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Climate Change Resilience in Chemical Facilities: Data Visualization Support Using R Shiny

Sarah Paik, Thushara Gunda, Nicole Jackson
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Outline

1. Background/Motivation

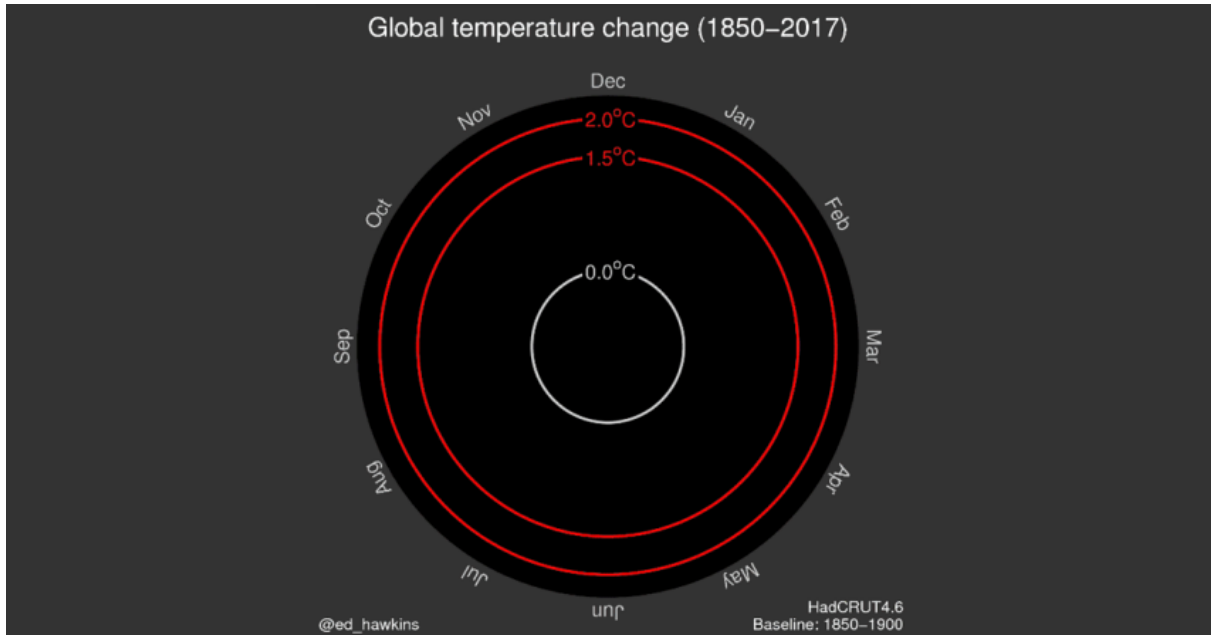
1. Problem Statement

1. Interactive Visualizations

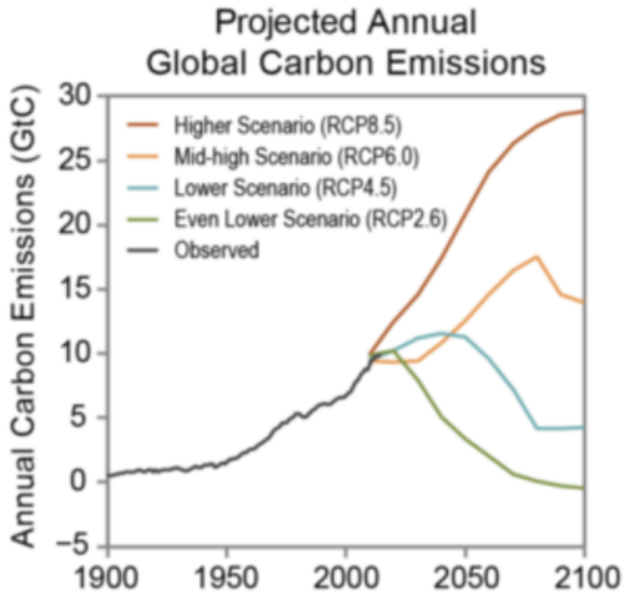
1. Ongoing Work

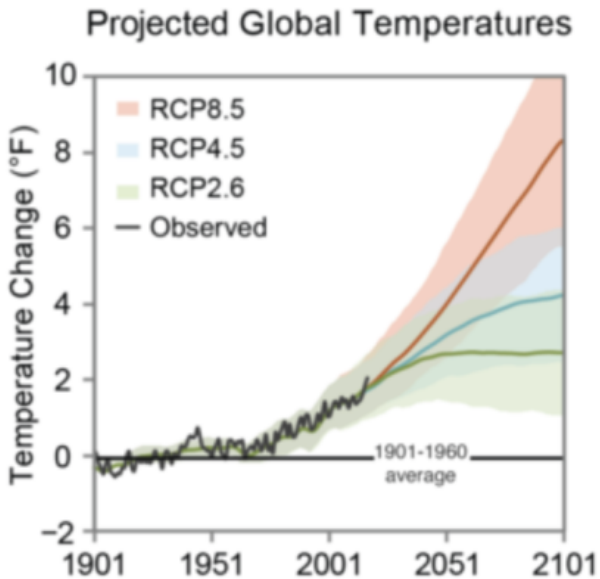
Background: What is Climate Change?

- Long-term shifts in temperatures and weather patterns
- Chronic vs Acute weather events



Global average temperature anomalies since 1850. Source: [UK Climate Lab]

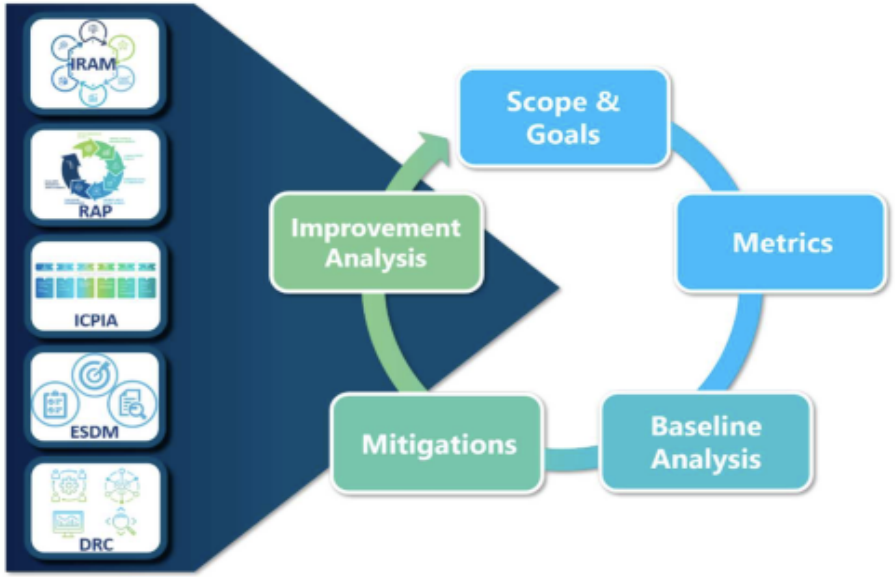




Climate Change: Global Temperature, 2022. Source: [Climate Change: Global Temperature]

Prior Work: Infrastructure Damages

- Infrastructure systems - the system of public works of a country, state, or region
- Types of damage:
  - Physical: damage to infrastructure due to natural disasters
  - Operational: when infrastructure cannot be used as intended due to damages
- Sandia's Methodology in Infrastructure Resilience and risk assessments



Sandia's Integrated Methodology and Infrastructure Resilience Analysis. Source: Sandia Report

Damage caused by heavy rains and mudslides along the Coquihalla Highway, near Hope, B.C., on Nov. 18. Source: Costs of Ignoring Climate Change

