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

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08925

2022 Sandia FORCEE Summer Research Symposium





Outline

1. Background/Motivation

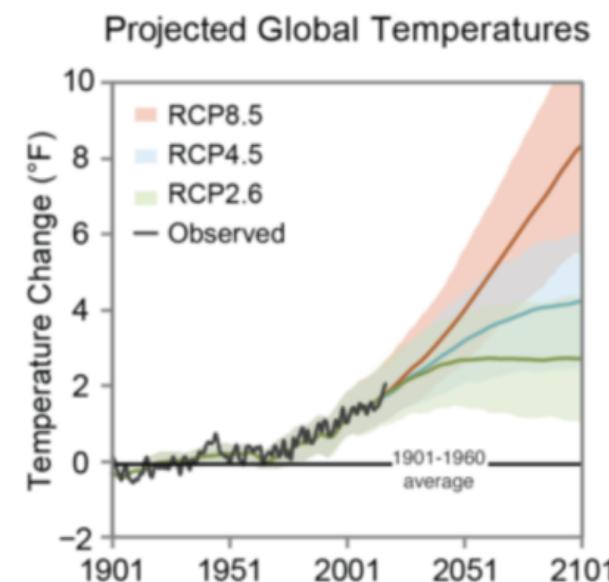
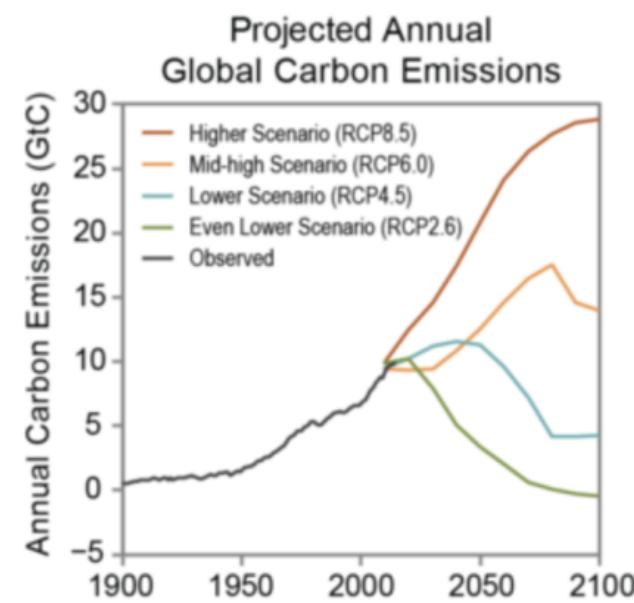
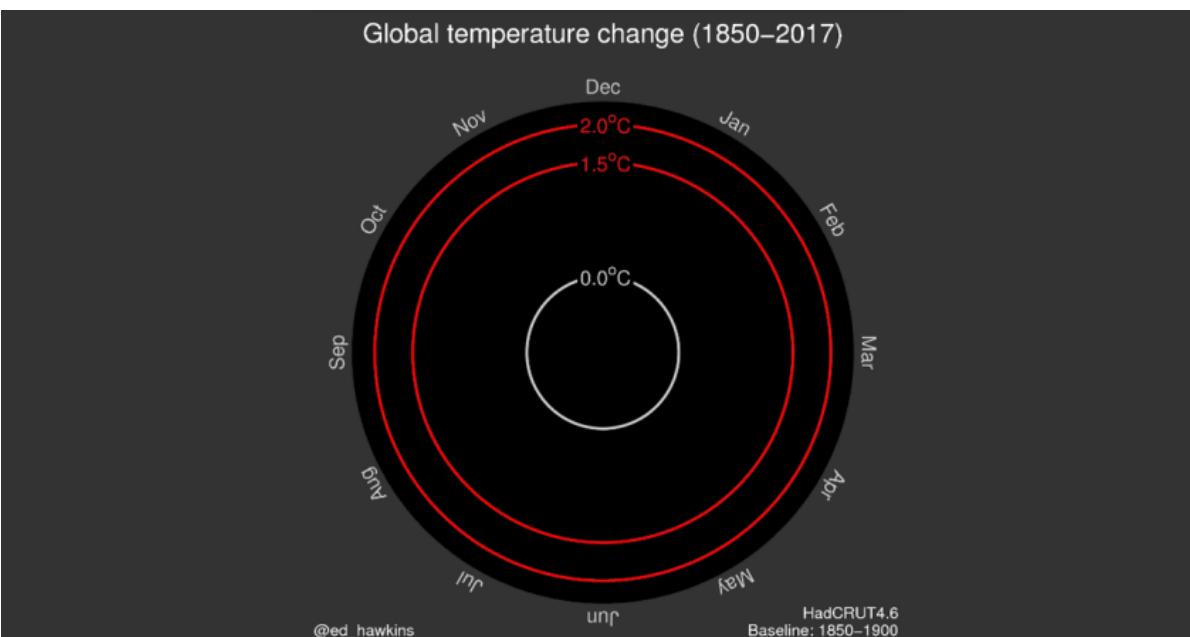
1. Problem Statement

1. Interactive Visualizations

1. Ongoing Work

Background: What is Climate Change?

