AI Powered Weather Emergency Response System

Team 2

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Motivation

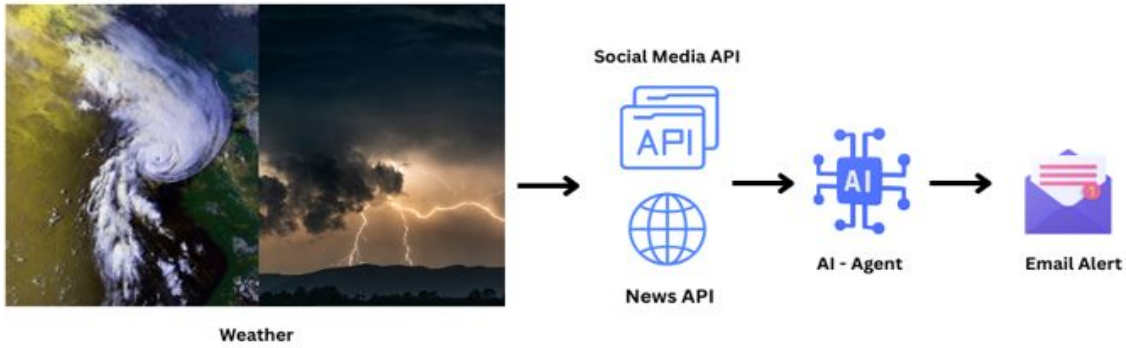
Natural disasters are unpredictable and increasingly severe, Recent disasters like Hurricane Harvey and the 2015 Houston floods revealed how traditional, fragmented emergency response systems led to delayed rescues and greater harm. As climate disasters grow more severe and unpredictable, real-time coordination and data sharing are critical. Smarter, integrated disaster management is urgently needed to save lives and protect communities.

Problem Definition

Traditional disaster management systems lack real-time data integration and adaptive coordination, resulting in delayed and inefficient emergency responses.They often lack contextual awareness, limiting their ability to respond effectively in high-severity situations. These systemic issues result in poor information sharing, confusion over roles, and an inability to adapt rapidly to complex, cascading disasters.

Our Solution

Simulated + intelligent routing



Baseline & Related Works

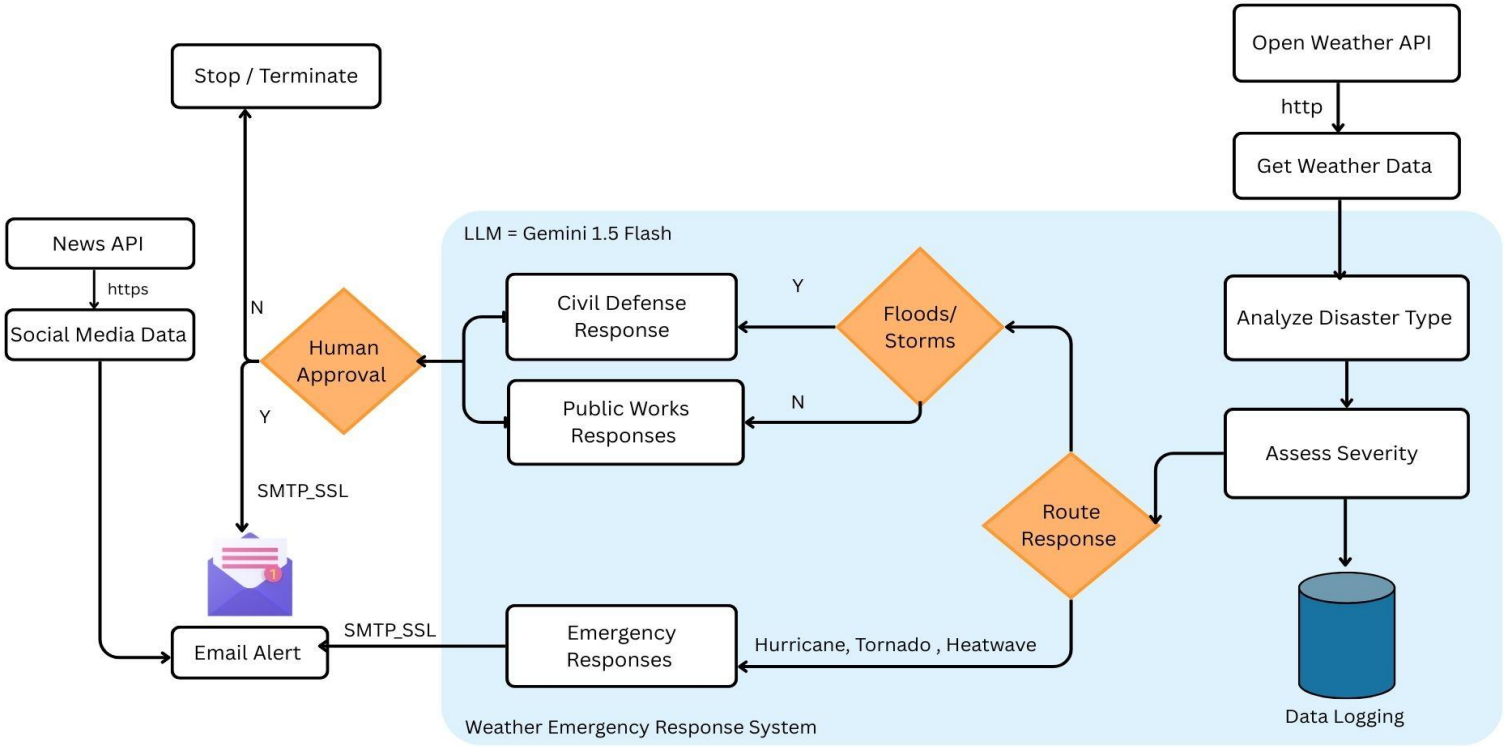
Traditional disaster response systems struggle with real-time adaptation and public sentiment integration. Recent advances using LLMs have addressed parts of this challenge:

