



Use of Small Unmanned Aerial Systems for Emergency Management of Flooding

By Matt Cate

It seems like Unmanned Aerial Systems (UAS), or drones, are everywhere. We see them in the news as military weapons and intelligence systems. We see that companies like Amazon want to use drones to deliver packages to our homes. As their cost decreases, drones are even available as toys. As this technology becomes available to almost anyone, some experts worry that drones could bring down other aircraft through accidental mid-air collisions or even be used against us by terrorists.

But if you watch closely, you may also notice that drones are increasingly useful to those of us in transportation and public works. Many parts of Tennessee experienced flooding in the winter of 2019. Newscasts and social media sites were filled with aerial videos of the flooding and the resulting damage to homes, businesses, and roads. These same videos can be used to provide valuable information to the public officials who must manage these events before, during, and after the floods.

The following excerpts from FHWA's Use of Small Unmanned Aerial Systems for Emergency Management of Flooding Tech Brief (FHWA-HIF-19-019) discuss seven basic UAS applications available to emergency management and transportation officials during flood events.



Small UAS used by Fort Bend, Texas, Office of Emergency Management before, during, and after Hurricane Harvey flooding (Center for Robot-Assisted Search and Rescue)

Why Focus on Floods?

Flooding is a unique event or occurrence: it may be a standalone incident, or it may accompany another event. As examples, a hurricane may produce flooding as well as wind damage, or a landslide may dam a river and create a flood.

Flooding events are unique in terms of their scale of occurrence or time.

There is likely some warning prior to a flooding event, and flooding is generally a long duration event, when it can be weeks or months before flood dangers subside. The event may be a series of floods, with a flood from initial intense rain directly falling in the affected area, followed by river flooding from drainage or upstream rain moving into the area, as seen with Hurricane Harvey in the metropolitan Houston, Texas, area.

Flooding impacts can be gradual or sudden, such as the levee breach in New Orleans, Louisiana, with Hurricane Katrina in 2005. Flooding poses immediate threats to personal safety and infrastructure, along with general risks of hazardous material leaks or spills. Flooding may also result in search and recovery of missing persons.

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From the Director

It's amazing how big a difference a couple of months can make. At my last update I closed this column by saying, "Maybe we can talk about UT Football's miraculous turnaround and a great start to the season for the UT Men's and Women's Basketball teams in my next report." Two out of three isn't bad, but it's not the two that I would have guessed at that time. The football Vols closed out the season with six straight wins to turn in a pretty decent showing for the season and the Lady Vols are off to a good start under new head coach Kelly Harper. Maybe Coach Harper can soon add some more national championship rings to the collection that she earned while playing for the legendary Pat Summitt. Now it's the men's basketball team that has hit a rough patch. More help is on the way in the form of a great recruiting class, so this should be a short term issue.

It wouldn't be a "From the Director" column without mentioning the weather. As I scrolled through the pictures on my phone I saw a lovely picture of my snow-covered yard. That was November 12. It was 61 degrees on Christmas Day and Knoxville hit 78 degrees on December 29. My annual early January trip to Washington, DC, for the National Local Technical Assistance Association's Winter Business Meeting was the warmest that I can remember with highs in the 70s. It's been wet, it's been windy, and I'm sure that we haven't seen the last of Old Man Winter. No wonder bears hibernate through the winter! Can someone wake me up when spring arrives?

2020 is going to be a year of changes for TTAP. This issue of RoadTalk marks our last quarterly newsletter in the traditional format. Moving forward, the print version of RoadTalk will only find its way to your mailbox twice per year. The internet has changed the format and timeline of the information that we need to share with you over the years, and we've decided that a monthly email newsletter is a more effective way of delivering that information to you. Our new "RoadTalk Express" emails will allow us to share webinars, videos, time-sensitive requests for information and feedback, and news as it happens. More importantly, the email newsletter makes it much easier for us to share news from other sources.

Many of you will have already received the January 2020 RoadTalk Express by the time this issue reaches you. If you aren't on TTAP's email list, I encourage you to join. Signing up is simple: just visit the TTAP website at <http://ttap.utk.edu> and look for the form at the bottom of the home page. We will always do our best to respect your time by delivering information to you using the lowest possible number of messages. You can unsubscribe from our list at any time if the information is not what you expected.

