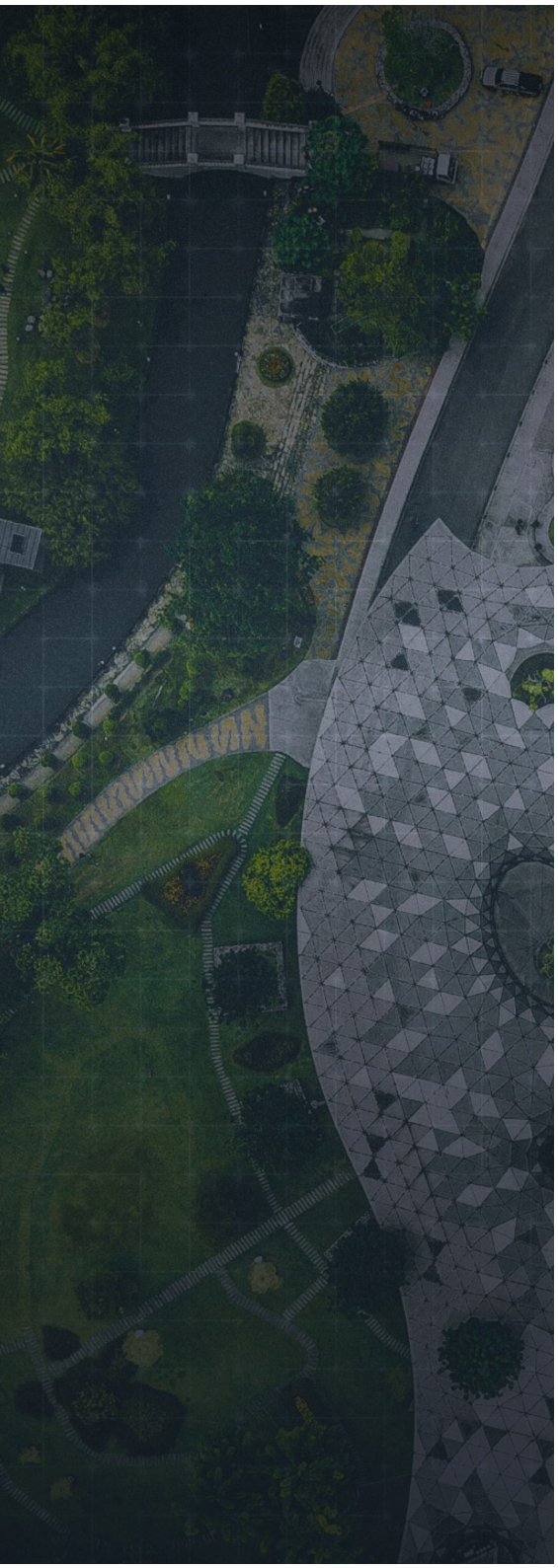

Mapware

CASE STUDY

Mapware Works with Comcast to Improve Infrastructure Damage Assessments with UAVs

Executive summary

Mapware was one of the first drone companies ever deployed for disaster response in the U.S., and has responded to 4 out of the last 5 hurricanes that made landfall.

In the wake of Hurricane Matthew in October of 2016, Mapware deployed in an emergency response capacity to assist Comcast Corporation's recovery efforts in Savannah, GA.

Using UAV technology, Mapware mapped 160 square miles with 150 flights over 6 days, and identified the precise coordinates of 117 sites where infrastructure assets had been damaged.

Compared to past methods used to assess physical infrastructure damage after a natural disaster, the methods pioneered by Mapware in this case provided a model to drastically improve safety and response time for future disaster recovery efforts, illustrating potential opportunities for improvement in infrastructure management.

