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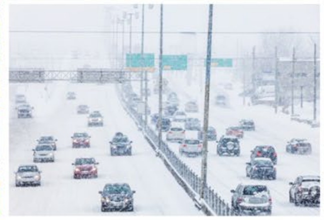
Innovation for a Nation on the Move




Mobility · Safety · Quality · Environment · Shortening Project Delivery

EDC-5 UAS Peer-to-Peer Exchange

Puerto Rico & U.S. Virgin Islands

May 12-13, 2021

U.S. Department of Transportation
Federal Highway Administration

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16. Abstract: This peer exchange brought together representatives from the Puerto Rico, U.S. Virgin Islands, Alabama, Utah, Minnesota, and Ohio Departments of Transportation. The peer exchange facilitated discussion and collaboration around Unmanned Aircraft Systems (UAS) practices and use cases across infrastructure inspections, emergency response, geotechnical evaluations, construction, and material estimations. This report summarizes the presentations and discussions of the peer exchange held between Puerto Rico and the U.S. Virgin Islands on May 12-13, 2021.

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ACRONYMS AND ABBREVIATIONS

3D	Three-dimensional
DOT	Department of Transportation
DTPW	Department of Transportation and Public Works
FHWA	Federal Highway Administration
GIS	Geospatial Information Systems
LiDAR	Light Detection and Ranging
NHS	National Highway System
PRHTA	Puerto Rico Highways and Transportation Authority
PRLTAP	Puerto Rico Local Technical Assistance Program
RCUT	Restricted Crossing U-Turn
UAS	Unmanned Aircraft Systems
U.S.C.	United States Code
USVI DPW	U.S. Virgin Islands Department of Public Works

BACKGROUND

As part of the Federal Highway Administration (FHWA) Every Day Counts Unmanned Aircraft Systems (UAS) Initiative, the Puerto Rico Local Technical Assistance Program (PRLTAP) hosted a virtual peer exchange on May 12-13, 2021. The Puerto Rico Department of Transportation and Public Works (Puerto Rico DTPW) and the U.S. Virgin Islands Department of Public Works (USVI DPW) highlighted the importance and relevance of innovation in transportation for their region. After experiencing Hurricane Maria in 2017, Puerto Rico and USVI relied on Unmanned Aircraft Systems (UAS) assistance for emergency debris management, damage assessments, inspections, and recovery efforts. In a region commonly at risk from hurricanes, earthquakes, and other natural disasters, Puerto Rico DTPW and USVI DPW have found UAS to be a helpful tool to assist with emergency response, and have seen an increase of safety and efficiency when using UAS. Puerto Rico DTPW and USVI DPW hosted this peer exchange to describe regional UAS innovations and allow other State DOTs to showcase their UAS advancements and innovations.

Representatives from Alabama, Utah, Minnesota, and Ohio DOTs hosted breakout sessions where these representatives shared UAS advancements in design and construction, inspections, emergency response, and traffic management during natural disasters or climate change challenges. This report summarizes the information presented by the Puerto Rico DTPW and USVI DPW and others, the information was up-to-dateat the time of the peer exchange.

FAA REGULATIONS

UAS operators in both the public and private sectors must also adhere to statutory and regulatory requirements. Public aircraft operations (including UAS operations) are governed under the statutory requirements for public aircraft established in 49 USC § 40102 and § 40125. Additionally, both public and civil UAS operators may operate under the regulations promulgated by the Federal Aviation Administration. The provisions of 14 CFR part 107 apply to most operations of UAS weighing less than 55 lbs. Operators of UAS weighing greater than 55 lbs may request exemptions to the airworthiness requirements of 14 CFR part 91 pursuant to 49 USC §44807. UAS operators should also be aware of the requirements of the airspace in which they wish to fly as well as the requirements for the remote identification of unmanned aircraft. The FAA provides extensive resources and information to help guide UAS operators in determining which laws, rules, and regulations apply to a particular UAS operation. For more information, please see https://www.faa.gov/uas/.