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



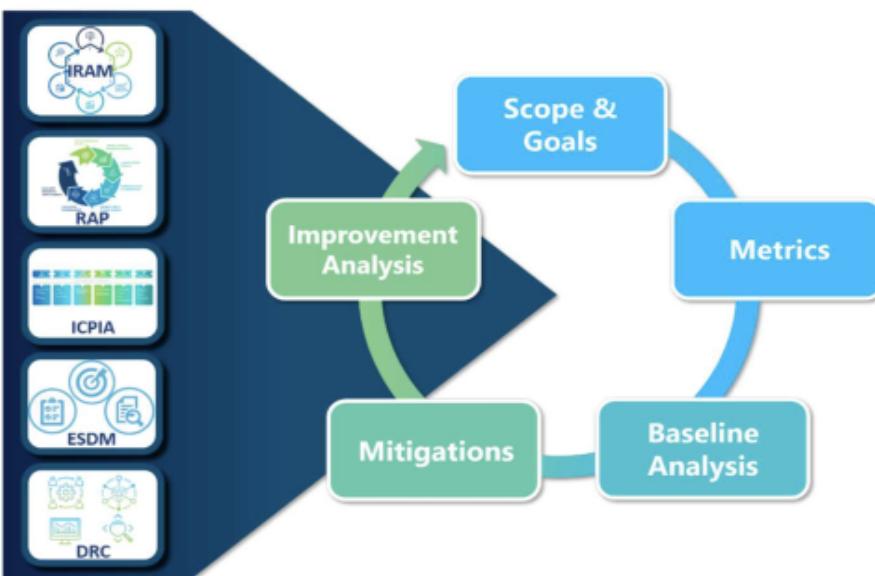
Global average temperature anomalies since 1850. Source: [UK Climate Lab](#)

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

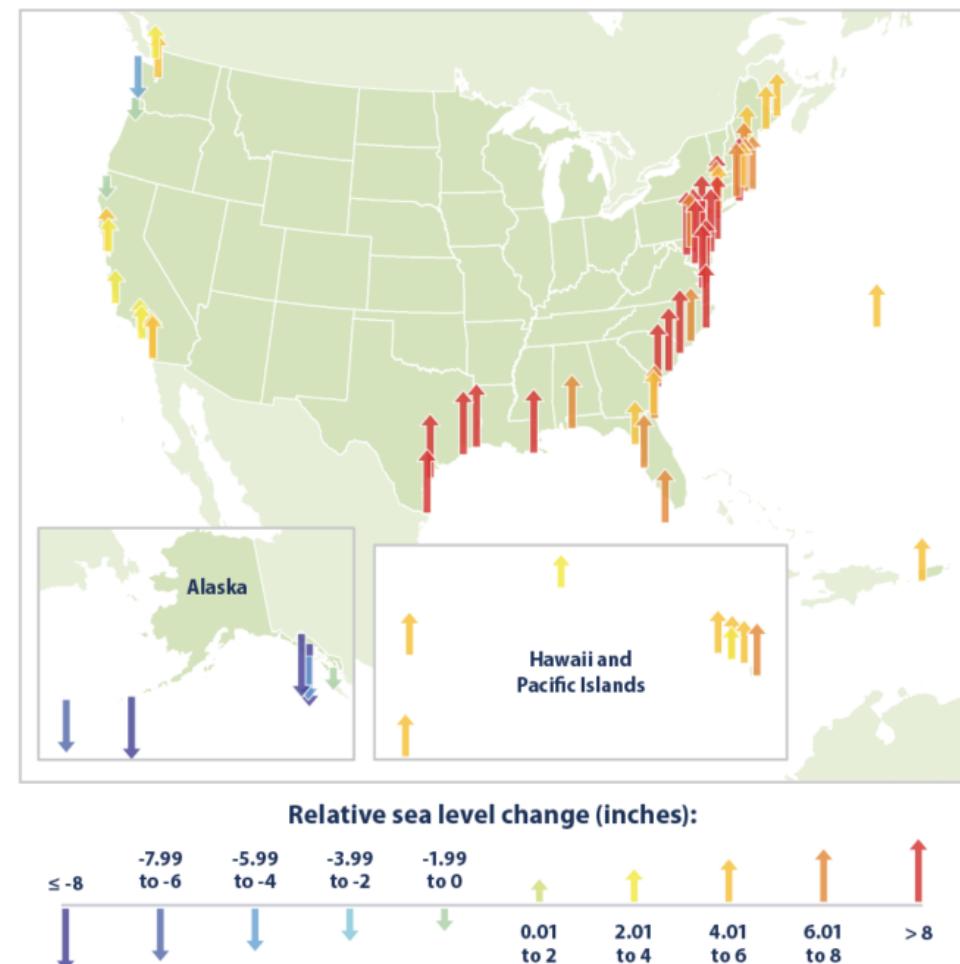
- Focus: Chemical sector
- Limited information on how to translate existing resilience frameworks for facility operators
- Support climate-related risk assessments