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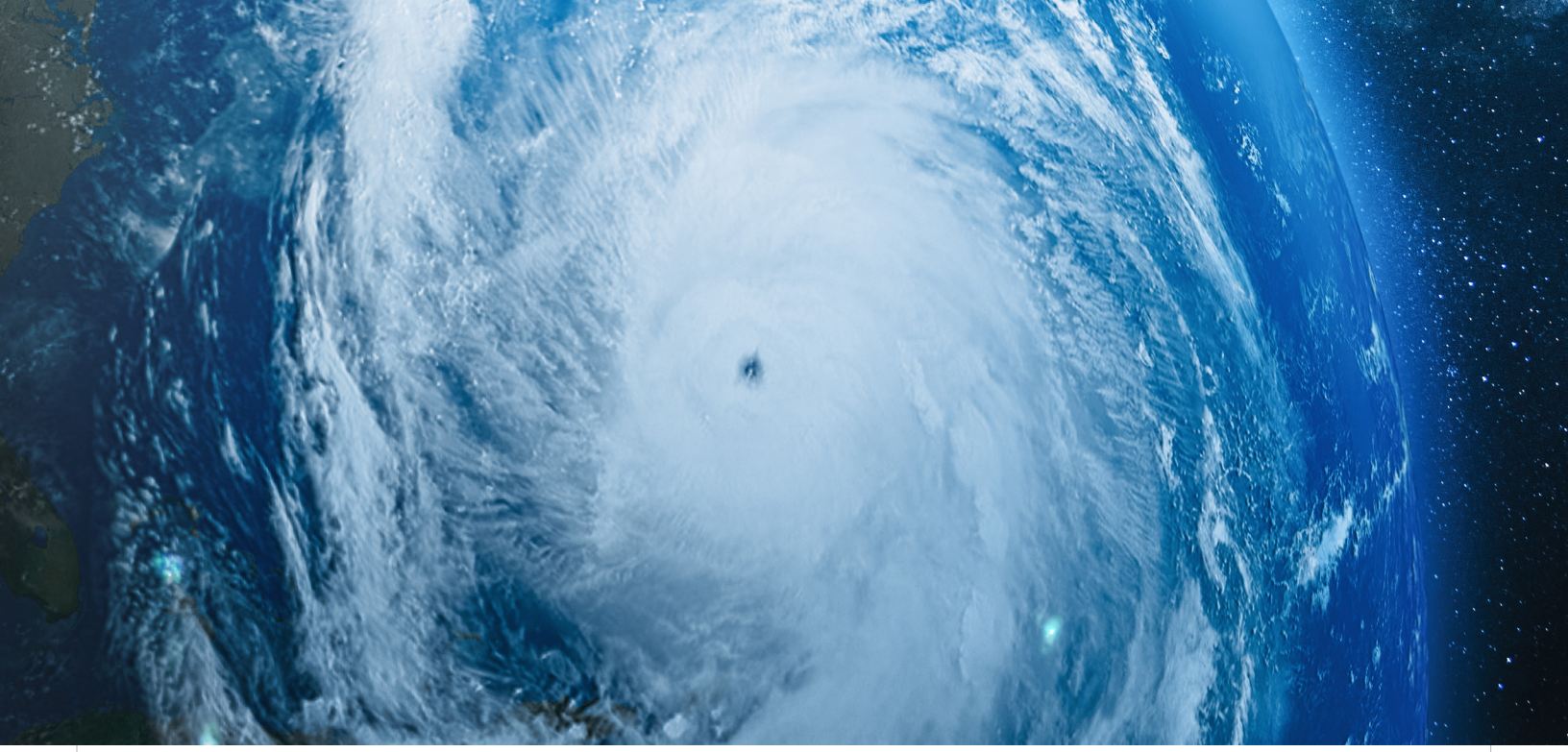


The challenges of damage assessment following a natural disaster

Communication infrastructure is critical in the immediate aftermath of a natural disaster, yet loss of service (partial or complete) remains a common characteristic of all disaster zones. As a critical capability for coordinating response efforts, informing the public, and identifying individuals in need of assistance, this loss of service can be a matter of life and death, resulting in property damage or even loss of life that could be prevented with fast response times. Efficiently restoring communication service is key to avoiding these collateral losses in the wake of a disaster event.

Communication infrastructure is naturally susceptible to physical damage. After a node or line is physically damaged, the structure of telecommunications networks makes remotely identifying specific areas of damage difficult. In the past, assessing

physically damaged infrastructure and prioritizing repairs required a fleet of technicians on the ground capable of combing through the impacted areas, locating damage, capturing that information, and then physically moving to another location. This method is both dangerous and inefficient, but until recently was common practice.

UAVs provide several advantages over the current methodology, including:

- **Improved range**, including the ability to locate previously inaccessible damaged infrastructure such as in areas with rear easements or roadblocks
- **Improved safety**, because pilots (and any assisting spotters) can find the most open, safe location in each area to launch a flight, without being in close physical proximity to damaged or unsafe areas
- **Reduced assessment times** for large areas impacted by disaster

The danger of Hurricane Matthew

Hurricane Matthew grew from a tropical storm to a Category 5 hurricane on October 1, 2016, with sustained wind speeds of more than 160mph. This overnight intensification from a tropical storm to a Category 5 hurricane is one of the fastest on record.

