USGS Statements for Support of the Utilization and Impact of the of Dept. of the Interior Restriction on UAS Procurements and Services*

Response from USGS UAS Field Operators
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Introduction:

The USGS National Unmanned Aircraft Systems (UAS) activities have formally been coordinated and implemented since May 8, 2008. During that 12-year period, significant investments have occurred into developing policy, procedures, coordination, testing and implementation that have been adopted for applied scientific research and daily operational activities. The USGS has been on the cutting-edge of this technology and is widely recognized as leading experts in this technology. Particularly in the past two years with the addition of new, affordable and dependable aircraft, the integration of highly advanced sensors has created remarkable novel capabilities and safer, cost-efficient methods in data collection. Among this usage are new approaches to stream flow measurement, ground surveys and mapping data, volcanic gas measurements, biological monitoring and real-time emergency response. Investigation and integration onto the small UAS platforms of cutting-edge sensors such as ground penetrating and doppler radars, laser technology, geomagnetic sensing, water sampling, multi- and hyperspectral sensing, photogrammetric and thermal cameras, gas sensing, animal collar telemetry, and high-definition video streaming, would not be possible without the UAS platform and dedicated flying skills that have been acquired by the operators.

<u>USGS UAS Platforms and Operators</u>
In order for the USGS to progress and lead this technology integration into routine usage, the USGS has trained 137 operators in safe and efficient use of UAS for data acquisition. The USGS has procured 180 UAS platforms to test and accomplish this work, with an additional 33 UAS on order to be delivered to the approved operational Science Centers.

<u>Flight Activity</u>
Tracking of the flight activity by the USGS in the past two years as the interest and technology has advanced totaled 3,015 flights (557 hrs.) in FY2018 and 2,581 flights (407 hrs.) in FY2019. The flight activity numbers indicate not only the wide usage of UAS for data acquisition, but also the investment by the individual operators to take it upon themselves to remain proficient with their flying skills in accordance with FAA and DOI operational procedures and to provide the best skills possible to complete their work.

Impacts on the USGS

A request to the USGS UAS pilots on the impacts of the recent Departmental directives generated the following.

- The total impacted funding due to grounding of USGS UAS is at least $5.8 million.
- A total of 83 projects from 29 different offices were identified as directly impacted.
- Over 100 cooperators (both federal and non-federal) were identified.

A contextual analysis approach to identify and count recurring themes was used on the responses and yielded the following paraphrased themes.

- Without the ability to deploy UAS we delay or lose the opportunity for valuable science work, damage chances for continued work, and/or damage cooperator relationships.
- UAS needed for aerial mapping at required high-resolution scales / there is not another cost-effective method available.
- UAS data collects are time sensitive to the project objectives.
- UAS used for protecting lives and livelihoods.
- UAS methods used to save people-hours and/or increase safety of the workforce.
- UAS part of programmatic / mission area level or similar technology development.
- UAS used for modeling earth processes.
- Proficiency requirements not met, and pilots will be out of compliance with FAA regulations.
- UAS used in efforts to protect endangered species, or preserve habitat.

A sample of the impact statements are provided below.

<u>Geologic Hazards</u>

In July 2019 the Woolsey Fire burned over 100,000 acres in the Superstition mountain range in Arizona. Within weeks of the fire USGS Geologic Hazards scientists were able to visit the site and use a small UAS with a camera to take photos over an entire basin. Using computer techniques they were able to process those data to obtain topographic data over an entire watershed with 10 cm precision. This is as good as better than a lidar flight, and it was done with a simple UAS. The total cost of the trip cost approximately $1k, whereas a lidar flight would have taken months to plan and would have cost >$30k. The scientists then went back to survey the site on September 19-20, and again obtained centimeter-scale topography. On Sept. 23 a rare high intensity rainstorm hit the site causing so much erosion that it washed out key portions of the road and compromised bridges so that large portions of the highway became unpassable and will remain so into the foreseeable future. The USGS Geologic Hazards Science Center is planning to resurvey the site to document the erosion with the UAS. This will enable us to determine how the erosion happened, and how to improve guidance on mitigation of post-fire debris flow hazards. The ability to use a UAS makes this possible, and it is much less expensive than any alternative. However, our UAS is hitting end of life and will need to be replaced in the near future. These instruments are very inexpensive compared to manned aircraft that support airborne lidar and much more flexible, although they provide similar results. This is just one of many examples of how the Geologic Hazards Science Center using UAS to respond to hazardous events and improve situational awareness and hazard mitigation products – we are concerned about the impact to our hazards missions if this functionality is taken away or made more difficult to procure.