REGIONAL UAS APPLICATIONS

Puerto Rico DTPW and USVI DPW are primarily using UAS for the following applications:

- Survey mapping
- Construction management
- Structural inspections
- Emergency relief
- Incident management
- Training

After Hurricane Maria, there was a critical need to remove debris and sediment blocking waterways across the island and restore the hydraulic capacity of culverts. Imaging gathered during UAS flights provided the needed information without relying on boats or additional equipment to evaluate the damage. For landslide repairs, UAS have been used across the island for preliminary damage assessments, to gauge impacts on utilities and accessibility to residencies, and to flag any riskier locations for personnel. Additionally, members of the Puerto Rico Police Academy used UAS for emergency response, which it reports has increased safety for first responders.

Not all UAS applications in Puerto Rico and USVI involve emergency response during natural disasters. Crash analysis and traffic monitoring are also applications where UAS have helped the region with faster, more detailed, and accurate documentation for recreating accidents and understanding drivers' maneuvers even in remote locations of the island.

INITIATIVES BY PUERTO RICO'S SOILS ENGINEERING OFFICE

Puerto Rico Highways and Transportation Authority (PRHTA) manages approximately 782 miles of roads attached to the National Highway System (NHS) and manages additional roads that are not part of the NHS. Puerto Rico's Soils Engineering Office is involved in every step of the transportation system, from planning to maintenance across all PRHTA-managed roads. Since purchasing a UAS in 2015, the Soils Engineering Office has used UAS throughout different stages of transportation projects. Figure 1 shows an example of UAS-collected data being overlaid on a map to complete a geotechnical and geological evaluation for a route study in San Sebastian.