- **QuakeBERT**: Used fine-tuned BERT to classify social media posts during earthquakes, improving impact detection by 23% over traditional models (Chen, Qianqian, et al., 2024)
- **FloodBrain**: Applied Retrieval-Augmented Generation (RAG) to generate flood disaster summaries using web data and LLMs, accelerating humanitarian coordination (Shu, Kai, et al., 2023)

Our Contribution:
We extend these ideas by building a real-time, hybrid agent system that:

- Uses Gemini LLM for disaster type and severity assessment
- Simulates social media signals for added realism
- Routes responses to specialized agents (emergency, civil, infrastructure)
- Includes human-in-the-loop approval and structured alerting

Method


Open Weather API
http
Get Weather Data
Stop / Terminate
News API
https
Social Media Data
LLM = Gemini 1.5 Flash
N
Human Approval
Y
SMTP_SSL
Civil Defense Response
Public Works Responses
Y
N
Floods/ Storms
Analyze Disaster Type
Assess Severity
Route Response
Email Alert
SMTP_SSL
Emergency Responses
Hurricane, Tornado , Heatwave
Data Logging
Weather Emergency Response System

Experiments

1. Disaster Classification & Severity Assessment
2. Simulated Environment
3. Response Time & Accuracy
4. Social Media Integration & Validation
5. Impact of Human Approval

