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Drones: A Solution for Disaster Responders

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14. ABSTRACT

For decades drones have been used for military or governmental purposes which has created a stigma among the U.S. population and interest groups as a system that could jeopardize citizens constitutional rights of privacy. This paper identifies that that stigma is outdated and with technological development, proven by commercial and recreational users, drones have been identified as a critical asset for disaster responders. Through the work of regulators, non-governmental organizations, and the commercial enterprises, there are processes for certification, codes of conduct, and best practices to effectively use drones. Drones are one of the most important pieces of equipment that can be deployed in response to disasters in the United States.

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Introduction

Emerging technology has continued to be created and adapted to improve lives, advance capabilities, or just for fun. Unmanned vehicles, or drones, are no exception. The first concept of drones may be dated back to 1849, when an Austrian artillery officer developed a plan to attack Venice with weaponized balloons.[1] Modern aerial drones ultimately can link back to the era of WWI as both the advent of the airplane and radio control capabilities were combined. The term drone came to be in 1935, referring to the British DH 82B Queen Bee, because of the relationship between the controller and the remote aircraft.[2] Drones have become a powerful tool to the military and a cool toy for a recreational user. However, unlike innovations of satellite imagery, computers, and phones, drones seem to have a stigma linked to invasions of privacy, espionage, or a weapon system. The benefits of these systems in terms of disaster responses far outweigh potential negative uses of these machines.

This paper argues that the stigma of drones needs to be overcome because they are one of the most important pieces of equipment that can be deployed in response to disasters in the United States. This will be demonstrated first by showing the vast options of drone systems available that are economically feasible for disaster responders. Secondly, in showing that the drone stigmas are outdated, as regulation, standardized practices, and an increase in acceptable use for drones is making the industry more professional and accepted. Third, is that drone

[1] Kashyap Vyas "A Brief History of Drones: The Remote Controlled Unmanned Aerial Vehicles (UAVs)," *Interesting Engineering,* June 29, 2020. https://interestingengineering.com/a-brief-history-of-drones-the-remote-controlled-unmanned-aerial-vehicles-uavs .

[2] Jake Daniels, "How Did Drones Get Their Name?" *BestSpy,* April 1, 2020, https://www.bestspy.org/drones-get-name/.

potential has been recognized by high levels of government and is easily integrated into the disaster response framework.

Drone Types, Uses and Capabilities

The variety of disasters in the United States requires the most versatile and innovative equipment responders can muster. Drones are the answer to complex problems that disaster responders face upon arrival on the incident scene. The first use of drones for disaster response in the U.S. occurred in the aftermath of Hurricane Katrina; however, because of regulatory restrictions use of civilian drones in the US for disaster response is limited.[3] Drones have been used in several disasters worldwide to map displaced civilians, evaluate the damage to the nuclear power plants, and even find a car crash in remote Saskatchewan in 2013.[4] These incidents demonstrate that drones are practical and capable of performing different jobs superbly and in different extreme environments. Drones come in numerous configurations and sizes, offering an almost complete rolodex of options to disaster responders. The National Search and Rescue Committee issued a supplemental to the International Aeronautical and Maritime Search and Rescue Manual that broke drone types into five groups based on the weight and payload of the drone.[5] Payloads contribute to the drone's overall weight and ultimately depend on what the drone can physically carry or power. Most payloads include electro-optical/infrared sensors, mapping sensors, communications relays, sniffers, or cargo space or lift capability.[6] The ability of a responder to assess a situation in a rapid, safe manner is critical. In disasters, there are many

[3] Faine Greenwood, Erica L. Nelson, and P. Gregg Greenough. "Flying into the Hurricane: A Case Study of UAV Use in Damage Assessment during the 2017 Hurricanes in Texas and Florida." PLOS ONE, 15, no. 2, February 5, 2020, e0227808, https://doi.org/10.1371/journal.pone.0227808. PG. 2
[4] Ibid. PG. 3.
[5] "Unmanned Aircraft System (UAS) Search and Rescue Addendum to the National Search and Rescue Supplement to the International Aeronautical and Maritime Search and Rescue Manual," National Search and Rescue Committee, Version 1.0, July 2016. PG. 2-3.
[6] "Drones for Disaster Response and Relief Operations," Measure – 32 Advisors LLC and the American Red Cross, April 2015, PG. 37-39.

variables that decision-makers need to address. The utilization of drones provides options to overcome unknowns and develop practical solutions allowing disaster responders to focus priorities where the need is most.