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Hydrologic Research

The use of UAS has made our research [on tile-drain presence, extent, and connectivity] at agricultural edge-of-field sites better informed, benefitting all of the involved agencies (EPA, NRCS, local cooperators). It is now being done for each of the GLRI edge-of-field sites in an effort to better avoid nutrined and sediment movement that lead to harmful algal blooms in the Great Lakes. The Director recently came and discussed this approach at an edge-of-field site near Indianapolis, where we have not flown, and immediately understood the limitations of proceeding without this information (we are now getting regional support for this). Better understanding of what we are seeing in the landscape using UAS has also enabled us to more successfully use satellite data to look for similar features, improving our understanding of the ubiquitous practice and its potential effect on water balance, streamflow, groundwater recharge, and water quality. This feeds directly into the EarthMAP and the data-lake concepts. As for impact, it has taken three years to get a position in our WSC that is first and fore-most a UAS pilot. This is key for hazard response and the ability to acquire and process the necessary data. Our new airframe is key to maintaining this momentum and expanding the benefits that this technology can provide.

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Hydrologic Applications

CA has had a sUAS program for two years now and funded project work to go with it. We have a capable fleet of solos in good shape; however, we are looking to expand our fleet to accommodate staff and interest from our data monitoring program. Like other states out west we deal with flashy and difficult to measure conditions where getting staff and equipment in the water to validate and calibrate flow ratings can be dangerous or, at times, impossible. The promise of using an airborne platform to aid in capturing surface velocities will potentially allow us to obtain measurements we have not been able to collect in the past helping to improve data quality and what we serve the public when it is needed most; high flows. In addition, we hope to use sUAS for high water mark surveys for indirect flow computations improving efficiency manual surveys on the ground. Without the ability to purchase additional aircraft we'll be handcuffed in our ability to improve data quality and increase efficiency in our operations.

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Hydrologic Hazards (Flood Response)

(Abstract) Flooding affected approximately two billion people around the world from 1998-2017, causing over 142,000 fatalities and over 656 billion U.S. dollars in economic losses worldwide. Accurate flood data, such as the extent of inundation and elevation of the peak water surface, are critical to define the environmental, economic, and social impacts of flood events. Ground-based GPS surveys of post-flood high water marks that are commonly used to define flood inundation and stage can be time consuming and expensive to conduct. Here, we explore the use of small unmanned aircraft systems (sUAS) that apply close-range remote sensing techniques to improve post-flood data collection efficiency while maintaining sufficient accuracy. We compare sUAS surveys with traditional GPS surveys, which have acceptable accuracy for many post-flood assessments, at two flood sites at two small streams in the United States. The mean elevation error by the sUAS survey at a semiarid site was 0.07 m, which is similar to errors produced by RTK methods. The mean elevation error at the temperate site was 0.14 m, which is within the typical GPS survey error at similar sites. The results suggest that sUAS surveys may be an inexpensive and more efficient alternative to GPS surveys, and we provide insights into the situations where either sUAS or GPS techniques will be most efficient.

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Hydrogeophysics Applied Research

Even prior to this new potential delay in UAS procurement, our procurement options and timeline have not kept up with the Water Mission Area and Water Science Center demand for training and the need for aircraft capable of deploying sensors for hydrologic studies. sUAS have become standard geoscience field tools. Additional delays and stagnation harm our scientific activities by preventing us from using modern tools that can 1) increase our access to data needed for USGS science, 2) improve field safety, and 3) increase data collection efficiencies.

Our existing fleet provides significant capabilities, but even that does not adequately meet current needs. I frequently hear from Water Science Centers who already don't have access to the tools they need, delaying their ability to integrate sUAS into USGS water science activities. Our primary fleet of Solos is aging and can't yet be replaced with either new Solos or comparable lightweight, portable quadcopter alternatives that can carry similar sensor payloads (thermal IR, multispectral, etc). USGS only has a handful of larger hexacopters procured during the DOI testing/evaluation phase that are capable of carrying heavier scientific payloads being implemented in the larger geoscience community, including lidar, GPR, magnetometers, EM induction tools, and hyperspectral sensors.

I hope the USGS will continue to advocate to DOI on the need to expedite and expand UAS procurement options, rather than increase delays and further limit options. I know NUPO works closely with DOI to get USGS scientists access to the tools we need to do our work, and I greatly appreciate those efforts!

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Geospatial Applications

Recent advancements in UAS technology have seen an increase of small LiDAR payloads for surveying and forestry applications. As this technology continues to grow, it's important to understand the strengths and weaknesses of these data acquisitions. The U.S. Geological Survey's, National Unmanned

Aircraft Systems Project Office, provides research, and recommends best practices for UAS LiDAR derived modeling. UAS LiDAR data collects are another validation tool for the USGS 3DEP program.