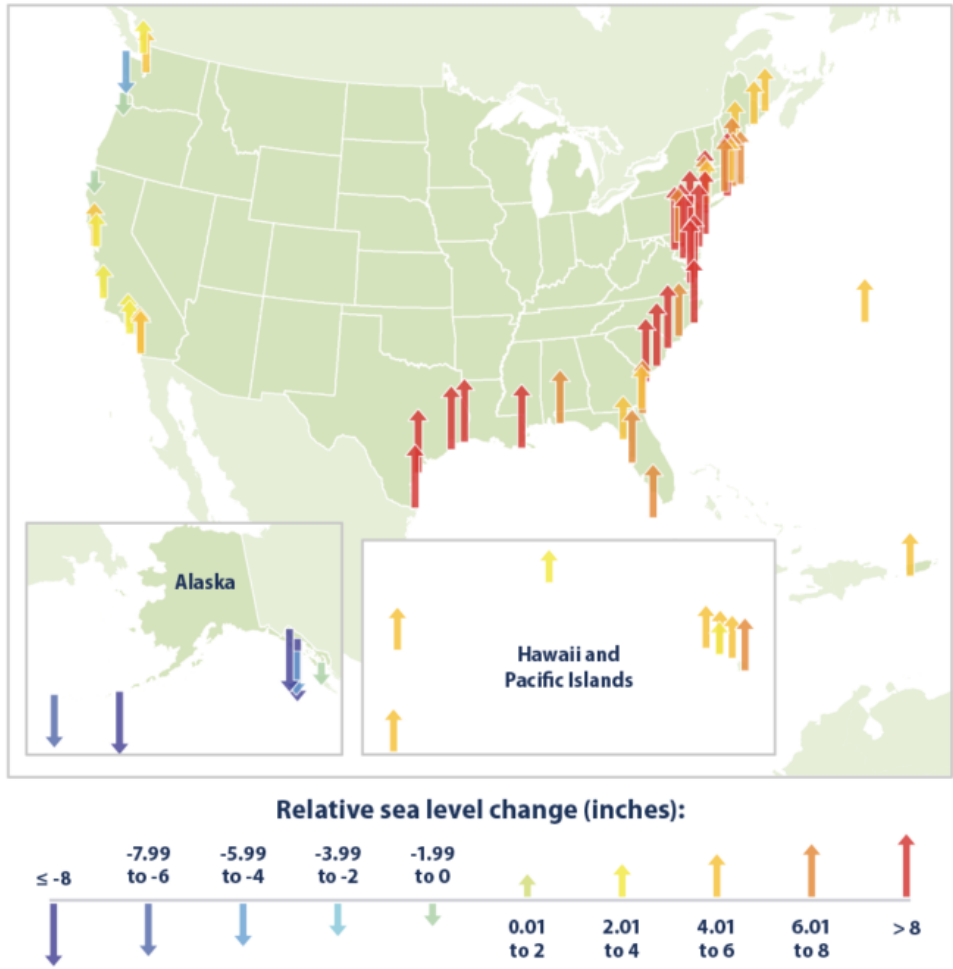
Challenges for Specific Infrastructure

- Focus: Chemical sector
- Limited information on how to translate existing resilience frameworks for facility operators
- Support climate-related risk assessments

Arkema Inc. Chemical Plant Fire, 2017. Source: Arkema Inc Chemical Plant Fire

Diversity of Climate Data

- National-level assessments have identified specific climate risks to chemical facilities: wildfires, storm surges, flooding, and sea level rise.
- Challenges of working with climate data: various formats and levels of detail
- Where do facility operators start with parsing through information?



Relative Sea Level Change Along US Coasts, 1960-2021.
Source: Climate change indicators: Sea Level Rise

R Shiny as a Decision-making Tool

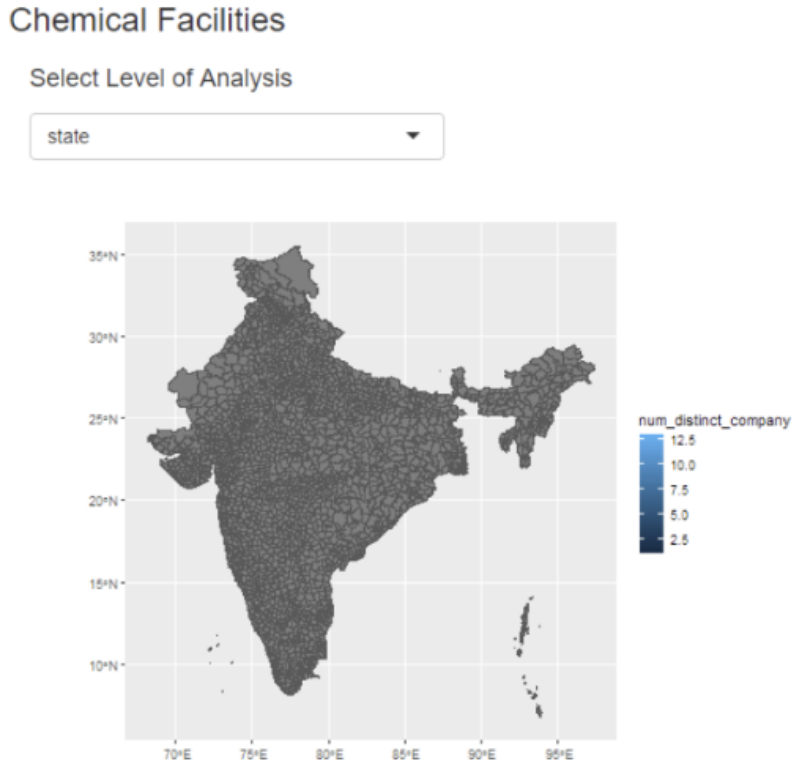
- Open source software
  - R back-end
  - HTML hosting

