# Mining of Unmanned Aerial System Operations and Data to Improve Emergency Operations during Natural Disasters

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$210,000

*Using unmanned vehicles to capture and analyze infrastructure damages from natural disasters.*

During natural disasters, infrastructure assets including roads, bridges, buildings, and other structures are affected and communication and accessibility disruptions occur. Accessing information in a timely manner is vital in judging infrastructure health. Natural disasters make this task challenging due to allocating considerable human resources to search and rescue operations rather than collecting asset condition data. Using Unmanned Aerial Systems (UAS) can help gather information about the actual state of structures, water levels in dams and levees, road blocks due to fallen trees, lighting poles or others, among other information that is vital before, during, and after a disaster. The need for relatively fewer human resources also contributed to the widespread use of unmanned aerial platforms during emergency response operations. The purpose of this project is to use unmanned aerial system operations and data to improve emergency operations during natural disasters. The outcomes of this study will drive forward the potency of emergency operation centers (EOCs) by leveraging UAS technologies and advanced analytical tools for data mining and fusion.

## Problem Statement

Hurricane Barry hit the Louisiana coast on 12 July 2019, with 70 mph winds, 10-inch rainfall, and a surge of 6 ft. This led to flooding in Morgan City and Houma, LA, and left 150,000 people without power across Louisiana. Disasters like Hurricane Barry present a chance to document how emergency operation centers (EOCs) use technology to respond to disasters and understand where uncertainties exist and how they can be fixed. EOCs which include transportation officials and infrastructure are the central command and control facilities responsible for carrying out disaster preparedness and management. To achieve this, EOCs are to (1) collect and analyze data; (2) make decisions that protect life and property; and (3) disseminate decisions to all concerned parties. To achieve objective (1), EOCs need to continually adopt technologies, such as unmanned aerial systems (UAV or UAS), to extract as much information possible to fulfill objectives (2) and (3). Documenting the current operational inefficiencies, technology gaps, and data analysis limitations of EOCs are important to improving disaster preparedness and response.

## Objectives

The objective of this study is to use unmanned aerial system operations and data to make efficient decisions and documentation of transportation infrastructure damage during natural disasters. The outcomes of this study are intended to improve the efficiency of emergency response during natural disasters. The following research objectives will be explored:

- **Technological Operations**: Determine a more efficient workflow to evaluate critical infrastructure before, during, and after a natural disaster. For example, UAV operations take considerable time to get to the site, manually select a flight path, operate the UAV(s), store the data, go back to the EOC, and finally analyze the video. This workflow is very inefficient due to human latency. Other considerations include beyond line of sight, nighttime, and flying over the public will be vital during UAV operations and they need to be addressed and integrated into the workflow as well.
- **Data Mining**: Mine UAS video for updates on infrastructure damage and emergencies. This gives street level conditions of roads, flood control structures, power lines, number of damaged homes and waste debris piles, rising water levels, among many others.
- **Data Fusion**: Converge emergency calls, UAV sensing, meteorological conditions, and computational models to improve real-time evaluation of disasters for better emergency response. The collected UAV data needs to be

integrated with existing socioenvironmental data to better plan for recovery. This includes locations of critical infrastructure, industrial plants, road networks, potential shelters, demographics, and housing characteristics. If collected before the event for the study region, this data will help guide the UAV mission. Data collected from the UAV mission during and after the event will need to be mapped to pinpoint areas that need urgent attention.

- **Data Management**: Determine how EOCs archive disaster information and data. With 'Big Data', the volume, velocity, and variety require better data management to analyze the situation and disseminate information. However, the PIs observed Beaumont EOC storing waste debris tickets in plastic bins. With many moving parts, data management becomes even more important to provide damage documentation to FEMA for reimbursements.

## Intended Implementation of Research

**Workforce Development:** This will be achieved directly by training graduate, undergraduate, and high school students interested in pursuing a career in STEM or Transportation Engineering career.

**Education:** This task supports the federal initiative to build the next generation of transportation professionals to meet the demands of the rapidly changing the 21st-century transportation system. The PI currently supports and mentors five graduate students and three undergraduate students from external grants. The proposed study will help the PI to recruit and train more graduate and undergraduate students in transportation research.

**Outreach:** Technical articles, posters, and presentations will be delivered at national and local conferences and symposia such as ASCE, Transportation Research Board, ARDOT, Tran-SET, and Create@STATE. Also, a Create@State radio (KASU) podcast will be prepared.

## Anticipated Impacts/Benefits of Implementation

This research aims to improve the current methodology to evaluate damage to structures, roadblocks, waste debris, and the exact location for special needs. It also intends to advance and expand the UAS application in Louisiana and Texas for emergency operations, airport operations, and asset management. Reaching out to other states is also intended. The main deliverables of this project include:

1. A final report including a complete description of the problem, approach, methodology, findings, conclusions, and recommendations developed for the tasks.

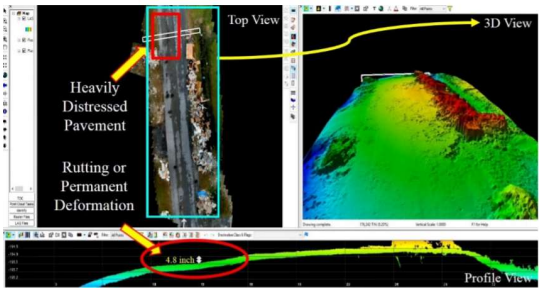


**Figure 1: Photogrammetry Data Identifying Failure of a Pavement Section Immediately after Hurricane Harvey**

## Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

## Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.