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

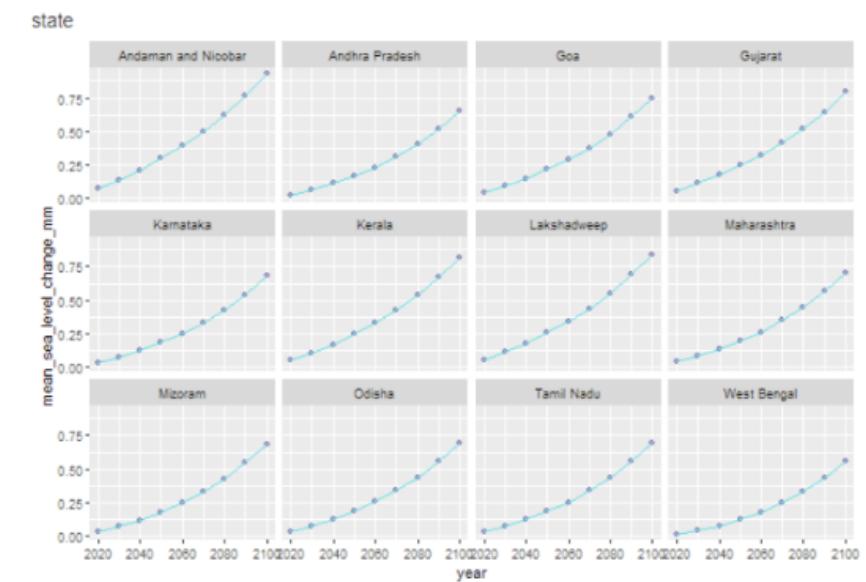
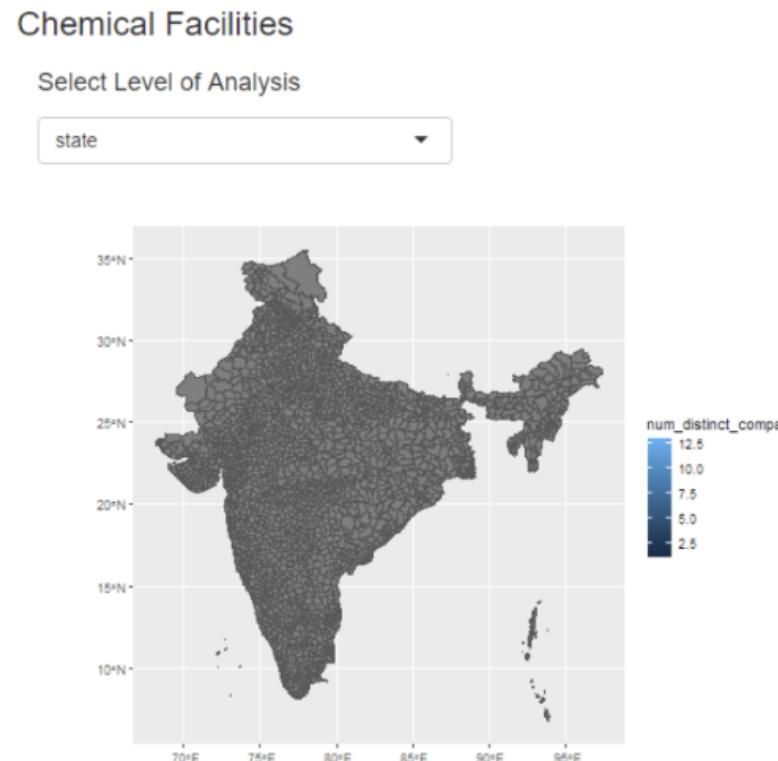
- Open source software
 - R back-end
 - HTML hosting
- Enables more effective:
 - Organization of diverse data
 - Visualization of information
 - Exploration of trends