Beyond our email newsletter, we are working on several more updates and additions to our program. This list includes new training titles, more website updates, more social media activity (@TNLocalRoads on Facebook), and maybe a few more things that we aren't quite ready to share. We'll share more information on these changes through our newsletters. As always, please let me know if there is anything that TTAP can do to help you.



The Seven Basic Small UAS Missions

UAS missions can be divided into seven basic categories, as described below. UAS have been used for all seven categories for flooding events, although not all seven for a single event. Missions provide either images and video, digital elevation maps, or photogrammetric stitching of images into an orthomosaic image. Some of these missions are directly related to your responsibility for roadways and other transportation infrastructure, while others would represent an opportunity to assist other agencies in flood-related operations (these are marked with an asterisk).

Strategic Situation Awareness, Survey, and Reconnaissance

Strategic situation awareness (SA), survey, and reconnaissance consists of multi-purpose scans of the area. Depending on the specifics of the mission, the flights may be either real-time video and imagery or photogrammetric mapping. Typically, situation awareness favors a cinematic style of flying to give the viewer the sense of the area, while surveys and reconnaissance favor specific paths (e.g., lawnmower scans, follow a river).

For floods, the objectives of this category of mission are to answer questions such as where's the flooding? How bad? Are people in distress? What is the state of the transportation infrastructure, roads and bridges?

Another application is to identify easement and standing water conditions that prevent power utility crews from restoring electricity. Hazardous material leaks are a real concern; What's that sheen on the water? diesel? chemical? sewage? and where is it coming from? Are those propane tanks floating away?

Another use is to identify stranded livestock. Strategic SA can be used to inform the public about the flood, the impact on individuals or their relatives, or why evacuation orders are in place, especially if data are readily available on a social media site.



UAS Image of flooded area (Center for Robot-Assisted Search and Rescue)

Detailed or Structural Inspection

The detailed or structural inspection mission is about experts examining built structures via either a quick look or a formal examination. One example is the examination of levees for signs of overflow (over the top) or for seepage (indicating incipient collapse). The most informative imagery is dependent on the structure and damage, and thus it is helpful to have an expert with the UAS team to direct the flight.

The flight may require more elevation (oblique) views than plane (nadir) views. Three-dimensional (3D) reconstruction is generally not used for

the quick assessment.

This type of inspection is generally performed 10 feet (3 meters) away from the structure, which can be very challenging due to poor global positioning system (GPS) signals and wind shear. While some platforms have obstacle avoidance mechanisms, these mechanisms may be unreliable in such challenging conditions.

Debris, Flood Estimation, and Damage Assessment

Debris, flood estimation, and damage assessment is more detailed than general reconnaissance and more focused on documenting boundaries of an event, counting affected houses, and relating the current state of the area to the prior conditions. This type of assessment can enable drainage experts to confirm flood inundation maps and determine causes of variances (e.g., a fallen tree acting as a dam).

The mission might enable rapid volumetric estimations of debris after the flood recedes. It can also

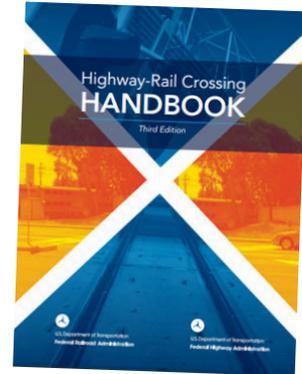
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Highway – Railroad Crossings Guidelines

Edited by Airton G. Kohls (Source: Highway-Railroad Crossings Handbook – 3rd edition – Federal Railroad Administration/Federal Highway Administration)

The third edition of the *Highway-Rail Crossing Handbook* was released in July 2019. The Handbook is a compendium of recommended safety engineering treatments for at-grade highway-rail crossings which summarizes current noteworthy or best practices and provides a range of options for consideration. It is an information resource to provide a unified reference document on prevalent and best practices as well as adopted standards relative to highway-rail grade crossings. The purpose of the Handbook is not to establish standards, but to provide guidance about how existing standards and recommended practices may be applied in developing safe and effective treatments for crossings. The Handbook is intended for use by practitioners of all levels of knowledge and experience involved with the design and management of highway-rail crossings. This includes:

local highway agencies/authorities, municipal planners, traffic engineers, transportation planners, safety analysts, Metropolitan Planning Organizations (MPOs), State Departments of Transportation (DOT), and allied regulatory commissions (including people responsible for program development, safety management, and data management sections of the applicable State agency), railroad public project managers, public safety coordinators, railroad maintenance officials, and signal designers and maintainers, law enforcement agencies and emergency responders. A free download of the Highway-Rail Crossing Handbook is available at: https://safety.fhwa.dot.gov/hsip/xings/com_roaduser/fhwasa18040/fhwasa18040v2.pdf