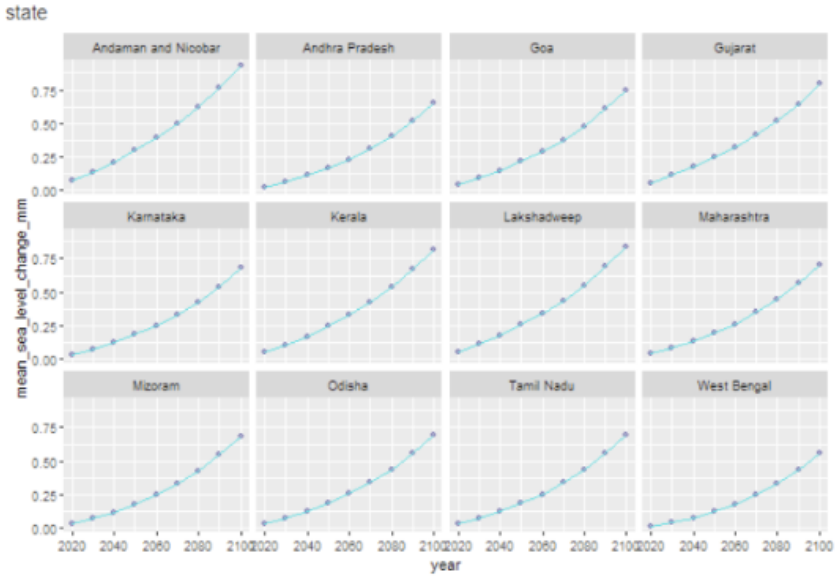
- Enables more effective:
  - Organization of diverse data
  - Visualization of information
  - Exploration of trends

Research Toolkit: Trends Over Time, 2018. Source: Shiny Gallery

Preliminary R Shiny Visualizations

- First draft of web application
- Enables more effective:
  - State
  - District
  - Subdistrict