A heavy lifting drone platform (estimated payload lift capability of 5-12lbs) is required for these types of acquisitions. The DJI Matrice 600 UAS platform currently meets the stringent requirements for these heavier payloads, provides the proper form factor for integration, has proven reliable over years of use, and meets the FAA guidelines for Part 107 rules.

The DJI Mavic Pro small UAS is a required platform for UAS LiDAR scanning. UAS LiDAR scanners are required to scan close to the surface for optimal collects. These small inexpensive platforms are used as “scout drones” flying areas of high risk, before putting an expensive UAS and LiDAR payload in flight. This cost saving and risk mitigation technique allows operators to fly areas with high relief, test terrain awareness flight plans, and helps remote pilots avoid obstacles that may impact the success of a collect. Consistent flight planning software between platforms is required for terrain awareness scouting flights, and this technique is critical for low altitude LiDAR UAS acquisitions.

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Hydrologic Research (Cooperator Impact)

Failing to allow the purchase of new UAS technology and grounding all non-emergency related flight operations will directly impact the Washington Water Science Center’s (WAWSC) ability to keep pace with the advancement of UAV capabilities and to remain a relevant contributor to Bureau’s and Department’s overall UAS operations. The WAWSC currently has one air-worthy UAV. This UAV (3DR Solo) is no longer available as a new manufacturer and has been eclipsed by other companies. The 3DR Solo platform is also no longer used in Department approved initial flight training. Further, peripheral equipment for the 3DR Solo is becoming more expensive, less functional, and increasingly difficult to source. The WAWSC had planned to add the DJI Matrice 600 (M600) in FY2020, specifically to improve data outcomes during upcoming FLIR thermography flights.

At present, the WAWSC has committed UAS support to several cooperators in FY2020. While these commitments vary in formality, grounding our program in FY2020 would cause the direct loss of over $100,000 in program funding. Further, this hamstrings the WAWSC’s ability to move our program forward and commit to any future work. Interest and cooperator support for the WAWSC UAS program was readily apparent during a recent stream temperature workshop, sponsored by the WAWSC and attended by members of the Northwest Indian Fisheries Commission.

The Department of the Interior position as the national leader in commercial UAV use is in jeopardy. Our expertise is not only in data collection and processing but also in UAS program management and development. No one has the capacity to establish a nationwide standard for the safe and appropriate use of UAVs for research other than the Office of Aviation of Services (OAS). The relationship between OAS and the Federal Aviation Administration (FAA) has been developed intentionally: The policies and procedures agreed to by these cooperating agencies will turn into SOPs and eventually doctrine for commercial UAV use.

With absolutely no explanation behind the purchasing and, now, flight moratoriums, science centers will be left holding the bag when cooperators realize they will not be receiving the products they have paid for. Furthermore, allowing only emergency flight operations puts pilot currency, which requires three takeoffs and landings every 90 days, at extreme risk of non-compliance. This puts not only the local WAWSC UAS program in jeopardy but also the national UAS program as a whole.

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Geologic Hazards (Earthquakes)

As earthquake geologists, a key component of our work is making ground-surface observations along faults capable of generating large earthquakes and strong ground shaking. This research serves a critical mission of the USGS Earthquake Hazards Program to assess sources of potentially damaging earthquakes in the United States and produce products that will help reduce losses in future quakes. Unmanned aircraft systems (UAS) are a unique tool that fit into this mission and allow us to make high-quality surface observations at a fraction of the price of manned aircraft operations (such as airborne lidar). Data generated from low-cost UAS allow us to map geologic features at a resolution ten times greater than that from lidar, make real-time observations (no delay related to aircraft deployment), collect data in remote locations, and generate photos from unique perspectives for public relations efforts. The USGS stands to be negatively impacted by unnecessary delays in UAS acquisition, which would prevent us from making timely upgrades to outdated technology. USGS science would be unnecessarily hampered by a decision to delay the purchase of UAS tools that are proven safe and are readily available to non-government researchers. From a practical standpoint, our acquisition of a Parrot Anafi system has been delayed by this UAS purchasing decision. The low-cost Anafi system is small and lightweight, perfect for remote deployment, and offers excellent real-time feedback on photo acquisition. We've already invested funds in peripherals to support equipment (~$800), which will result in wasted spending if the purchase is further delayed. We hope that DOI leadership will help prevent unnecessary UAS purchase restrictions and recognize UAS as an important tool that will help advance USGS earthquake science.

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*Reference: U.S. Dept. of the Interior, Memorandum Oct. 10, 2019
Unmanned Aircraft System (UAS) Acquisition, Susan Combs