A benefit to disaster responders is that the commercial sector provides proof of concept for various drone options and operations. With the drone industry's economic growth rate of over 15% per year, commercial and private companies in the U.S. are expanding what drones will do.[7] Agriculture industries are using live video drones to monitor fields and livestock. Construction has adapted drones with infrared radar to conduct structural surveys of buildings. Even shipping companies like DHL have developed the "parcelcopter" to overcome challenges in remote or physically challenging locations for delivery trucks to reach.[8] These developments provide the disaster responder with technologies that until now were limited to the military. With the addition of light detection and ranging (LiDAR) and thermal imaging, responders can efficiently conduct searches, mapping, and small package delivery. Unlike other aircraft, drones can offer from a bird's eye view to ground level and even get into tree canopies. Drones also do not need to leave to refuel or change crews, which means that as long as there are batteries to keep it going, loiter time is extended significantly, which is lifesaving in many instances. For example, in the Saskatchewan incident noted earlier, a drone was brought in to replace a helicopter and found the lost person and guided the rescue personnel directly to save him.[9] By

[7] Harry McNabb, "Research Says Small Drone Market in U.S. Worth 22.55 Billion by 2026: But Which Region Will Grow the Fastest?" *DRONELIFE,* March 13, 2020. https://dronelife.com/2020/03/13/research-says-small-drone-market-in-u-s-worth-22-55-billion-by-2026-but-which-region-will-grow-the-fastest/.
[8] Susan Fourtané, "Drones: From Search-and-Rescue to Emergency Delivery They Are Here to Stay," *Interesting Engineering,* November 7, 2018, https://interestingengineering.com/drones-for-search-and-rescue-delivery-services-take-off .
[9] Carl Franzen, "Canadian Mounties Claim First Person's Life Saved by a Police Drone." *The Verge*, May 10, 2013. https://www.theverge.com/2013/5/10/4318770/canada-draganflyer-drone-claims-first-life-saved-search-rescue.

capitalizing on the commercial sector's success, disaster responders will be better positioned to provide rapid and lifesaving data to decisionmakers.

Drones provide a cost-efficient solution to reduce the need for traditional airframes in disasters. Suppose a municipal fire department or a federal emergency management rapid response team purchases a commercial off-the-shelf (COTS) drone or utilizes a system owned by another organization. In that case, the cost analysis demonstrates that drones are by far the best option, especially if the organization has a limited budget. First is the upfront cost of training and purchase. For a private pilot license, the cost is upwards of $10,000 and can take 6-12 months to get the minimum 40 hours required to obtain the license.[10] Add another $13-15,000 and 40-60 hours to obtain instrument, commercial and multi engine certifications.[11] For a drone pilot, 10-20 hours of exam preparation, $160 for the exam, and a person can get their certification in 6-8 weeks by mail. There is no comparison between the cost of becoming a drone pilot and an airplane pilot, not to mention the continued training required. A drone can fly almost anywhere below 400 feet and just about any time of day; where a larger aircraft has restrictions on where they can fly, there needs to be a qualified pilot, file a flight plan, pre-flight, weather checks, all of which burns time. The cost of a drone compared to an aircraft is substantially less. Even the most expensive drone, estimated at $300,000, is far less than purchasing a helicopter or airplane.[12] For the most part, equipping a drone costs several thousand dollars, even a municipal department or small company could afford. The most significant advantage of a drone is the people-power required to operate it. Multiple people can

