An additional important functionality for efficient VFR operations and airspace management in disaster relief situations is “volume release,” i.e., once the helicopter has completed the mission in the assigned volume, the airspace should be released and made available to other users. Ideally, this volume release should happen automatically once the vehicle leaves the volume or begins a mission in another volume. Final confirmation on the release should be issued by the pilot, using a mission support system such as D-NET’s D-PAS. The timing of “volume release”, how the pilots are informed of volume release, and concept details will be part of our future research.

Operation volume modifications were reported to be a necessary capability to provide the needed flexibility when the mission changes in flight and should be executed promptly and upon pilot’s discretion. Some mission changes might require temporal and/or spatial operation plan modification, while other mission changes might be supported within the existing operation plan.

Landmarks play an important role in VFR flights. The flight test proved that large rivers, railroads, and highways provided clear guidance when the disaster did not affect their visibility. On the other hand, canals were more difficult to track. Bridges are clear and visible, but identification of specific bridges remain a challenge. The same is true for factories and school yards, often used as evacuation grounds- some schools have their name written clearly on the roof of the building but others do not. Some types of disasters such as fire and flooding might obstruct the distinction of visual landmarks where further research is needed. The pilots recommend that geographic landmark situation awareness can be better supported by a mission support system.

VIII. CONCLUDING REMARKS

The flight tests conducted in December 2019 had the goal of examining the concept of landmark-based design of operation volumes when applied to manned flight operations under VFR within a D-NET and UTM-integrated environment. Test results and pilot feedback suggest that the approach taken to operation planning may have helped the pilots maintain conformance with their operation volumes. This conformance is important for the integration of manned air assets and UAS within a UTM-supported disaster response environment for predictability and planning. However, there were challenges identified during the flight test that warrant further refinement moving forward. Despite careful planning, three volume violations occurred. Pilot feedback suggested that overlapping current and previously flown volume segments while still active was confusing at times and contributed to the violations. The ability to release volume segments when exited was proposed as one step toward reducing confusion and increasing airspace efficiency. The use of wearable devices or heads-up displays for visual augmentation and more salient alerting to the pilot were also proposed as mitigations. Greater operation state flexibility in line with the dynamic nature of disaster response was also proposed along with the need for a more automated capability to update operation volumes prior to exiting volumes unintentionally or as a result of new mission tasking.

The results and feedback pave the way forward for continued development of the approach to operation volume design for manned operations under VFR, which will improve the overall effectiveness and safety of integrated manned and unmanned operations in disaster response situations supported by D-NET and UTM. The results also highlighted the need for better understanding and further research into the trade space between pilot flexibility and more structured airspace to support sUAS operations in the same operational area.

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