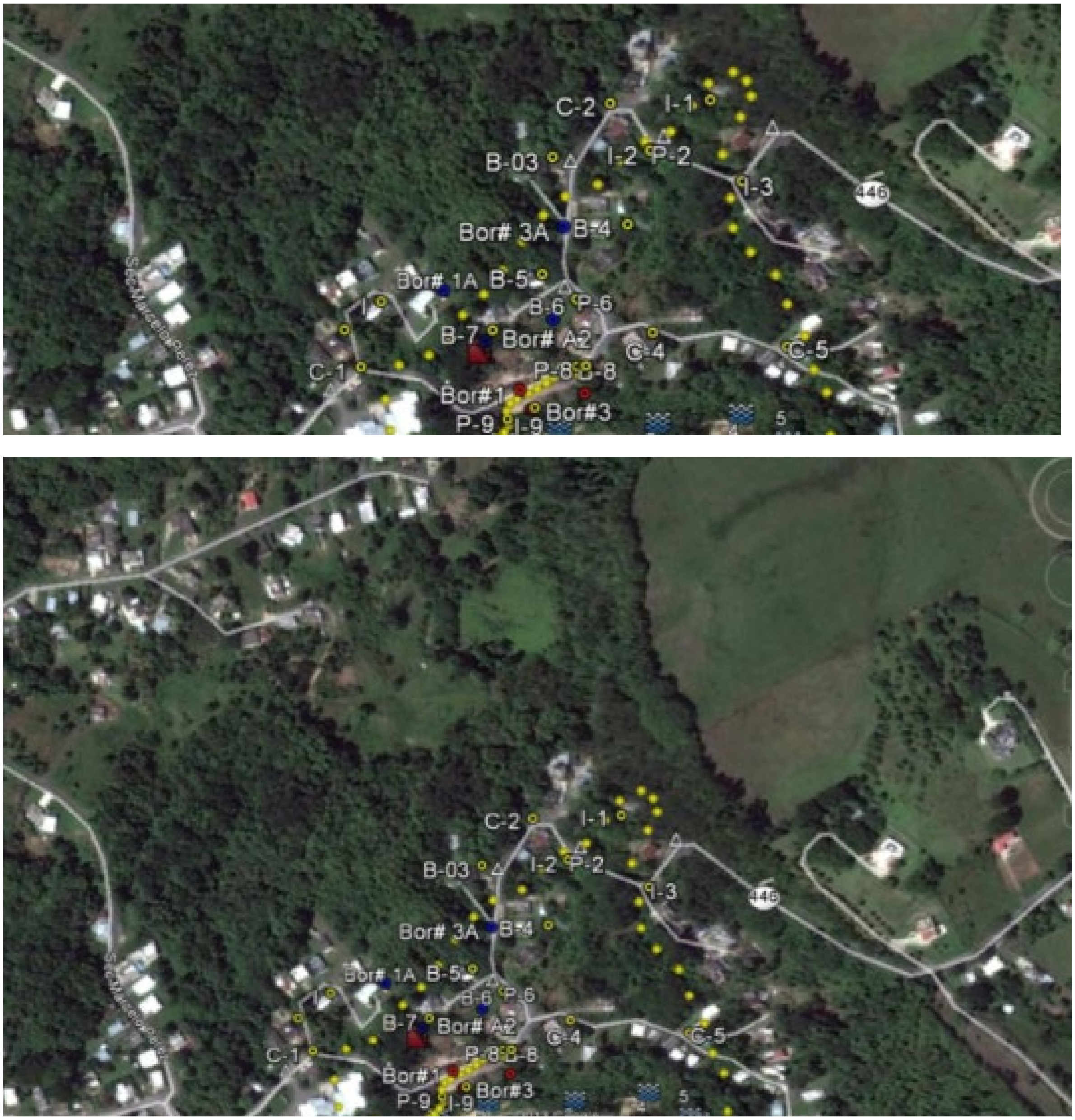

Figure 1. Geotechnical and Geological Evaluations for Route Reconnaissance Study in San Sebastian. (Source: Puerto Rico DTPW)

The Soils Engineering Office is also exploring the use of UAS to identify assets like small bridges and gather information regarding dimensions, properties, and condition to create alternatives for investments. Another example is using UAS to assess the condition of three different assets in the same spot. Figure 2 shows a retaining wall and two mechanically stabilized earth walls that were analyzed with the assistance of UAS.

Figure 2. Use of UAS for Data Gathering of Three Assets in One Site. (Source: Puerto Rico DTPW)

The Soils Engineering Office intends to train more pilots under 14 U.S.C. § 107 but is facing several challenges that it is currently working to overcome, including insurance to operate UAS and legal accountability. Pueto Rico DTPW reports one of the biggest challenges in maintaining a robust roster of pilots is that Spanish is predominantly the first language of potential pilots, and all the materials and tests are in English.

USVI UAS APPLICATIONS IN GEOSPATIAL INFORMATION SYSTEMS (GIS)

USVI established its UAS program in 2016; significant storms and Hurricane Maria impacted the region in 2017. As the program has continued to expand, USVI has employed a variety of UAS platforms and software. USVI personnel noted the importance of having capable software to process the UAS-collected data and deliver high-quality GIS deliverables. The UAS team can produce high-quality aerial imagery and missing imagery by stitching the gathered data properly and projecting using coordinate tools.

Among USVI's applications for UAS usage are reconnaissance, three-dimensional (3D) modeling for historic preservation, and monitoring project progression. One of the most prominent projects that will benefit from UAS is the freeway expansion on Saint Thomas's waterfront. UAS will be used to gather imagery from the start of the project and throughout its various stages as the two-lane freeway is expanded to four lanes. During this specific project, UAS will fly over water to collect data to create elevation and 3D models for use by the engineering departments. Figure 3 shows UAS imagery of a portion of this freeway expansion project.

Figure 3. UAS Imagery of the St. Thomas Waterfront Freeway Expansion Project. (Source: USVI)

UAS TECHNOLOGY AS A TOOL TO DETERMINE DEBRIS VOLUME FROM HURRICANE MARIA

After the estimated $108.9 billion[1] impact of Hurricane Maria in 2017, the road to recovery started with stockpiling debris and preparing it for removal. Prior to removal, it was important to estimate the amount of debris and the disposal services and costs associated with its removal to submit the eventual reimbursement claim to the Federal Emergency Management Agency. The estimate was obtained by measuring the volume of piles of debris. Using UAS and data-processing software and procedures based on the principles of photogrammetry, the assigned team was able to create a digital elevation model from where the volume was obtained. Figure 4 shows the site divided by zones and the digital elevation model for zones 1, 2, and 3.