[10] Charlie Gasmire, "How Long Does It Take to Get a Private Pilot's License?" *AirplaneAcademy.Com,* https://airplaneacademy.com/how-long-does-it-take-to-learn-to-fly-an-airplane/.
[11] Ibid
[12] Jack Brown, "Cost of Drones: What Affects the Drone (Quadcopter) Prices?" *My Drone Lab*, April 18, 2016. https://www.mydronelab.com/buyers-guide/cost-of-drones.html.

be trained on a drone system and traded out even in-flight, making crew rest cycles much more manageable. As stated earlier, most drones can come back to their operators, loiter time constrained by the number of battery packs on hand. Drones are a viable asset that is cost effective, especially to responders that may have limited budgets.

Changing the Rules

Initial drone regulations in the United States were a "knee-jerk" reaction that negatively impacted drone use in disasters. One month after Hurricane Katrina, the Federal Aviation Administration (FAA) issued its first drone regulations, to be followed by the FAA Modernization and Reform Act of 2012, which required non-hobby drone operators to be issued Certificates of Authorization to fly.[13] This regulation came with exemptions under Section 333, which benefited commercial operations but proved prohibitive for disaster responders because of time constraints to obtain waivers.[14] Worst yet, concerns over drone use continued to mount across the country, specifically about privacy violations. Additionally, 24 States have regulations on privacy, and over 14 have specific regulations with protections from law enforcement and non-governmental uses.[15] These regulations did not intend to stop the use of drones for disaster response, and in many cases, identified the use of drones specifically for disaster response situations. The fact is drone regulations sought to protect privacy and protect citizen's 4th amendment rights. Disaster responders need to demonstrate that their drones are in the public's best interest and overcome the hurdles the initial regulations created.

[13] Abby Speicher, "Drone Laws: The History of Drone Regulations and Laws." *DARTdrones* (blog), November 9, 2016. https://secure.dartdrones.com/blog/drone-laws/.
[14] Robin Murphy, "Drones Save Lives in Disasters, When They're Allowed to Fly (Op-Ed)." *Space.com,* September 16, 2015, https://www.space.com/30555-beginning-with-katrina-drones-save-lives-in-disasters.html.
[15] 2016 Unmanned Aircraft Systems (UAS) State Legislation Update, National Conference of State Legislatures, March 20, 2017, https://www.ncsl.org/research/transportation/2016-unmanned-aircraft-systems-uas-state-legislation-update.aspx

Changes in regulation and the creation of guidelines for the proper use of drones change the negative perception of drones and how valuable drones are. The issuance of new FAA regulations 14 CFR Part 107, which allows drones under 55 pounds to fly with certified pilots in national air space, was a vast improvement.[16] Having FAA trained, and certified pilots provides a level of professionalism that goes hand in hand with disaster responders saving lives and property. Another addition was the creation of the Humanitarian UAV Code of Conduct. Created by Humanitarian UAV Network with over 60 contributing organizations, this document served to "inform the safe, coordinated and effective use of UAVs" by basing the code around the humanitarian principles of humanity, neutrality, impartiality, and independence.[17] By far, the most considerable boost to promoting confidence in drone use was the change in the use of Department of Defense (DoD) drones to aid in disasters. DoD directive 3025.18 integrated the DoD in the National Incident Management System (NIMS) and authorized DoD drones to aid in defense support to civil authority (DSCA) operations with the Secretary of Defense (SECDEF) approval.[18] The SECDEF has since modified this guidance allowing Governors to utilize smaller UAS in the National Guard inventory.[19] With these authorizations are protocols specific to protecting citizens' privacy, and disaster responders benefit from using the abilities of the most highly trained drone pilots in the world. All these developments demonstrate the acknowledged importance drones are to disaster responders. In recent years, even more codes and guidelines have been produced. These documents are to ensure to the public that not only are these drones