Code

```python
import schedule
schedule.clear()

def main():
    """Main function to run the weather emergency system"""
    os.environ["SENDER_EMAIL"] = "AI.Project.625@gmail.com"
    os.environ["RECEIVER_EMAIL"] = "dyavadi324@gmail.com"
    os.environ["EMAIL_PASSWORD"] = "nlrs xhbb hjjd vidz"

    print("\nWeather Emergency Response System")
    print("1. Run normal monitoring")
    print("2. Run test with simulated data")
    choice = input("Select mode (1 or 2): ")

    if choice == "2":
        print("\nSelect test scenario:")
        print("1. High severity (no human verification needed)")
        print("2. Medium severity (requires human verification)")
        print("3. Low severity (requires human verification)")

        scenario_choice = input("Select scenario (1, 2, or 3): ")
        scenario_map = {"1": "high", "2": "medium", "3": "low"}
        scenario = scenario_map.get(scenario_choice, "medium")

        city = input("\nEnter city name for test: ").strip()
        print(f"\nRunning test scenario: {scenario.upper()} severity for {city}")
        run_weather_emergency_system_test(city, scenario)

    else:
        # Accept comma-separated cities from the user
        raw_input = input("\nEnter comma-separated cities to monitor (e.g., Austin, Illinois): ").strip()
        cities = [c.strip() for c in raw_input.split(",") if c.strip()]

        print("Monitoring these cities:", cities)

        def scheduled_check():
            """Function to perform scheduled checks for multiple cities"""
            print(f"\n🚨 Starting scheduled check at {local_time.strftime('%Y-%m-%d %H:%M:%S')}")
            for city in cities:
                try:
                    print(f"\n🚨 Checking weather conditions for: {city}")
                    run_weather_emergency_system(city)
                    time.sleep(2)
                except Exception as e:
                    print(f"Error checking {city}: {str(e)}")

        schedule.every(1).minute.do(scheduled_check)
        print("Weather Emergency Response System started.")
        print("Monitoring scheduled for every minute...")

        while True:
            try:
                schedule.run_pending()
                time.sleep(1)
            except KeyboardInterrupt:
                print("\nShutting down Weather Emergency Response System...")
                break
            except Exception as e:
                print(f"Error in main loop: {str(e)}")
                time.sleep(1)

if __name__ == "__main__":
    main()
```

```
...
Weather Emergency Response System
1. Run normal monitoring
2. Run test with simulated data
Select mode (1 or 2): 1

Enter comma-separated cities to monitor (e.g., Austin, Illinois): College Station
Monitoring these cities: ['College Station']
Weather Emergency Response System started.
Monitoring scheduled for every minute...

🚨 Starting scheduled check at 2025-04-22 17:11:45

🚨 Checking weather conditions for: College Station

============================================================
Low/Medium severity alert for College Station requires human approval:
Disaster Type: No Immediate Threat.  The conditions described are typical of a pleasant, warm, and sunny day with no indication of any imminent severe weather.
Current Weather: clear sky
Temperature: 30.93°C
Wind Speed: 3.09 m/s
Severity: Low
Response Plan: **Civil Defense Response Plan: No Immediate Threat**

**Date:** 2025-04-22 17:11:45

**City:** College Station, Texas

**Incident:** No Immediate Threat - Routine Conditions

**Severity Level:** Low
```

```
Type 'y' to approve sending alert or 'n' to reject (waiting for input):
============================================================
y
Human verification result: Approved
Attempting to send email from AI.Project.625@gmail.com to rishitha532@gmail.com via SSL...
send: 'ehlo [172.28.0.12]\r\n'
reply: b'250-smtp.gmail.com at your service, [34.148.122.39]\r\n'
reply: b'250-SIZE 35882577\r\n'
reply: b'250-8BITMIME\r\n'
reply: b'250-AUTH LOGIN PLAIN XOAUTH2 PLAIN-CLIENTTOKEN OAUTHBEARER XOAUTH\r\n'
reply: b'250-ENHANCEDSTATUSCODES\r\n'
reply: b'250-PIPELINING\r\n'
reply: b'250-CHUNKING\r\n'
reply: b'250 SMTPUTF8\r\n'
reply: retcode (250); Msg: b'smtp.gmail.com at your service, [34.148.122.39]\nSIZE 35882577\n8BITMIME\nAUTH LOGIN P
send: 'AUTH PLAIN AEFJLlByb2plY3QuNjI1QGdtYWlsLmNvbQBubHJzIHhoYmIgaGpqZCB2aWR6\r\n'
reply: b'235 2.7.0 Accepted\r\n'
reply: retcode (235); Msg: b'2.7.0 Accepted'
send: 'mail FROM:<AI.Project.625@gmail.com> size=4964\r\n'
reply: b'250 2.1.0 OK a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp\r\n'
reply: retcode (250); Msg: b'2.1.0 OK a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp'
send: 'rcpt TO:<rishitha532@gmail.com>\r\n'
reply: b'250 2.1.5 OK a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp\r\n'
reply: retcode (250); Msg: b'2.1.5 OK a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp'
send: 'data\r\n'
reply: b'354 Go ahead a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp\r\n'
reply: retcode (354); Msg: b'Go ahead a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp'
data: (354, b'Go ahead a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp')
send: b'Content-Type: multipart/mixed; boundary="===============7716677550765556264=="\r\nMIME-Version: 1.0\r\nFrom
reply: b'250 2.0.0 OK  1745363573 a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp\r\n'
reply: retcode (250); Msg: b'2.0.0 OK  1745363573 a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp'
data: (250, b'2.0.0 OK  1745363573 a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp')
send: 'quit\r\n'
reply: b'221 2.0.0 closing connection a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp\r\n'
reply: retcode (221); Msg: b'2.0.0 closing connection a1e0cc1a2514c-87764799454sm2511867241.28 - gsmtp'

Verification was approved by human, Email sent to rishitha532@gmail.com successfully
Completed weather check for College Station
```