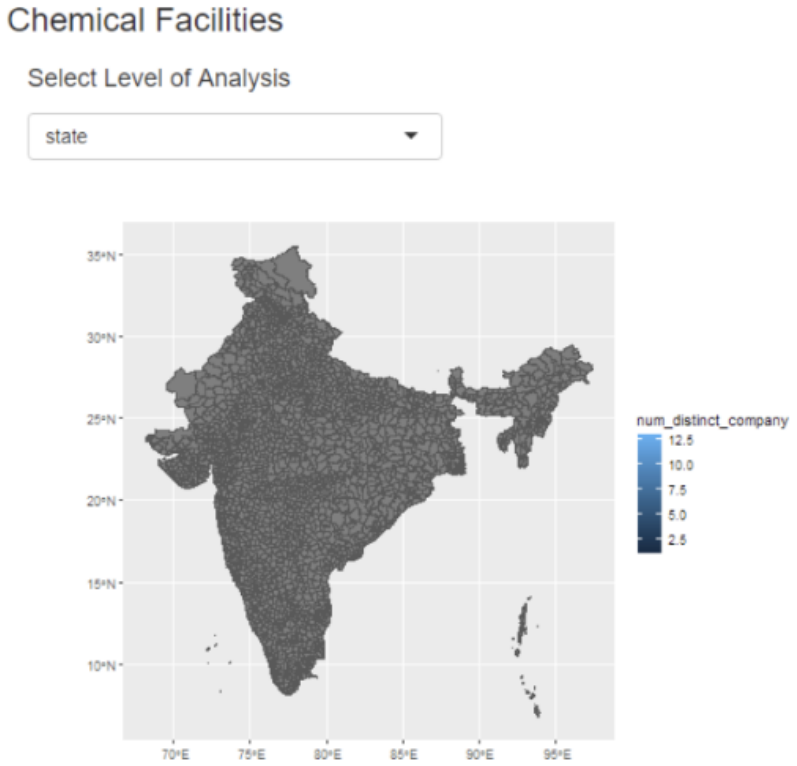


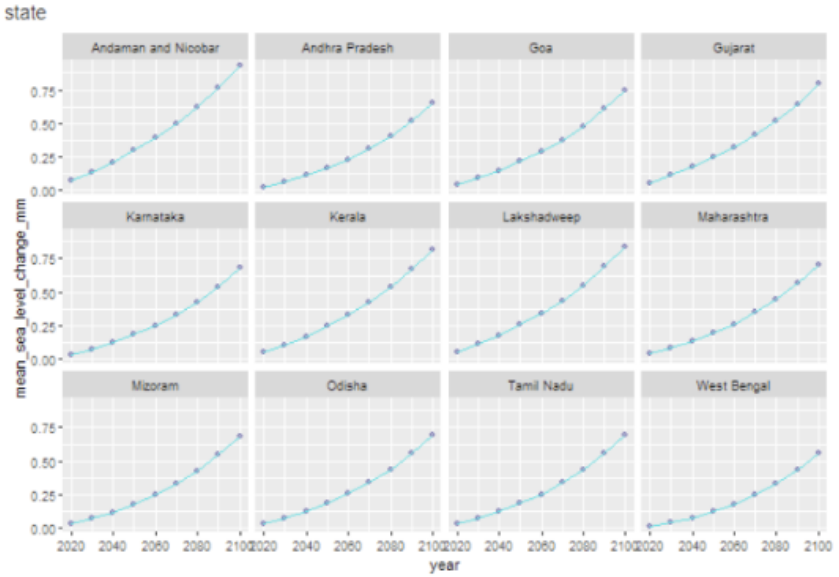


Preliminary R Shiny Visualizations

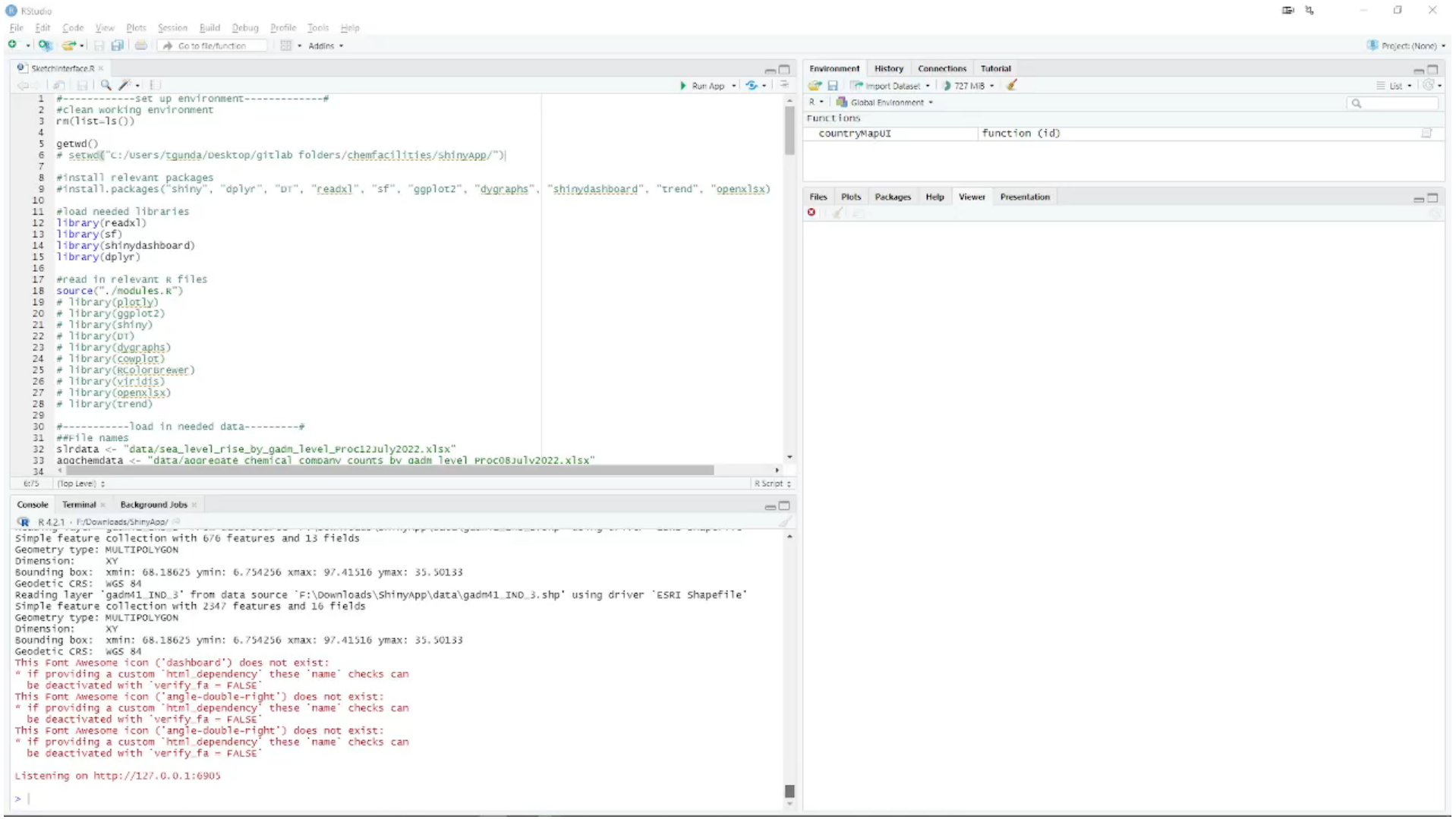
- Climate model outputs:
  - Sea level rise
  - Precipitation
  - Temperature