[1] Estimated costs received from National Centers for Environmental Information: https://www.ncei.noaa.gov/access/billions/dcmi.pdf?sort=cost-asc

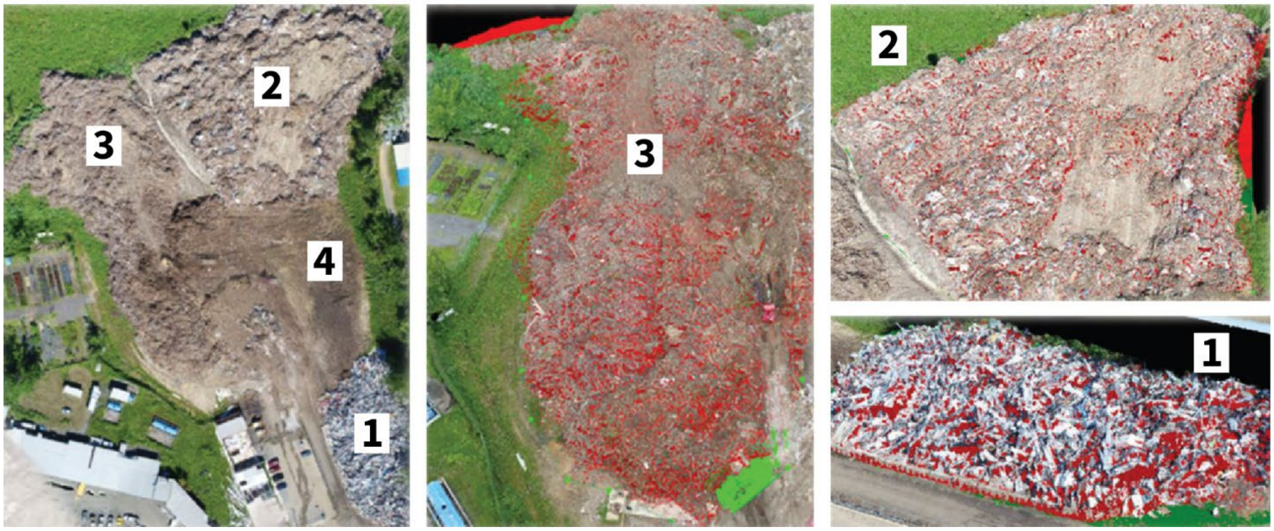

Figure 4. El Hoyo Site and Digital Elevation Model. (Source: Municipality of Bayamón, Puerto Rico)

This UAS application enabled data to be collected and processed quickly. In addition, it mitigated occupational safety hazard for surveyors presented by the nature of the debris, and involved a smaller economic investment than traditional methods.

BREAKOUT SESSION CONCLUSIONS

In a **Design and Construction** session, representatives from Alabama DOT discussed the importance of maintaining its UAS fleet and data-processing software. Alabama DOT also emphasized the power of UAS-collected data and how helpful it can be when placed in the hands of decision makers. Alabama DOT uses UAS for ongoing monitoring and project reporting. Figure 5 shows a view of a UAS software report in which each icon is a live link that can be selected for additional details such as 3D models, imagery, videos, and project notes. Figure 6 is a close-up view of the project from one of the links within the progress report.

Figure 5. UAS Software Project Progress Report with Links (Source: Alabama DOT)

Figure 6. Still-capture of UAS-Collected Images Creating a 3D Experience of an Ongoing Project (Source: Alabama DOT)

Utah DOT has found that beyond the processing of collected data, using visualization tools for projects involving design and construction is an important use case for illustrating the need for UAS use on a project. Utah DOT described an instance when additional parking was needed for a State park, and it was not until a 3D model was used that the need for the project was made clear to relevant stakeholders and decision makers. Utah DOT has used UAS imagery for:

- Planning during the conceptual phase of a project.
- Topographic mapping during the design phase in pre-construction.
- Hybrid survey models combining UAS, Light Detection and Ranging (LiDAR), GPS Rover, and Total Station data.
- Measuring slope distance, surface area, and volume.
- Cross-section views and digital as-built drawings.
- Construction progress (as shown below in Figure 7).