Results

Weather Alert: Low severity weather event in New Delhi Inbox ×

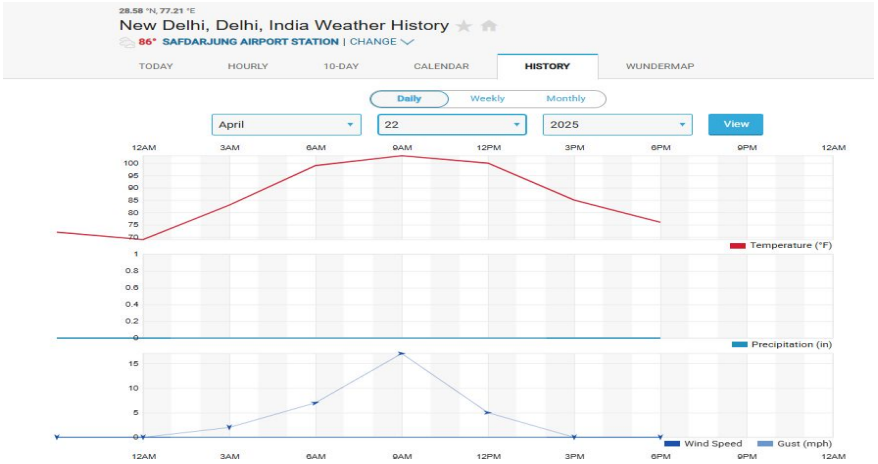
ai.project.625@gmail.com
to me

Weather Alert for New Delhi

Disaster Type: No Immediate Threat. The conditions described are relatively mild and don't indicate any imminent severe weather event.
Severity Level: Low

Current Weather Conditions:
- Weather Description: haze
- Temperature: 26.09°C
- Wind Speed: 1.54 m/s
- Humidity: 22%
- Pressure: 1007 hPa
- Cloud Cover: 0%

Social Media Reports:
'Lost Everything In One Night': J&K's Ramban Residents After Landslides — NDTV News
https://www.ndtv.com/india-news/lost-everything-in-one-night-jammu-and-kashmir-ramban-residents-after-landslides-8210920
Delhi-NCR To See Thunderstorms Over Weekend, Predicts Weather Body — NDTV News
https://www.ndtv.com/delhi-news/delhi-ncr-to-see-thunderstorms-over-weekend-predicts-weather-body-8202373
Building Collapses In Delhi After Heavy Rain, Many Feared Trapped — NDTV News
https://www.ndtv.com/delhi-news/building-collapses-in-delhis-mustafabad-after-heavy-rain-many-feared-trapped-8200350
Rain Brings Relief For Delhi Amid Scorching Heat — NDTV News
https://www.ndtv.com/india-news/rain-brings-relief-for-delhi-amid-scorching-heat-8197993



Weather Alert: Critical severity weather event in Dallas Inbox ×

ai.project.625@gmail.com
to me

Weather Alert for Dallas

Disaster Type: Severe Storm.

While the high wind speed (32.5 m/s) and low pressure (960 hPa) could be associated with a hurricane, the description explicitly states "severe thunderstorm," making "Severe S
contribute to the instability fueling the storm, but don't define the primary hazard. A flood is "possible" due to heavy rainfall, but the immediate and dominant threat is the severe th
Severity Level: Critical

Current Weather Conditions:
- Weather Description: severe thunderstorm with heavy rainfall and strong winds
- Temperature: 35.5°C
- Wind Speed: 32.5 m/s
- Humidity: 90%
- Pressure: 960 hPa
- Cloud Cover: 95%

Social Media Reports:
Local reports of rising water levels and minor flooding.

Response Plan:
Emergency Response Plan: Severe Thunderstorm – Dallas, TX

Date: 2025-04-23
Time: 15:24:42
Incident: Severe Thunderstorm – Dallas, TX (Critical Severity)

1. Situation Assessment:

A severe thunderstorm with high wind speeds (32.5 m/s) and low pressure (960 hPa) is impacting Dallas, TX. High temperatures and humidity contribute to the storm's intensity.
concern.