Research Toolkit: Trends Over Time, 2018. Source: [Shiny Gallery](#)



Preliminary R Shiny Visualizations

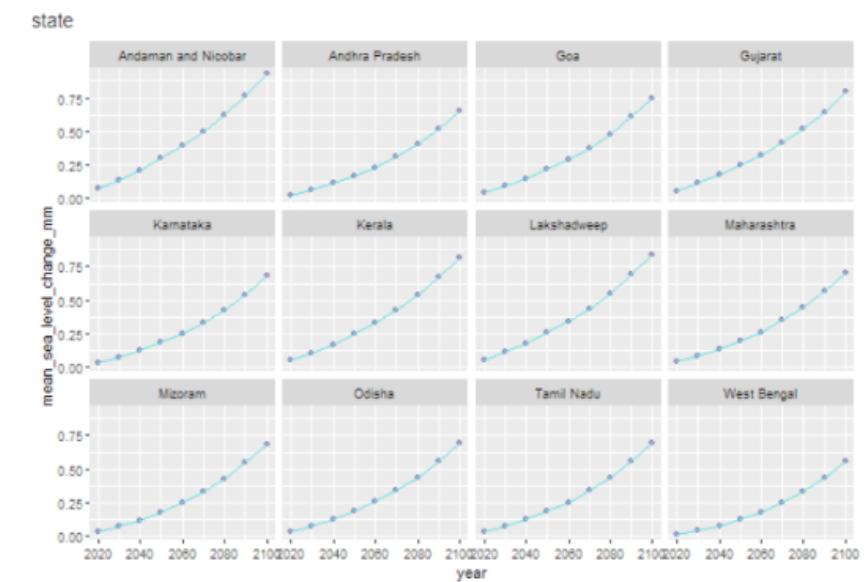
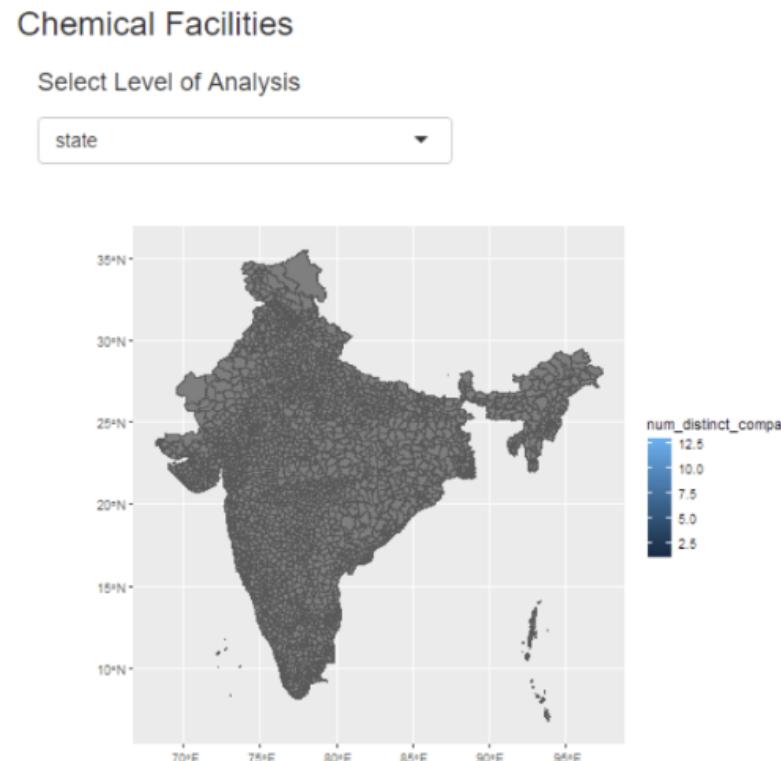
- First draft of web application
- Enables more effective:
 - State
 - District
 - Subdistrict



