FRE 521D: Data Analytics in Climate, Food and Environment

Final Project: Climate Vulnerability Assessment for Global Agricultural Systems

Integrated Analysis and Executive Presentation

Course	FRE 521D - Winter 2026
Instructor	Asif Ahmed Neloy
Released	January 7, 2026
Presentations	**February 11, 2026 (in class)**
Report Due	**February 10, 2026, at 11:59 PM PST**
Weight	30% of final grade
Team Size	3-4 students (same teams as assignments)

1. Project Overview

Throughout this course, you have built a comprehensive data infrastructure for analyzing climate-agriculture relationships. In Assignment 1, you created a SQL database with crop production and temperature anomaly data. In Assignment 2, you enriched this foundation with detailed weather data through an automated ETL pipeline. The Final Project brings everything together: you will conduct an integrated analysis that answers meaningful questions about climate vulnerability in global agriculture.

Your team has been engaged by an international development organization that advises governments and NGOs on food security policy. They need data-driven insights to guide resource allocation for climate adaptation programs. Specifically, they want to understand which crops and regions are most vulnerable to climate variability, and what factors distinguish resilient agricultural systems from vulnerable ones.

This project requires you to demonstrate mastery of the entire data analytics workflow: from data cleaning and preprocessing, through exploratory analysis and visualization, to communicating findings to a non-technical audience. You will present your findings in both a written report and a live presentation.

2. Learning Objectives

Upon completion of this project, you will be able to:

1. Integrate data from multiple sources into a coherent analytical framework
2. Apply appropriate data cleaning and preprocessing techniques based on analytical requirements
3. Design and execute an analysis plan that addresses specific business questions
4. Create effective visualizations that communicate complex relationships to diverse audiences
5. Justify methodological choices and acknowledge limitations
6. Present technical findings in a compelling narrative suitable for policy audiences

3. Research Questions

Your analysis must address the any of the three following core questions (3 out of 4). While you must address any three, you have flexibility in the depth and approach for each. Choose to go deeper on questions most relevant to your team's interests and skills.

Question 1: Identifying Climate-Vulnerable Crops

Policy makers need to know which staple crops are most threatened by climate change so they can prioritize breeding programs and adaptation investments.

Core analysis: Quantify the relationship between climate variables (temperature, precipitation, their variability) and crop yields for major cereals (wheat, rice, maize, soybeans). Control for other factors where possible (fertilizer use, irrigation, economic development).

Deliverable: A ranked assessment of crop vulnerability with supporting evidence. Which crop shows the strongest negative response to temperature increases? Which is most sensitive to precipitation variability?

Extension options: Examine whether vulnerability differs between high-income and low-income countries. Analyze whether crops in certain climate zones are more vulnerable.

Question 2: Mapping Regional Food Security Risks

Development organizations need to identify regions where climate change poses the greatest threat to food production so they can target adaptation support.

Core analysis: Create a composite "climate vulnerability index" that combines exposure (historical climate trends), sensitivity (yield response to climate), and adaptive capacity (irrigation, fertilizer use, economic resources). Rank countries or regions by overall vulnerability.

Deliverable: A map or ranking of climate-vulnerable regions with clear explanation of the index methodology. Identify the top 10 most vulnerable countries and explain what factors drive their vulnerability.

Extension options: Separate analysis for different crops. Project future vulnerability under different climate scenarios. Compare your index to existing food security indices.

Question 3: Understanding Agricultural Resilience

Some agricultural systems maintain stable yields despite climate variability. Understanding what makes them resilient can inform adaptation strategies.

Core analysis: Identify countries or systems that maintain stable yields (low year-to-year variability) despite experiencing significant climate variability. Analyze what factors distinguish these resilient systems from vulnerable ones. Consider irrigation infrastructure, crop diversification, input use, and economic factors.

Deliverable: Case studies of resilient agricultural systems with data-driven explanations of their success factors. What can vulnerable regions learn from resilient ones?

Extension options: Quantify the "resilience premium" - how much does investment in irrigation or other adaptations reduce yield variability? Identify tipping points where resilience breaks down.

Question 4: Production Trends and Future Outlook

Strategic planners need to understand how global food production is evolving and whether current trends are sustainable.

Core analysis: Analyze long-term trends in crop production, yields, and harvested area. Decompose yield changes into contributions from different factors (climate, technology/inputs, area expansion). Identify regions where yields are stagnating or declining.

