ASU® Ira A. Fulton Schools of **Engineering**

Arizona State University

Patrick Buckley

Manuel Ceballos

Addison DeFrancisis

Jesse Duron

Jacob Ferrer

Konstantinos Tsakalis

Natural Disaster Early Warning System

Introduction

- Flooding is a major U.S. natural disaster, claiming 181 lives in 2024 despite National Weather Service forecasts. Residents in flash-flood areas often lack timely, localized alerts, especially without reliable devices or visibility of rising water.

- Team NDEWS developed the Natural Disaster Early Warning System (NDEWS) for urban flood channels. It uses compact, low-power sensors to deliver immediate, site-specific warnings, bridging regional forecasts and on-the-ground needs.

- Objective: Build an affordable, durable, easy-to-deploy flood detection network. Each autonomous unit senses water levels, sends real-time alerts to a remote receiver, and enables rapid, widespread installation by municipalities and communities.

Theory

- The Natural Disaster Early Warning System (NDEWS) is based on a network of sensors tailored for urban flood channels. The sensing node uses ultrasonic (HC-SR04) and resistive water level sensors to continuously monitor rising water, with GPS for precise location tagging. When critical thresholds are exceeded, the node transmits data via long-range, low-power LoRa (RFM95W) to a remote alerting node. The alerting node, powered by an Arduino Uno R4 with Wi-Fi, receives the signal, processes it, and sends real-time email alerts with location and severity to residents and first responders. This event-triggered, two-node architecture bridges the gap between broad National Weather Service forecasts and immediate, hyper-local warnings, enabling rapid response. Designed for autonomy (solar + battery), durability (PCB + 3D-printed enclosure), and affordability, NDEWS removes barriers to scalable, life-saving flood monitoring in high-risk urban areas.

Results

- Team NDEWS successfully prototyped and validated the NDEWS flood early warning system, with both sensing and alerting nodes fully assembled on custom PCBs. Controlled flood simulations confirmed accurate water level detection using ultrasonic and resistive sensors, precise GPS location tagging, and reliable LoRa designed to transmit data over 1km. The alerting node seamlessly receives signals and dispatches email warnings with location and severity details in under 10 seconds via Wi-Fi. Solar-powered operation sustains the sensing node for 5 days in favorable conditions, and the complete system can reliably trigger real-time visual and email alerts during simulated rising water events.

- **How to read email information:** Received: Dangerous limit condition, ultrasonic sensor flood measurement, latitude, longitude, error code

Arduino 9:28 PM
to me

Warning! - The water reached the dangerous limit at node 170 > Received:1,9.66,32.99,-117.06,0

Conclusion

- Team NDEWS researched flood disasters and their impact on life and property. Customers desire a broad network of sensors to provide real-time data used for emergency response and public evacuations. The Natural Disaster Early Warning System is uniquely designed for urban flood control channels, and as such, provides a cost-effective and easy deployment product for municipalities. By developing this system, Team NDEWS removed the barriers to entry for robust flood detection and alerting systems in urban areas.

SENSING NODE

ALERTING NODE

SENSING NODE IN THE FIELD

- Two-Node Architecture: A Sensing Node (Arduino Nano Every) measures water levels and a remote Alerting Node (Arduino R4 WiFi) receives status via LoRa to provide public visual alerts.
- Sensors Used: The system uses two ultrasonic sensors to measure water height in inches and two water level sensors to detect safe, critical, and dangerous water thresholds independently.
- Communication: A LoRa module on each node enables long-range wireless transmission of real-time water data, LED status, and system diagnostics.
- Visual Indication: Both nodes use Green (safe), Yellow (critical), and blinking Red (danger) LEDs; the sensing node also displays readings and alerts on an OLED screen.
- GPS Integration: A GPS module on the Sensing Node provides location data for mapping, logging, or future expansion into centralized monitoring systems.
- Self-Diagnostic Error Codes: The system includes built-in fault detection—Error 1 (water level sensor fault), Error 2 (ultrasonic sensor fault), Error 3 (LoRa communication fault)—which are shown on the OLED and transmitted to the Alerting Node.