[16] Fact Sheet – Small Unmanned Aircraft Systems (UAS) Regulations (Part 107), Federal Aviation Administration, United States Department of Transportation, October 6, 2020, https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=22615
[17] Humanitarian UAV Code of Conduct, uavcode.org March 2014, https://uavcode.org/
[18] "Defense Support of Civil Authorities (DSCA)", DoDD 3025.18, December 29, 2010, updated March 19, 2018, PG. 4, 7.
[19] Secretary of Defense Memorandum, "Guidance for the Domestic Use of Unmanned Aircraft Systems in U.S. National Airspace," August 18, 2018

there to help but will ensure the public rights are sufficiently protected. However, regulations need further improvement. Disaster responders need rapid processes for granting certificates of authorizations, drone registrations strictly for emergency management, and authorities for emergency management officials to establish air restriction zones in their disaster areas. It is incumbent on drone operators and disaster responders to operate in the existing regulation and provide the public with additional security needs in a disaster.

Drone Integration

The largest question for disaster responders grapple with is when and how do drones integrate into the operation? This question is usual for many that are not familiar with drones or other technologies and what they can do. NIMS provides the best approach to integrating drones into disaster response with the development of the Air Operations Branch (AOB). The AOB director is responsible for developing the air coordination section of the incident action plan (IAP) while synchronizing all air assets for the incident.[20] If the AOB is not part of the IAP, the drone pilot code guides operators to integrate, inform, and provide guidance to the incident commander (IC). As stated in the National Search and Rescue Plan, "in any SAR case, the UAS team should coordinate their operations with the on-scene commander and any other aviation units, as well as surface assets and personnel."[21] Bottom-up integration is essential for the promotion of safe and legitimate drone operations. It is imperative for the incident commander that drone operators articulate their equipment's capabilities to develop appropriate missions. This will answer questions like "what data needs to be collected," "what locations need to be

[20] "Air Operations Branch Director Job Aid," Incident Command System, United States Coast Guard, July 2017.
[21] "Unmanned Aircraft System (UAS) Search and Rescue Addendum to the National Search and Rescue Supplement to the International Aeronautical and Maritime Search and Rescue Manual," National Search and Rescue Committee, Version 1.0, July 2016. PG. 3-3.

surveyed," and "what flight plans are currently existing for aircraft?"[22] Disaster responders and ICs may not be thinking about these questions; however, drone operators will not only demonstrate competence in drone abilities but will provide IC with confidence to employ these systems.

Government officials are seeing the benefits of the drone industry and directing a top-down approach for drone integration. In a memorandum from President Trump, he stated, "UAS present opportunities to enhance the safety of the American public," and "the Secretary of Transportation in consultation with the Administrator of the FAA shall establish a UAS Integration Pilot Program (IPP) to test the further integration of UAS into the NAS."[23] Following this the FAA started the three year IPP with the States of Alaska, California, Kansas, North Carolina, North Dakota, Nevada, Tennessee, Virginia and the Choctaw Nation of Oklahoma.[24] Providing this pilot program demonstrates the recognition of the value added and the need to coordinate drone usage across all government aspects. Kansas took this program further by building a team of 44 participants from state agencies, academia, and industry to conduct a field exercise that proved that drones saved time, money, provided safe examinations of disaster areas, and opened new revenue-generating sources technology sector.[25] By integrating these sectors, confidence in drone systems and capabilities continues to grow. It also shows that the use of drones by qualified operators safely and ethically provides disaster responders another avenue to get to the ground truth of situations rapidly and safely on site. Ethics and safety are paramount

[22] Patrick Meier, "Humanitarian UAV/Drone Missions: Towards Best Practices," W*eRobotics,* May 28, 2018.
[23] Presidential Memorandum for the Secretary of Transportation. "Unmanned Aircraft Systems Integration Pilot Program," October 25, 2017, https://www.whitehouse.gov/presidential-actions/presidential-memorandum-secretary-transportation
[24] Federal Aviation Administration, Integrated Pilot Program, December 14, 2020, https://www.faa.gov/uas/programs_partnerships/integration_pilot_program/lead_participants/
[25] Sarah Motter, "KDOT Uses Drones for Disaster Response." WIBW13, November 4, 2020, https://www.wibw.com/2020/11/04/kdot-uses-drones-for-disaster-response/.

as they provide the public a sense of security that their interests are protected. North Carolina recognized these facts and has developed a "UAS Disaster Response Database" with the specific interest of providing lower-level emergency responders access to drones through a list of vetted drone operators.[26] This is an innovative program because it establishes a direct link from the pilots to disaster responders in areas that crewed aircraft may not get to rapidly. Also, having a drone operator talking directly to an incident commander provides that link to the incident response framework and removes the concern of a rogue drone operating in the area or in an area that may interfere with other operations.