Deliverable: Trend analysis with projections. If current trends continue, which regions face potential production shortfalls? Where is climate change already affecting yield trends?

Extension options: Compare yield trajectories between countries at different development stages. Analyze whether yield gaps are closing or widening.

4. Deliverables

4.1 Technical Report (30% of project grade)

Submit a comprehensive report documenting your analysis. The report should follow this structure using an IEEE paper format:

Abstract: Key findings and recommendations for a non-technical audience.

Introduction, Data and Methodology (1 page): Context, objectives, and scope of analysis. Description of data sources, cleaning steps, preprocessing decisions, and analytical methods. Justify your choices.

Results (no page restrictions): Findings for each research question with visualizations. Present results in order of importance to the business questions.

Discussion (1 page max): Interpretation of findings, limitations, and recommendations for policy or further research.

Appendix and References: Additional tables, figures, and technical details. Include a data dictionary for your final analytical dataset.

4.2 Presentation (30% of project grade)

Present your findings to the class. Imagine your audience is the leadership team of an international development organization with limited technical background but strong interest in actionable insights.

Duration: 15 minutes presentation + 5 minutes Q&A

Format: Slide deck (PowerPoint, Google Slides, or PDF)

Requirements:

- All team members must participate in the presentation
- Focus on insights and implications, not technical details
- Use clear, well-designed visualizations
- Be prepared to answer questions about methodology and data quality

4.3 Code Repository (40% of project grade)

Submit all code used in your analysis. The code should be organized, documented, and reproducible.

Required contents:

- All Jupyter notebooks or Python scripts used for analysis
- SQL scripts for any database operations
- A README.md with clear instructions for reproducing your analysis
- Requirements.txt or environment.yml for dependencies
- Final processed datasets (CSV or database exports)

- **Bonus: If you create a GitHub Repo and submit your code**

5. Evaluation Criteria

5.1 Technical Report Rubric (30 points)

Criterion	Excellent	Satisfactory	Needs Work	Points
Data Quality & Preprocessing	Thorough, justified, well-documented	Adequate handling, some gaps	Minimal preprocessing, poor documentation	10
Analytical Rigor	Appropriate methods, valid conclusions	Sound methods, some limitations	Flawed methods or unsupported claims	15
Visualizations	Clear, effective, publication-quality	Adequate visualizations, minor issues	Poor or misleading graphics	10
Business Insights	Actionable, well-supported recommendations	Reasonable insights, could be stronger	Vague or unsupported recommendations	10
Writing Quality	Professional, clear, well-organized	Readable, minor issues	Disorganized or unclear	5

5.2 Presentation Rubric (30 points)

Criterion	Excellent	Satisfactory	Needs Work	Points
Content & Story	Compelling narrative, clear takeaways	Adequate story, some gaps	Disjointed or unclear message	12
Slide Design	Professional, clear visuals	Acceptable design, minor issues	Cluttered or hard to read	8
Delivery & Q&A	Confident, handles questions well	Adequate delivery, basic Q&A	Unprepared or unable to answer	10

5.3 Code Repository Rubric (40 points)

Criterion	Excellent	Satisfactory	Needs Work	Points
Reproducibility	Runs without modification	Minor adjustments needed	Cannot reproduce results	10
Code Quality	Clean, modular, documented	Readable, some comments	Messy, no documentation	10

6. Recommended Timeline

Week	Milestone
Week 1 (Jan 5-10)	Form teams, review project requirements, begin Assignment 1
Week 2-3 (Jan 12-24)	Complete A1, begin A2, discuss project approach with team
Week 4 (Jan 26-31)	Complete A2, finalize analytical approach for project
Week 5 (Feb 2-7)	Execute analysis, create visualizations, draft report sections
Week 6 (Feb 9-11)	Finalize report, prepare presentation, rehearse

7. Academic Integrity

All work must be your team's original analysis. You may reference published research and cite it appropriately. Code libraries and tools are permitted with proper attribution. AI assistants may be used for debugging and writing assistance but not for generating analysis or conclusions. If in doubt about what constitutes appropriate collaboration, ask the instructor before proceeding.

8. Submission Instructions

Submit a single ZIP file named **FinalProject_TeamName.zip** containing:

1. **report.pdf** - Technical report
2. **presentation.pdf** or **presentation.pptx** - Slide deck
3. **code/** - Directory containing all notebooks, scripts, and README
4. **data/** - Final processed datasets used in analysis

We look forward to your presentations!