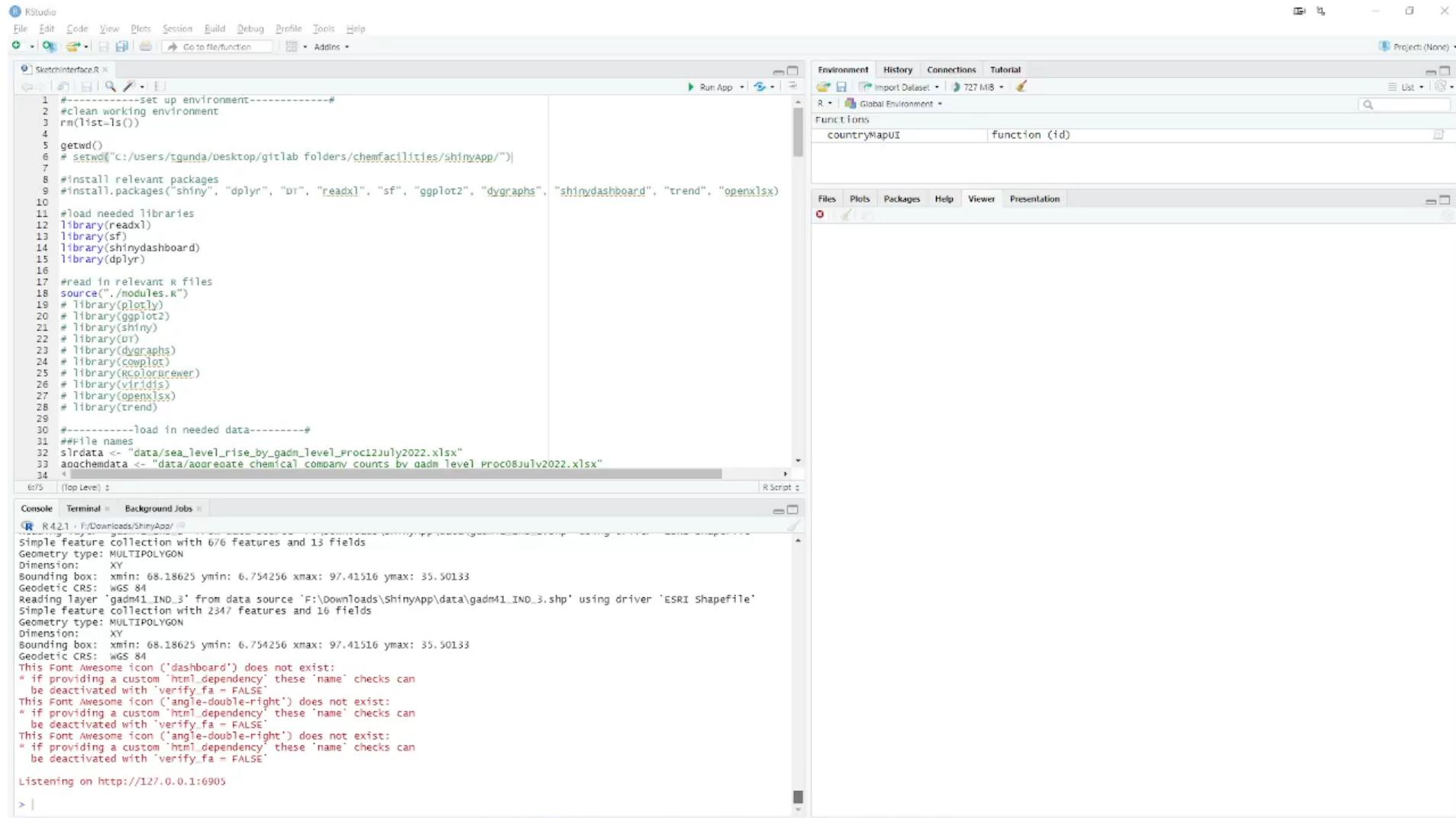


Preliminary R Shiny Visualizations

- Climate model outputs:
 - Sea level rise
 - Precipitation
 - Temperature
- Visualizations of spatial and temporal trends



