Use of an Unmanned Aerial System (UAS) For a Damage Survey of an EF-3 Tornado in Southwest Virginia

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Tornado at the beginning of it's path near Evergreen, VA. Photo by Jason Smith.

Overview and Ground Survey

On February 24, 2016 a tornado caused seven injuries, one fatality, and significant damage in Appomattox County, Virginia. There was considerable damage to over 100 structures, including some well-built brick homes, as well as many snapped and downed trees. The image to the left was taken when the tornado was near the beginning of it's path.

A ground based survey team from the National Weather Service (NWS) Blacksburg office deployed within 24 hours to Appomattox county, VA.

- **Preliminary findings:** EF-3 tornado (140-145 mph) with a track length of 13 miles
- **Exceptionally rare event:** This was the first documented EF3 tornado in the month of February for the NWS Blacksburg county warning area *(records since 1950).*

Figure 1: Aerial view of damage at point of tornado touchdown. Courtesy Autonomous Flight Technologies

Figure 2: Convergent damage pattern visible from the air. Courtesy Autonomous Flight Technologies

Aerial Survey

On February 26 the NWS Blacksburg returned to Appomattox county with Autonomous Flight Technologies (AFT) for a more thorough assessment of the tornado track. The UAS imagery provided by AFT proved to be extremely useful and was able to locate additional areas of damage which lengthened the tornado track to 17 miles (*30% increase from the ground survey*).

Figures 1 – 5: show a series of images from the UAS survey of the tornado damage path.

Figure 3: clearly shows how the UAS imagery was able to capture the more remote damage areas not easily seen from the ground.

Figure 5: Aerial image of EF2 damage to Central Church near Appomatox, VA. Courtesy Autonomous Flight Technologies

Figure 3: Aerial view of tornado track continuing into inaccessible areas beyond damaged house initially considered the last damage point. Courtesy Autonomous Flight Technologies

Figure 4: Clear evidence of rotation at the final point in the track where the tornado lifted and dissipated. Courtesy Autonomous Flight Technologies

3D Aerial Imagery

- Produced at a high horizontal resolution on the order of a few centimeters
- Can rotate to any angle; zoom to almost any level!
- Requires additional resources, but has the potential to be used for remote classification of tornado/wind damage
- Possibly time saving/cost effective for NWS