Organized in six chapters, the handbook presents detailed information on engineering treatments, treatment selection guidance, project implementation, maintenance, management and operations, and special topics. The following illustrates a few examples of treatments to accommodate vulnerable users at highway-railroad crossings:

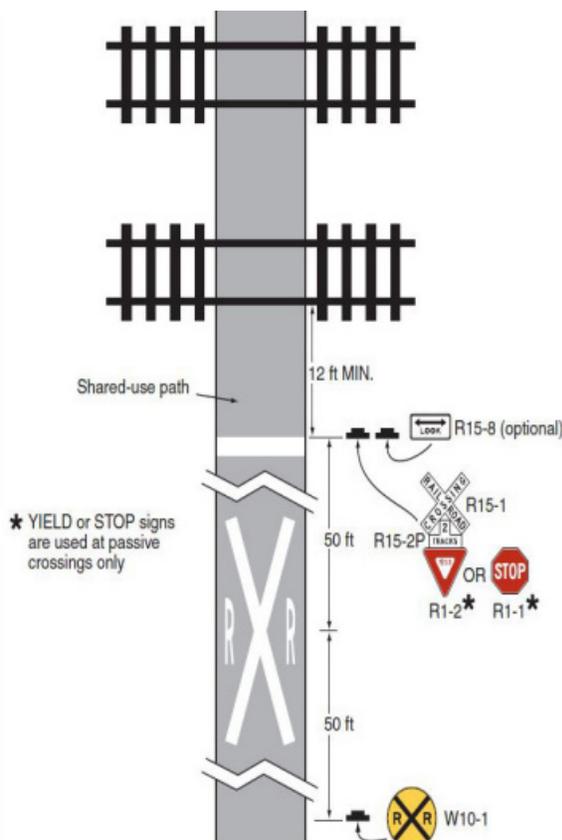


Figure 1. Example of Signing and Markings for a Pathway Crossing (Source: Manual on Uniform Traffic Control Devices, 2009 Edition, Figure 8D-1, Washington, DC, FHWA, 2009.)

Pathway Crossing Signing and Markings for Bicyclists and Skaters

Crossings which serve higher-speed users such as bicyclists and skaters should use a combination of treatments including advance warning signs and pavement markings along with a Crossbuck Assembly and optional LOOK (R15-8) sign as shown in Figure 1.

Z-crossing Channelization

A “Z-crossing” is designed to turn pedestrians toward approaching trains, forcing them to look in the direction of oncoming rail vehicles. Figure 2 shows a “Z-crossing application in Portland, Oregon. Z-crossing channelization may be used at pathway crossings where pedestrians are

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likely to run unimpeded across the tracks, such as isolated, midblock, pedestrian only crossings, particularly where there is good stopping sight distance and pedestrian volumes are low and active devices are not required. Standard configuration Z-crossings are not suitable for single- or double-track locations



Figure 2. Example of a Z-Crossing Application in Portland, Oregon (Source:

where trains operate in both directions on a regular basis. The angled crossing configuration can be adapted by extending the length of the diagonal zone so users face both directions while traversing the crossing but angled crossings are more difficult for wheelchairs and bicycles to navigate.

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document land use and drainage issues to be resolved later.

This mission can be accomplished with real-time video and imagery (e.g., the drainage confirms that the flood boundary matches expectations) or with photogrammetric mapping for formal analysis of the extent of the flood.

Tactical Situation Awareness

Tactical SA uses a UAS to help the rescue team assess the condition of roads or bridges ahead to decide where to go from their current location. It also permits overwatch of teams or canines, or in swift water rescue oversight of floating debris that might jeopardize crews in boats, thereby increasing responder safety. Use of UAS for tactical SA is a common practice with the Florida State Emergency Response Team (SERT). UAS also has a place in traffic monitoring and detour routing efforts, providing needed viewpoints for transportation planning.

Ground Search and Rescue*

In this mission, the UAS is generally assisting with the search for a missing person, object, or scene that is on the ground. In a flooding event, victims may have been swept away by the flood and the ground search is conducted after the waters have receded. For this mission type, high-resolution images are the most valuable, as video may be too difficult to freeze frame or lose resolution when paused.