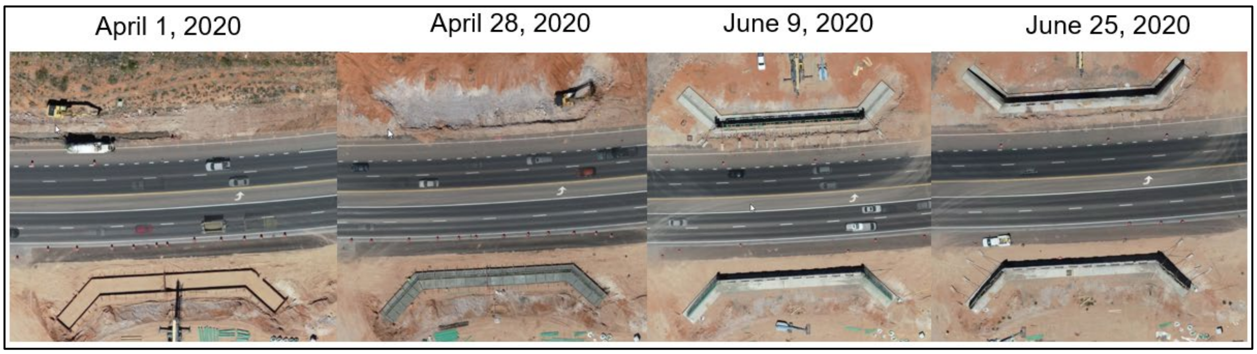

Figure 7. UAS Imagery for Construction Progress. (Source Utah DOT)

During the **Bridge Inspection** session, presenters from the Minnesota DOT discussed using UAS as a supplemental tool for bridge inspection teams and how its use has realized an approximate 40 percent savings over traditional methods. UAS can be a supplemental tool for bridge inspections and are not a replacement for National Bridge Inspection Standards and requirements. The session mainly focused on how the deployment of UAS can:

- Address worker safety by inspecting the area and assessing risks to workers.
- Geolocate imagery and share higher quality data efficiently.
- Increase productivity while decreasing processing time and user input by implementing artificial intelligence and machine learning techniques.

EMERGENCY RESPONSE AND TRAFFIC MANAGEMENT

The **Emergency Response and Traffic Management** session was facilitated by representatives from Ohio DOT which focused on transportation infrastructure applications that include:

- Traffic signals and lane closures.
- School zones (with direct communication with law enforcement).
- Special events (especially during COVID-19 and at testing/vaccination sites).
- Smart lanes.
- Emergency response and shutdown.
- Data collection (counting and classifying vehicles).
- Motor vehicle accident reconstruction.

- Radiation detection.

The Ohio DOT shared how it uses UAS to acquire traffic footage to evaluate traffic flow and monitor the effectiveness of new roadway design operations. Figure 8 is a UAS image from a new roadway design project in Ohio.

Figure 8. UAS Image of a New Roadway Design Project (Source: Ohio DOT)

CONCLUSION

During the closing general session all participants shared key takeaways from the various break-out sessions. These takeaways are noted below:

- UAS data collection can be used across numerous use cases and can be an impactful supplemental tool in making data-driven decisions.
- UAS can be a supplemental tool throughout the entire lifecycle of transportation assets, from the design and planning stages to the necessary ongoing inspections and maintenance schedules.
- UAS data when paired with the appropriate data-processing software can produce a variety of deliverables such as 3D models, interactive progress reports, and hybrid data models.
- UAS can increase safety, time savings, and cost savings on a variety of projects (e.g., the material estimation projects as part of the post hurricane cleanup efforts).