Matthew made landfall in Haiti on October 4, where it killed nearly 900 people and left tens of thousands homeless before turning towards the U.S. eastern seaboard.

Models for the hurricane's path had drastically different possible outcomes, and it was unclear what category it would be by the time it reached the U.S. coastline. Massive evacuations were initiated in Florida, Georgia, South Carolina,

Possible trajectories of Hurricane Matthew in the days leading up to landfall in Florida and Georgia. Photo courtesy of WLIX 19 News.

and North Carolina.

Luckily, Hurricane Matthew was down to a Category 3 by the time it reached the U.S., and therefore caused less destruction than it inflicted on Haiti during its Category 4 period. However, it still resulted in an estimate of more than $10 billion in damage.

Mapware received Comcast's request to mobilize to the greater Charleston, SC area on October 5, and began staging in Atlanta, GA on October 8. When staging began, the target area for deployment was unknown, as was the likely extent of the damage crews would find upon arriving there. Given the damage the storm had already inflicted, crews were instructed to expect the worst.

Staging and deployment

Mobilizing to respond in the immediate aftermath of a hurricane before it makes landfall presents unique challenges. Forecasts for a storm's trajectory can vary widely (and Matthew was no exception in this regard), which necessitates both patience and agility in the planning process.

To allow the storm's trajectory time to manifest itself, crews began staging in Atlanta with system checks and training procedure reviews. For this mission, Mapware chose a fixed-wing system over multirotor options for its greater

endurance and area coverage. This training time allowed the planning team time to study both potential deployment areas, Savannah and Charleston.

By the morning of October 9, crews deployed to Savannah on the estimation that damage was more severe in that area.

The first flights began the next morning, and the first set of finished data was delivered at 8 AM on October 11. After initial review of that data, Comcast requested higher-resolution data for their field teams, so crews were instructed to adjust altitude from 360 ft AGL to 200 ft AGL, translating to a ground sampling size of 0.5 cm. This level of detail helped the image tagging crews assess damage more accurately, which saved time during image processing, at a slight reduction in data acquisition speed.

Mapware Chief Pilot Michael Lederman (left) assists a field pilot to set up a SenseFly eBee, the fixed wing UAV system chosen for the Savannah, GA mission.

With subsequent flights covering less area per battery charge, battery management across all flight teams became more of a priority under the new, higher resolution requirements. This risk had been identified before deployment and was readily mitigated in the field with effective contingencies.

Regulatory compliance

Regulatory compliance is a critical function of any legitimate drone operation, and it is Mapware policy to abide by all relevant regulations at all times when operating in the field. For this project, a **dedicated compliance team** was established to oversee airspace coordination and general compliance throughout the entire operation.

This included coordinating with the Flight Standards District Offices (FSDO) for the area and operating all flights in compliance with 14 CFR Part 107. All pilots used in the operation were required to have remote pilot certificates with small Unmanned Aircraft Systems (sUAS) ratings, or alternatively could fly under an applicable Section 333 exemption, provided they held that exemption and followed its requirements. Restricted airspace was avoided entirely for this mission, and Mapware maintained close coordination with local authorities throughout field operations.

Since the project required the use of additional new aircraft systems to meet the scale of the project, compliance for this mission included the extra step of registering the new aircraft with the FAA, which was completed, as required, before any new system was used in the field. Notices to Airmen (NOTAMs) were filed using

the registration numbers for each aircraft for all flights, in coordination with local air traffic control.

Before deployment into the field, all flight teams were briefed on airspace restrictions, altitude requirements and weather conditions. Each team was given aircraft radios to monitor frequencies in the area and to maintain positive communication with other air traffic. All pilots referenced “sectionals” detailing local airspace restrictions, and any reports from the field flowed into a centralized mission command to be disseminated to all flight teams.

This planning and preparation maintained strict adherence to FAA guidelines and helped to maintain Mapware’s **100% safety record** to date.

Logistical considerations

In a disaster environment, logistics are a major concern. Under normal circumstances, access to power, water, and housing for flight teams and supporting staff on a mission is as plentiful as the local hospitality market. Conversely, in a disaster zone access to necessities is variable unless provided internally.

This project had the further caveat of being within a mandatory evacuation zone, which meant that access to highways headed into Savannah was restricted by state police. Simply getting into the city required coordination with the Department of Homeland Security; without agency credentials, the mission would not have been possible. Comcast was a major help on this front, facilitating access through DHS coordination and providing facilities for operations.