Weather Alert: high severity weather event in Dallas Inbox ×

ai.project.625@gmail.com
to me

Weather Alert for Dallas

Disaster Type: Severe Storm.

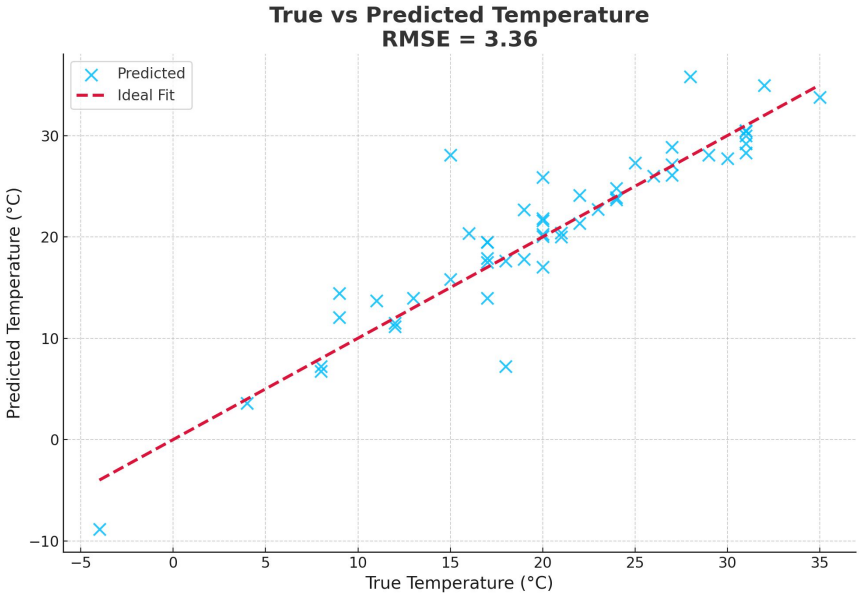
While not hurricane-force winds (a hurricane requires sustained winds of 33 m/s or higher), 15.2 m/s is a significant wind speed capable of causing dam
of extreme conditions characteristic of heatwaves or winter storms. Flooding is possible depending on the duration and intensity of the rain, but "severe
Severity Level: high

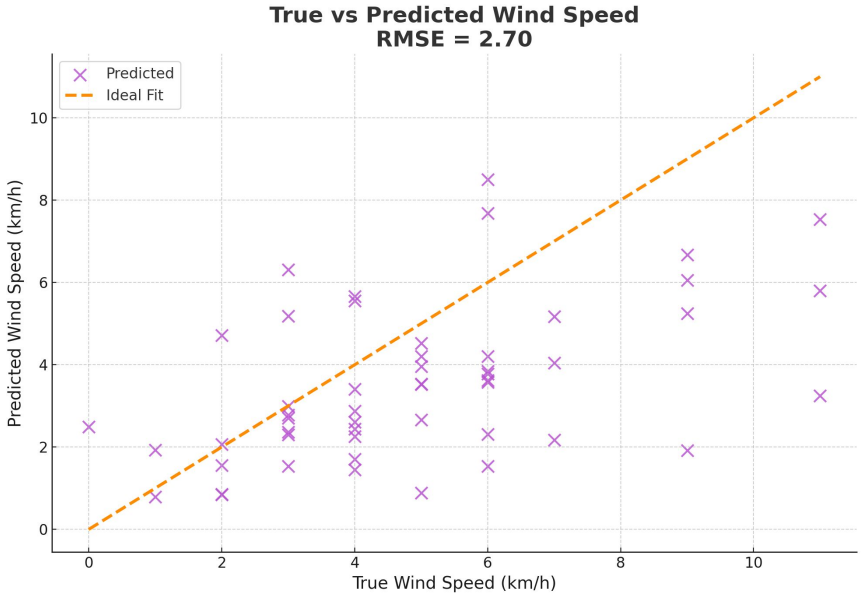
Current Weather Conditions:
- Weather Description: moderate rain with gusty winds
- Temperature: 22.3C
- Wind Speed: 15.2 m/s
- Humidity: 70%
- Pressure: 1005 hPa
- Cloud Cover: 75%

Response Plan:
Emergency services deployed. Public is advised to stay indoors.