Drones are too Dangerous

The prevailing counterargument is that drones have no business near a disaster area. This argument is based on the predisposed fact that drones and crewed aircraft do not mix. With a lack of synchronized flight plans, lack of communication between pilots, and just by size comparison, an unobserved drone can quickly create an in-air collision. Most of this comes from Hurricane Katrina, where rescue helicopters raised the concern of a drone-aircraft mishap while conducting rescue hoist operations.[27] And this is not an isolated concern. The National Interagency Fire Center continues to promote keeping drones away from active wildfire for fear of interference with wildfire aircraft.[28] With the need for immediate information and access to areas that drones provide, it is immensely tempting for hobbyists to boost their Facebook profile or the reporter looking for the big story. An incident commander trying to control a disaster cannot afford to have a drone jeopardize a precious aircraft. Sadly, near-misses have increased to

[26] NC-UAS Disaster Response Pilot Database, North Carolina Department of Public Safety, https://www.ncdps.gov/uas
[27] Murphy, "Drones Save Lives in Disasters, When They're Allowed to Fly."
[28] "Drones and Wildfires," National Interagency Fire Center, https://www.nifc.gov/drones/

over 385 per year from 2017 and account for "more than half of all reported events."[29] High profile incidents do not help disaster responders' confidence that even the best-intentioned drone operator will not negatively impact an ongoing operation. Nor does the increase in incidents help pilots' nerves flying into already hazardous areas, especially since many need to fly within the 400-foot altitude restrictions where drones are authorized. Additionally, a pilot holding a multi-million-dollar aircraft steady over a flooded area to hoist a person to safety is not looking for or would even see a five-pound drone trying to capture the live-action footage to put on YouTube. Introducing drones to a disaster area increases the risk to other aircraft and should be avoided at all costs.

Drones pose a significate potential for injury for both rescue workers and civilians in the disaster areas. While the numerous YouTube videos of drones hitting buildings, trees, or just crashing is amusing, the reality is there is a potential for severe damage or injury. If the drone accidentally goes into a controlled area or potentially threatens a critical leadership node, the impact could be devastating to disaster response. A prime example is when the White House was locked down in January 2015 when a drone crashed on the lawn and then again in May for a drone flyover.[30] Aside from interrupting operations, the damage costs can snowball. Most recently, a drone inflicted $10,000 worth of damages to Allegiant Stadium in Las Vegas. The most frightening aspect of a drone crash was demonstrated on the TV Show MythBusters, where it was determined plausible that a drone impact can cause severe injury and maybe death. A realization of this episode could rapidly come true if a drone crashed into a crowd of people

[29] Miriam McNabb, "Diving Into the FAA Administrator's Fact Book: Why 'Drone Incidents' Are Concerning for Regulators." *DRONELIFE* (blog), August 19, 2019. https://dronelife.com/2019/08/19/diving-into-the-faa-administrators-fact-book-why-drone-incidents-are-concerning-for-regulators/.