Water Search and Rescue*

Water search and rescue is typically associated with a marine incident, although for a flood this includes a swift water rescue. A water search may be combined with a ground search for a victim after a boating accident on a lake where they possibly swam to shore, or a flood where a survivor may have been swept away but climbed out.

Delivery*

This mission is for the UAS to facilitate delivery of material to any location. However, extreme care is needed when flying near people because operators tend to lose depth perception and may get far too close to objects and people. In addition, some platforms or payloads may not be able to maneuver safely for this mission type; something hanging off a small UAS changes the dynamics of the vehicle, creating a pendulum effect, so it may behave and move unpredictably.

Learn More about UAS Applications in Transportation

- FHWA Unmanned Aerial Systems website, <https://www.fhwa.dot.gov/uas/>
- *Use of Small Unmanned Aerial Systems for Emergency Management of Flooding*, Federal Highway Administration (2019), <https://www.fhwa.dot.gov/uas/resources/hif19019.pdf>

Cold Weather Work Safety

By Spence Meyers (Source: NLTAPA Tailgate Safety Talks - Cornell Local Roads Program)

This Everyday Safety Tailgate Talk was originally published as the January 2016 “Safety Pins” by Philip E. Spiezio, Safety Officer, Washington County Office of the Safety Officer.

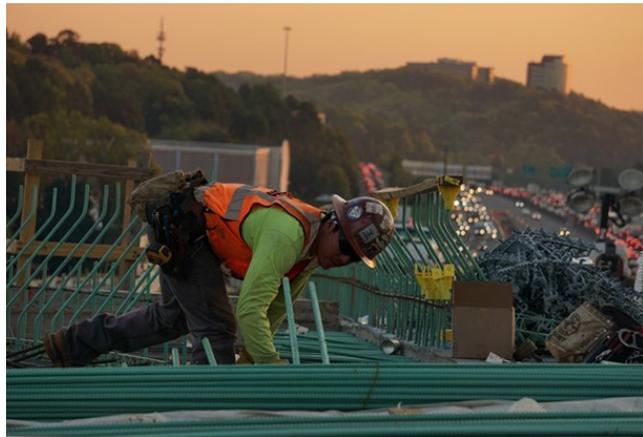
Here in Tennessee we are pretty lucky with our weather. I know it doesn't seem that way sometimes though. While we have had temperatures as low as 25 below zero once in my lifetime, we don't often have weather that cold. I do sometimes quip that Tennessee can have the best weather possible, a day about 68 degrees, a slight breeze, maybe a puffy cloud or two. And we can also have some of the worst weather, 33 degrees and raining. And we can have these, sometimes, a couple of days apart. But, as far as working for several days in a row with temperatures 10, 15, or 20 below zero we don't have that issue.

With my small story, though, you can see even our weather can be dangerous. I remember a tragedy from my youth. Some Airborne Rangers, one of our elite fighting service men, were on a training mission in North Carolina. The day started out cool, in the 40's, and dry. These men were dropped off with almost nothing. As the day progressed a light rain accompanied a small drop in temperature, into the 30's. The combination of wet clothes and cool temperatures led to the deaths of several of these service men.

As stated in Mr. Spiezio's article the principle concerns in a winter outdoor work scenario are: low temperatures, wind, dampness, and cold water. He also says that the combination of two or more of these situations is what causes dangerous conditions. You may be damp but if it is 80 degrees in the middle of summer you may be uncomfortable but not fighting for your life.

A good situational awareness is always your best protection. Keep an eye on the weather reports. On some occasions, short of an emergency, you may be able to wait until the conditions improve. Sometimes even emergencies may need to wait. You will not be helping the situation by becoming a casualty yourself. Proper protective clothing is your first and best defense against harsh weather conditions. Spiezio boils this down to his three W's: Wicking, Warming, and Weather.

The layer closest to your skin should be able



to wick excess moisture away from your body. One of the four dangers of winter weather is dampness. A good wicking fabric like polypropylene can move the sweat from exertion away from your skin. This keeps you more comfortable as well as warmer and safer.

The purpose of the second layer is to provide most of the insulation character to your attire. There are many natural and man-made fabrics that can provide this for you. Wool is a great natural fiber that you can use. Keep in mind that several thin layers are advantageous over fewer thicker ones. Multiple thin layers will allow you to adjust your insulation throughout the day as the weather changes and as your work load may change.