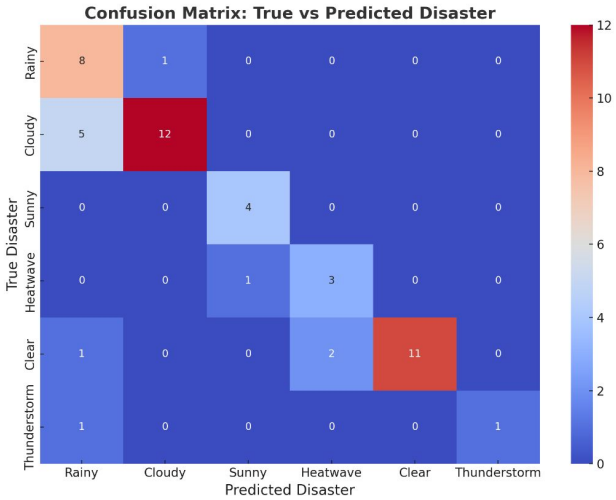
This is an automated weather alert generated at 2025-04-20 22:47:12

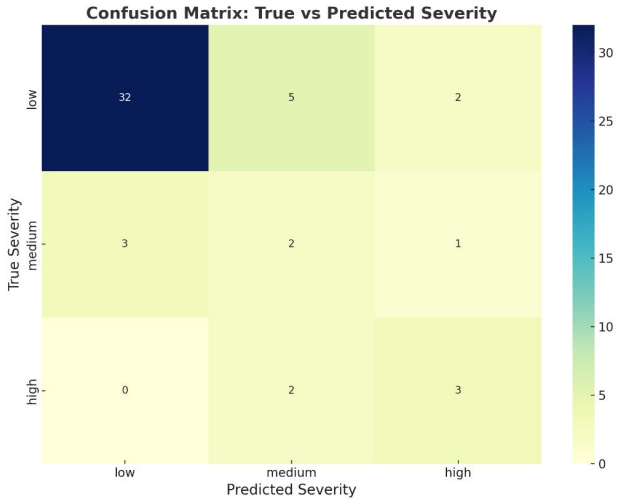
Results


True vs Predicted Temperature
RMSE = 3.36
Predicted
Ideal Fit
Predicted Temperature (°C)
True Temperature (°C)
−10
0
10
20
30
−5
0
5
10
15
20
25
30
35


True vs Predicted Wind Speed
RMSE = 2.70
Predicted
Ideal Fit
Predicted Wind Speed (km/h)
True Wind Speed (km/h)
0
2
4
6
8
10

Results





Average Response Time = 72 seconds

Results are 5x times better compared to baseline Model

Metric	Disaster	Severity
Precision	0.84	0.79
Recall	0.78	0.74
Accuracy	0.78	0.74
F1- Score	0.79	0.76