- Visualizations of spatial and temporal trends





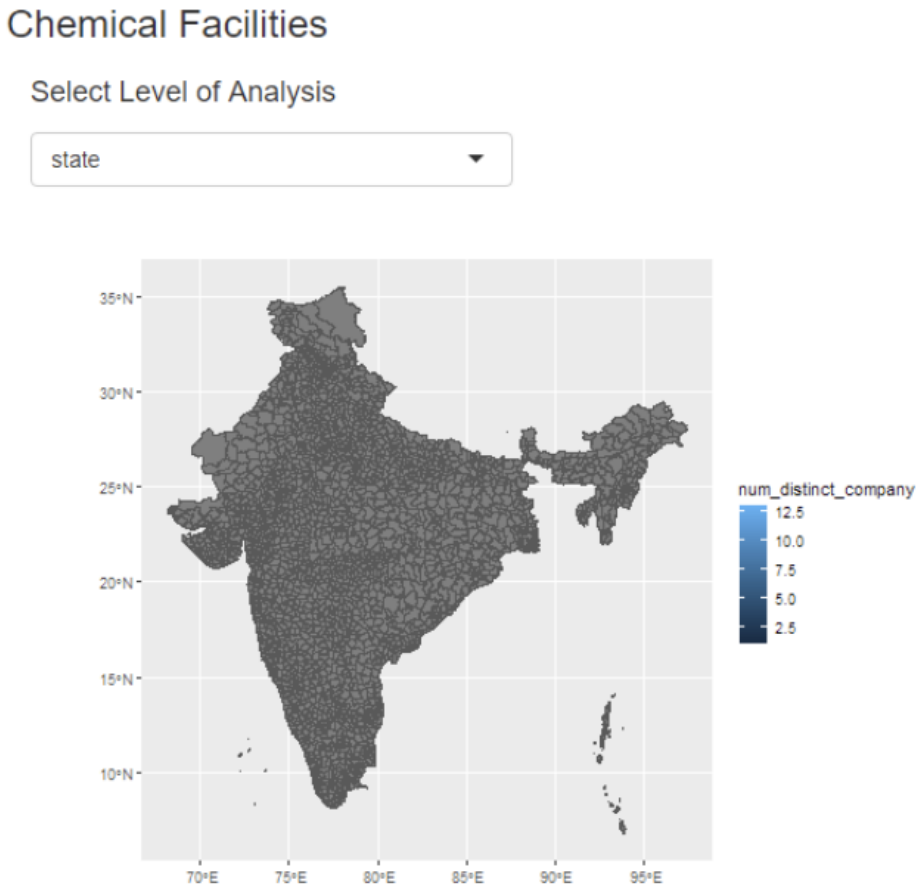
Preliminary R Shiny Visualizations



Ongoing Work

- Overall objectives:
  - Project: Improving resiliency of chemical facilities through awareness of climate change impacts
  - RShiny: Develop an interactive platform that enables the stakeholder to explore different climate data relevant to their region

- Ongoing RShiny development:
  - Improve aesthetics of application
  - Add more models of climate datasets (precipitation, cyclones/hurricanes)



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Thank you for your attention!

Questions?

Email me at sspaik@sandia.gov