The third or outermost layer he calls the “Weather” layer. This should be a waterproof and windproof layer. It could also provide some additional insulation. Most of the insulation will come from the layers below this. This outer layer will keep the lower levels dry in case of rain. Wool is a great insulator and will also continue to provide some insulation even while wet. Other fabrics are not so forgiving and need to be kept dry. These can also become heavy and uncomfortable if wet. Also, most of these fabrics, even wool, will allow wind to take heat away from your body through convection. This outer layer should be able to block the wind.

We have so far dealt primarily with your body's core temperature. This is the most important part. While keeping your core warm is very important, your hands, feet and head also must be considered. At very low temperatures, especially in windy conditions, frostbite can occur very quickly. Keep your extremities covered as much as possible. You may want to consider waterproof foot gear. The same considerations for your core apply to your feet, head and hands as well.

Your work habits should also be adjusted in cold weather. Taking many short breaks will help you avoid

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fatigue. It will also prevent a lot of sweating which can lead to other problems.

Try to plan your work in the warmest part of the day. This also provides the best lighting which leads to a safer work environment.

Working in pairs is also a good idea. Your work mate may be able to notice things about you that indicate distress. Keep an eye out for each other and seek warmth at the first signs of trouble.

Much of this is common sense to us all. If you are cold, go get warm. It seems simple. But, sometimes we may be trying to finish some important task. After a short time we may become poorer judges of our own well-being and soon we find ourselves in trouble. Work smart and take care of yourselves out there.

Cold Weather Driving Safety

By Spence Meyers (Source: NLTAPA Tailgate Safety Talks - Cornell Local Roads Program)

This Everyday Safety Tailgate Talk was originally published as the January 2016 "Safety Pins" by Philip E. Spiezio, Safety Officer, Washington County Office of the Safety Officer

The days are becoming shorter and cooler. As with every year each day brings a chance of severe weather. We must do our best to continue to perform our work duties as well as carry on with our personal day to day routines. Inclement weather can make this difficult and even dangerous. Some of these tips may help you in these situations.

The first consideration in slippery or even rainy weather is good tires. The demands on your tire treads increase in winter. Deeper treads help move water out of the tires' path better than shallow ones. This helps to reduce hydroplaning which is a major cause of wrecks. Good tire tread also helps in the snow. We don't often think about snow tires in Tennessee. People in many parts of the country, and my father in the old days, would keep an extra set of snow tires in the garage and switch out to them in winter. That, and tire chains, seems to be a bit of overkill for our recent mild winters, but good tread depth on our regular street tires (front and back) is still important.

Don't forget the antifreeze. Again, in Tennessee we don't have super hot days so about any level of coolant is going to keep our cars safe. And, in the winter, it rarely gets cold enough to freeze our engines. Occasionally we do have those snaps and we need to be ready for them.

Another thing we need in the winter more often is our wipers. It is a good idea to check our wiper blades. Contrary to popular belief wiper blades are not the same things as ice scrapers. Make sure your wiper blades are not frozen to your window before using them. It is a good idea to take a couple of minutes to warm up your windshield before using them. Some experts recommend leaving your wiper arms in an upright position over night in cold weather. This is especially true if an ice storm is predicted. It is important that everything is ready under the hood as well. Check your fluids. Of course we should always check our oil but also our wiper fluid. Salt spray on our windows can be very hard to see through. Make sure your battery is in good condition. Many auto parts stores will check them for free. Don't skimp on this important component.

We may not get much/any snow here these days but remember to clean the snow off of your vehicle before driving. This is mostly important to other drivers. Snow flying off of our cars can cause visibility issues to other drivers. But, this snow can cause us problems as well. Make sure you clean the snow away from your lights. Don't block your headlights, tail lights or any of your warning lights.

None of this advice will help you if you do not drive safely. Make sure you have plenty of time to drive safely to your destination during inclement weather. In fact, don't drive if you don't have to. Tennessee snow storms, while they do exist, rarely last very long. Any time you can give the highway crews to clear the roads, and for the roads to melt on their own, will help you the most. If you do have to go, maybe you are on one of those highway crews, keep a safe following distance. Keep your speed down too. Plan ahead to make a safe stop. Sudden stops and turns can cause dangerous skidding.

Please remember to buckle up. Don't drive distracted or drowsy. And certainly do not drive impaired.



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