Preliminary R Shiny Visualizations



The image shows a screenshot of the RStudio interface. The left pane displays an R script titled 'SketchInterface.R' with the following content:

```
1 #-----set up environment-----#
2 #clean working environment
3 rm(list=ls())
4
5 getwd()
6 # setwd("c:/users/tgunda/desktop/gitlab folders/chemfacilities/shinyApp/")
7
8 #install relevant packages
9 #install.packages("shiny", "dplyr", "DT", "readxl", "sf", "ggplot2", "dygraphs", "shinydashboard", "trend", "openxlsx")
10
11 #load needed libraries
12 library(readxl)
13 library(sf)
14 library(shinydashboard)
15 library(dplyr)
16
17 #read in relevant R files
18 source("./modules.R")
19 # library(plotly)
20 # library(ggplot2)
21 # library(shiny)
22 # library(DT)
23 # library(dygraphs)
24 # library(cowplot)
25 # library(RcolorBrewer)
26 # library(viridis)
27 # library(openxlsx)
28 # library(trend)
29
30 #-----load in needed data-----#
31 #file names
32 slrdata <- "data/sea_level_rise_by_gadm_level_Proc12July2022.xlsx"
33 aocchemdata <- "data/aocoreate chemical company counts by gadm level Proc08July2022.xlsx"
34
35
```

The right pane shows the RStudio environment and console. The environment pane shows a function named 'countryMapUI' and its definition. The console pane shows the output of running the R script, including messages about reading shapefiles and starting a shiny app on port 6905.

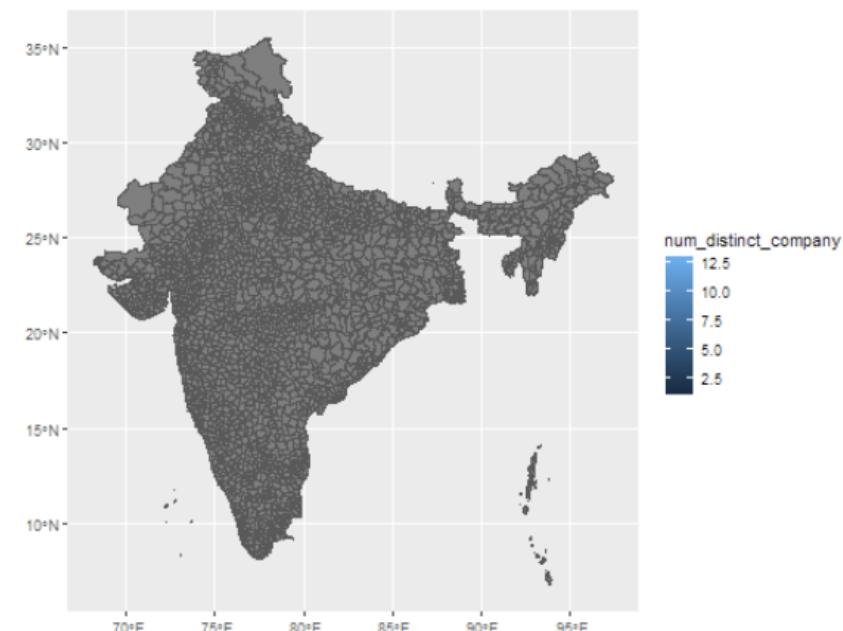
```
R 4.2.1 - F:\Downloads\ShinyApp\ 
Simple feature collection with 676 features and 13 fields
Geometry type: MULTIPOLYGON
Dimension: XY
Bounding box: xmin: 68.18625 ymin: 6.754256 xmax: 97.41516 ymax: 35.50133
Geodetic CRS: WGS 84
Reading layer 'gadm1_IND_3' from data source 'F:\Downloads\ShinyApp\data\gadm1_IND_3.shp' using driver 'ESRI Shapefile'
Simple feature collection with 2347 features and 16 fields
Geometry type: MULTIPOLYGON
Dimension: XY
Bounding box: xmin: 68.18625 ymin: 6.754256 xmax: 97.41516 ymax: 35.50133
Geodetic CRS: WGS 84
This Font Awesome icon ('dashboard') does not exist:
  " if providing a custom 'html_dependency' these 'name' checks can
  be deactivated with 'verify_fa = FALSE'.
This Font Awesome icon ('angle-double-right') does not exist:
  " if providing a custom 'html_dependency' these 'name' checks can
  be deactivated with 'verify_fa = FALSE'.
This Font Awesome icon ('angle-double-right') does not exist:
  " if providing a custom 'html_dependency' these 'name' checks can
  be deactivated with 'verify_fa = FALSE'.
Listening on http://127.0.0.1:6905
> |
```

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)

Chemical Facilities

Select Level of Analysis





LABORATORY DIRECTED
RESEARCH & DEVELOPMENT

Acknowledgements

Andrew Nelson and Mark Wingard (6826)

This project is funded by the Laboratory Directed Research & Development Program at Sandia National Laboratories.

Thank you for your attention!

Questions?

Email me at sspaik@sandia.gov