[30] Rebecca Kaplan, "White House Locked down after Toy Drone Scare." *CBS* News, May 14, 2015 https://www.cbsnews.com/news/white-house-locked-down-after-toy-drone-scare/. Jeff Pegues, "Drone over White House Highlights Security Concerns." CBS News, January 26, 2015, https://www.cbsnews.com/news/drone-over-white-house-sparks-new-security-concerns/.

seeking help. With 1.8 million drones registered in the U.S., only strengthens the fear of injury or damage to those on the ground.[31] Just like regular aircraft, things go wrong in flight. However, the significant difference is most piloted aircraft can control enough to steer away from a populated area. Drones do not have that option. Once out of sight, the pilot has no clue what the drone will hit. Even the best-trained drone operators fall victim to not knowing what their aircraft is doing until it is too late. The U.S. Army has logged over 320 drone accidents between 2008-2018, the worst being a Shadow that lost contact with the pilot and hit a C130 in Afghanistan.[32] Arguably, the U.S. military has invested the most in drone pilots to ensure the country's defense. Nevertheless, all that training cannot help if the pilot loses visibility or communication with the drone. In a disaster, the number of responders on the ground increases dramatically. The number of individuals who needed rescue amplifies the opportunity for things to go wrong. Disaster responders and those that depend on them do not need drones falling on them in their time of need.

These concerns, while valid, can be mitigated. Using trained and certified operators that abide by the regulations and codes of conduct is the first start. These people are professionals that have the best interest of those on the ground in an already precarious situation. They would have the technological capabilities to offset drones and capture images from locations away from people instead of directly overhead. Additionally, the integration of drones into the incident command structure allows the incident commander to control airspace. The commander or air operations chief can either coordinate flight routes away from other aircraft and high population

[31] "UAS by the Numbers." Federal Aviation Administration, January 30, 2021. https://www.faa.gov/uas/resources/by_the_numbers/.
[32] Jen Judson, "These Two Drones Are Leaders in Accident Rates. How Is the US Army Responding?" Defense News, April 26, 2018. https://www.defensenews.com/digital-show-dailies/aaaa/2018/04/25/these-two-drones-are-leaders-in-accident-rates-how-is-the-us-army-responding/.

areas. These two mitigation measures turn drones from a liability to a critical asset to disaster responders.

Conclusion

When it comes to drones, the fears and stigmas regarding use or abuse are outdated. The drone industry, federal and state governments are seeking safe and ethical practices for all users. Comparatively, the 200 million mobile phones in the U.S. provide a much easier means to violate one's privacy than a drone. The potentials drones offer for disaster responders are being recognized across the globe. Drones offer a safe, inexpensive, and rapidly deployable solution for disaster responders to get situational awareness, conduct search, and rescue, and even investigate questionable situations. Even the U.S. military recognized that it could do better and has recently requested "information from vendors capable of providing unmanned aircraft systems (UAS) that can deliver food and water to people in remote areas following a disaster."[33] In a recent study from Stanford University, they concluded that "drone's life-saving potential is not mere speculation," sighting that on average, "drones save one person's life a week."[34] To mitigate the fear of mid-air collations, many drone users that support disaster responders expressly state in the UAV Code of Conduct, "Do not operate UAVs during the first 72 hours after a disaster unless these are being used as part of formal Search and Rescue missions."[35] Even still, coordination with the incident commander and air traffic control during a disaster further reduces risk. Communication between drone operators, operational leaders, and

[33] Calvin Biesecker, "Defense Department Seeking Disaster-Relief Drone to Support DHS," *AVIATION TODAY,* January 17, 2019. https://www.aviationtoday.com/2019/01/17/defense-department-seeking-disaster-relief-drone-support-dhs/.

[34] Steve Calandrillo, Jason Oh, Ari Webb, "Deadly Drones? Why FAA Regulations Miss the Mark on Drone Safety." *Stanford Technology Law Review*, Stanford University, Vol 23, Issue 1. March 31, 2020. https://law.stanford.edu/publications/deadly-drones/.Don Reisinger, "*Here's How Many Lives Drones Have Saved Since 2013*," FORTUNE (March 14,2017), https://perma.cc/TV5R-FVK5.

[35] Meier, "Humanitarian UAV/Drone Missions: Towards Best Practices,"

the public is paramount to ensure the situation is clearly understood and everyone knows where operations are ongoing. Incorporating drones into operating procedures and planning will also help prevent mishaps while furthering the information flow across the disaster. Drones are the future of disaster response and are a critical piece of equipment that every disaster responder needs to access.

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