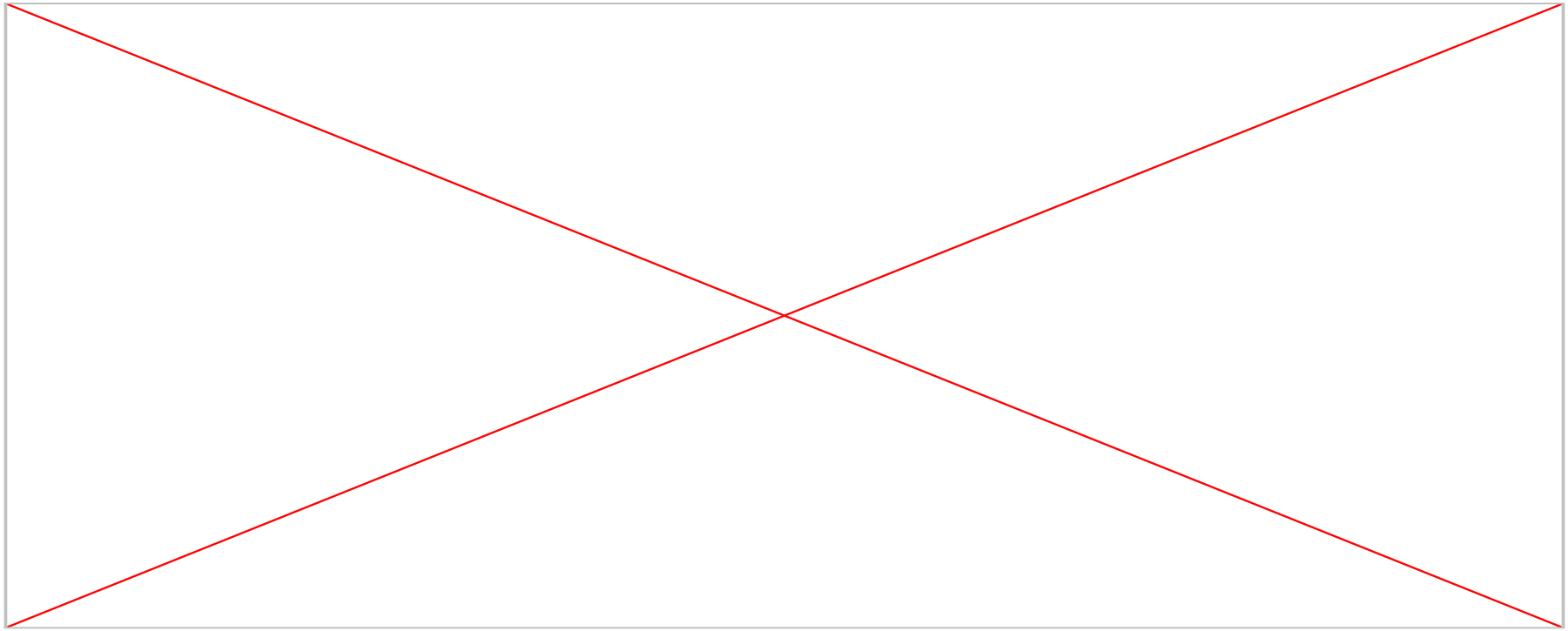
Interpretation

- High Severity Classification: LLM flagged cities with high wind (>30 m/s), extreme heat, or low pressure as critical, matching known disaster patterns.

- Impact of Human Approval: Reduced false alerts in low/medium cases by validating borderline scenarios, improving precision.

- Effect of Removing Social Data: Without simulated reports, the system missed external impacts like outages or flooding, lowering situational awareness.

Output Video



Conclusion & Discussion

This project built a hybrid weather emergency system that combines **real-time weather data**, **simulated scenarios**, social media monitoring and **LLM-based decision-making**. It successfully identifies disaster types, assesses severity, and routes response actions dynamically. Email alerts and human verification ensure safety and accuracy.

Key findings:

- **Reliable** across live and test modes
- **LLM accurately classifies** weather threats
- **Severity routing is effective**
- **Simulated social signals** add realism
- **Human-in-the-loop** adds trust
- **Modular design** supports future scaling

References

1. Li, Shixuan, et al. ClimateLLM: Efficient Weather Forecasting via Frequency-Aware Large Language Models. arXiv preprint arXiv:2502.11059, 2025. [https://arxiv.org/abs/2502.11059]

2. Luceri, Luca, Boniardi, Eric, and Ferrara, Emilio. Leveraging Large Language Models to Detect Influence Campaigns in Social Media. arXiv preprint arXiv:2311.07816, 2023. [https://arxiv.org/abs/2311.07816]

3. Chen, Qianqian, et al. QuakeBERT: Accurate Classification of Social Media Texts for Rapid Earthquake Impact Assessment. arXiv preprint arXiv:2405.06684, 2024. [https://arxiv.org/abs/2405.06684]

4. Shu, Kai, et al. FloodBrain: Flood Disaster Reporting by Web-based Retrieval-Augmented Generation with an LLM. arXiv preprint arXiv:2311.02597, 2023. [https://arxiv.org/abs/2311.02597]

5. Radhika, R., Selvaprasanth, P., & et al. (2025). *Psychological Impact of Real-Time Disaster Alerts and Preparedness*. Journal of Science Technology and Research (JSTAR), 6(1), 270–283. [https://philarchive.org/archive/SELPIO-2]

5.Article:https://www.securitymagazine.com/articles/100571-real-time-data-and-ai-are-the-new-weapons-against-climate-disasters

6. LangChain Documentation [https://docs.langchain.com]Framework used to implement prompt chaining and LLM interaction.

7. Google Gemini API (Generative AI) [https://cloud.google.com/ai/generative-ai] LLM used for disaster classification, severity assessment, and response generation.

Any Questions ?