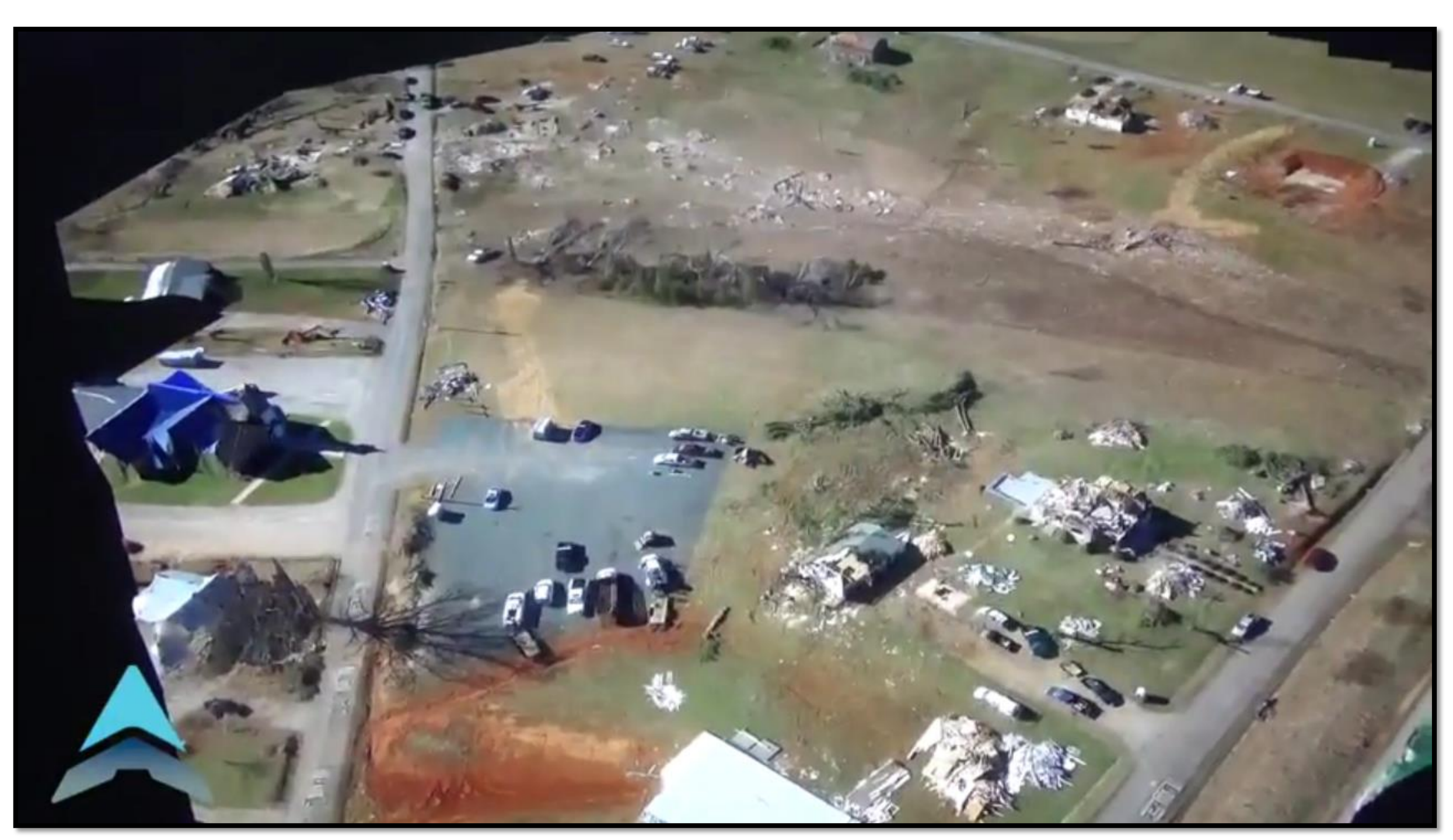

Figure 6: 3D digital rendering of EF2 and EF3 damage in Evergreen, VA. Courtesy Autonomous Flight Technologies