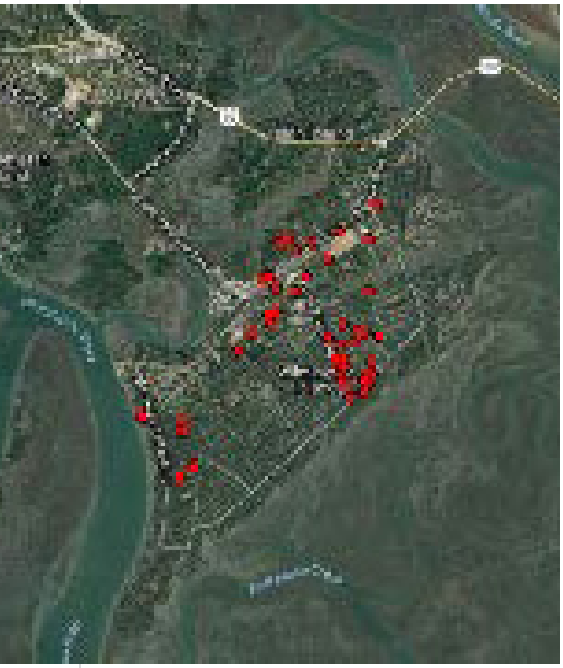
To mitigate environmental risks to the operation, the crew **planned for several contingencies** by:

- Supplying enough generators to recharge all batteries necessary for flight operations and power all servers for data processing
- Finding food, water, and housing within the evacuation zone before deployment (although ultimately success on this was limited, due to worsening conditions on the ground)
- Bringing a Class A RV as part of the load-out equipment into the disaster zone, to function as on-site housing for the project at the mission command location

Even with the above level of preparation, logistics remained challenging in Savannah immediately after the storm.

After several days in the field, Mapware found that the only way to minimize environmental risks to operational efficiency was to minimize reliance on environmental support; this experience resulted in the company establishing a policy to bring all necessary materials, including housing, into all future disaster zone operations.

The full orthomosaic created from a series of flights over Savannah, GA. For speed, each tile is analyzed individually for damage before being combined into a larger image.



A partial map of the areas around Savannah tagged as damaged. Maps such as this one were delivered daily as new areas were mapped and annotated, along with a spreadsheet of coordinates.

Project management and data processing

To demonstrate meaningful improvement over conventional methods, the mission had to be completed on a tight timeframe, and required efficiency in both project management and data processing capabilities.

Project management included mobilizing 10 flight crews within 2 days, including logistics for deploying to a location in a disaster zone. The imagery processing capabilities demanded by the project exceeded those available from any cloud-based service providers, so **Mapware designed and built new servers specifically for the project, reducing the processing time per square mile from an industry-typical 2-3 days to less than 2 hours on a single customized machine.**

During this project, teams were broken into two basic functions: data acquisition and data processing. These two functions were performed by two different teams, working two sequential half-day shifts in order to take advantage of all 24 hours per day.

Data acquisition (flight operations) ran from dawn to dusk, uploading their data to the on-site servers each night for the data processing team to process, analyze, and deliver the following morning.

Effective project management is the difference between reliable, on time data delivery and total project failure. Especially in a disaster response environment, where logistics make flexibility in housing, food, and power more difficult to obtain, Mapware has found that project management has outsized positive and negative effects on efficiency.

For this reason, maintaining operational awareness at every stage throughout the entire work day, especially in the transition between the “day” and “night” shifts, was critical to on-time data delivery.

Damage to telephone poles clearly visible from the air. Photos like these were used to identify areas where infrastructure was damaged. Once identified, a location like this one would be tagged with exact coordinates, helping Comcast technicians to quickly locate the downed lines.

Conclusion

For this project, Mapware rose to the incredible challenge of operating efficiently in the wake of a hurricane. In the process, we gained valuable insight into the infrastructure management strategies and best practices that enable infrastructure asset managers like Comcast to mitigate future storm damage as efficiently and safely as possible. Drones offer the unique capability to rapidly respond in an emergency, and that capability is augmented significantly by active, routine monitoring of infrastructure assets using consistent methodology and capabilities. For example, damage is much easier to assess across large network assets if those assets are being routinely mapped, so that a baseline status of those assets can be measured against.

Through our work in Savannah, the Mapware team demonstrated problem-solving expertise, focus under pressure, and project management skills, as well as the true potential of drone services to assist — and transform — disaster recovery efforts.

Learn more about Mapware

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