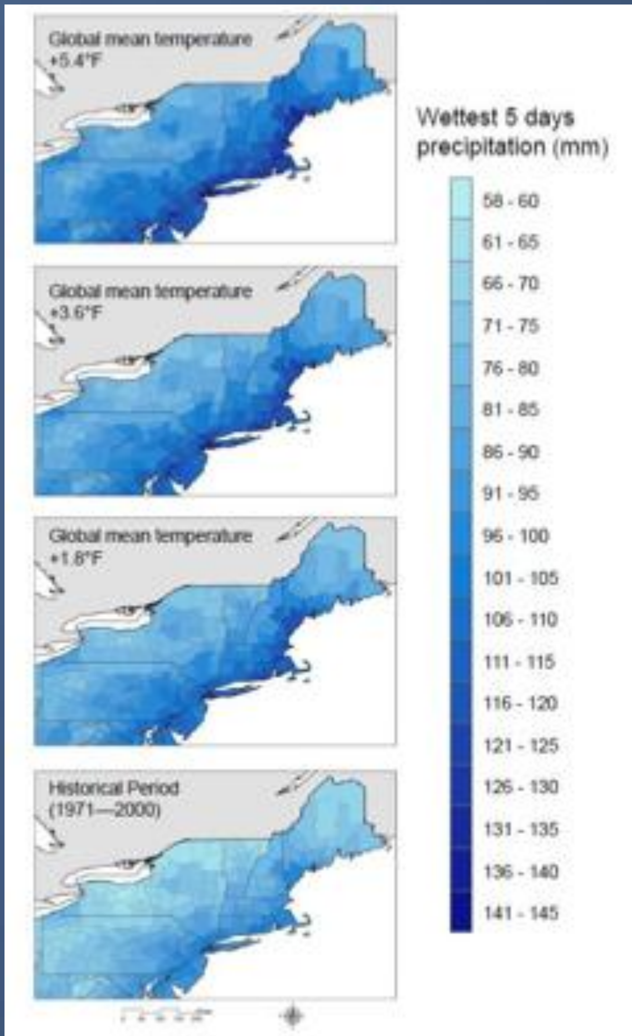
Indicator Maps



1. Annual Average Precipitation
2. Annual Average Temperature
3. Number of days over 2 inches of precipitation
4. Number of days over 3 inches of precipitation
5. Number of days over 95° F
6. Seasonal Average precipitation (Winter, Spring, Summer, Fall)
7. Seasonal Average Tmax (Winter, Spring, Summer, Fall)
8. seasonal Average Tmin (Winter, Spring, Summer, Fall)
9. Maximum temperature in the hottest week of the year
10. Minimum temperature in the coldest week of the year
11. Precipitation on the wettest day of the year
12. Precipitation in the wettest week of the year

Fact Sheets

- Key characteristics of each major database of climate projections available online,
- Best professional judgment (based on our independent climate model and downscaling intercomparison work) regarding appropriate applications of each one, and
- Source for how and where to download the information.

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