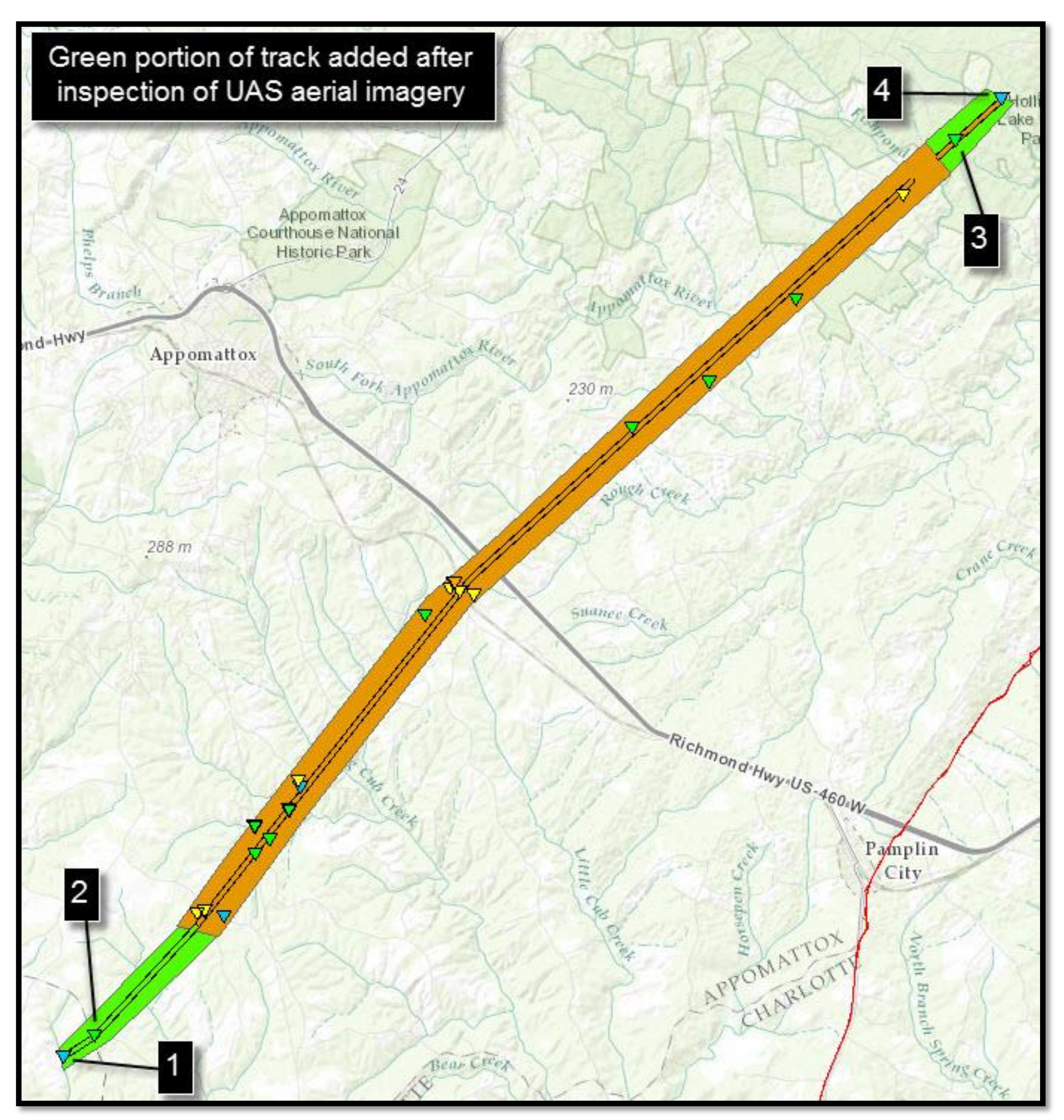

Figure 7: The tornado track as seen in the Damage Assessment Toolkti (DAT). The green portion of the track was added using the UAS imagery. Numbers correspond to figures 1 through 4.

Damage Assessment Toolkit (DAT)

- Creates a comprehensive archive of surveyed tornado and wind events
- Allows open online access to storm survey information and imagery

Typical UAS Platforms for Damage Surveys

Rotary Wing (Quad/Hexacopter):
Advantages - More stable/maneuverable, especially in higher winds; Can hover

Disadvantage – Shorter flight time

Fixed Wing:
Advantage – Longer flight times

Disadvantage - Harder to operate and control in stronger winds

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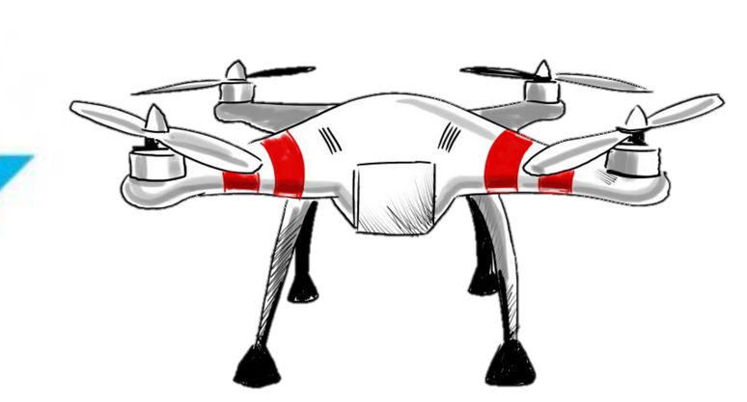

Summary/Key Points

- UAS imagery revealed damage along portions of the tornado path not easily viewable or accessible from the ground
- UAS survey proved to be quicker and more efficient for inspecting remote portions of the tornado track
- Thorough coordination with emergency management was critical to the successful use of a UAS during this damage survey

Challenges and Future Considerations

- UAS data may/may not add value to a ground damage survey
- Sharing image files of varying formats and sizes/resolutions
- DAT limitations on file size/type
- NWS should stress "socializing their need for UAS data"
- Possible budgetary allowance for acquisition of UAS data?