



Small UAS for Emergency Management

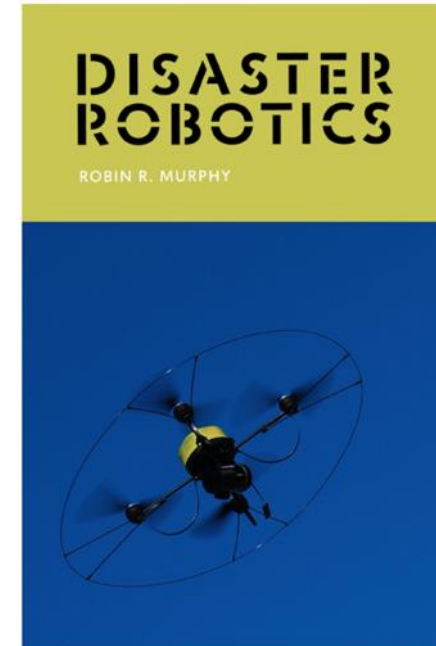
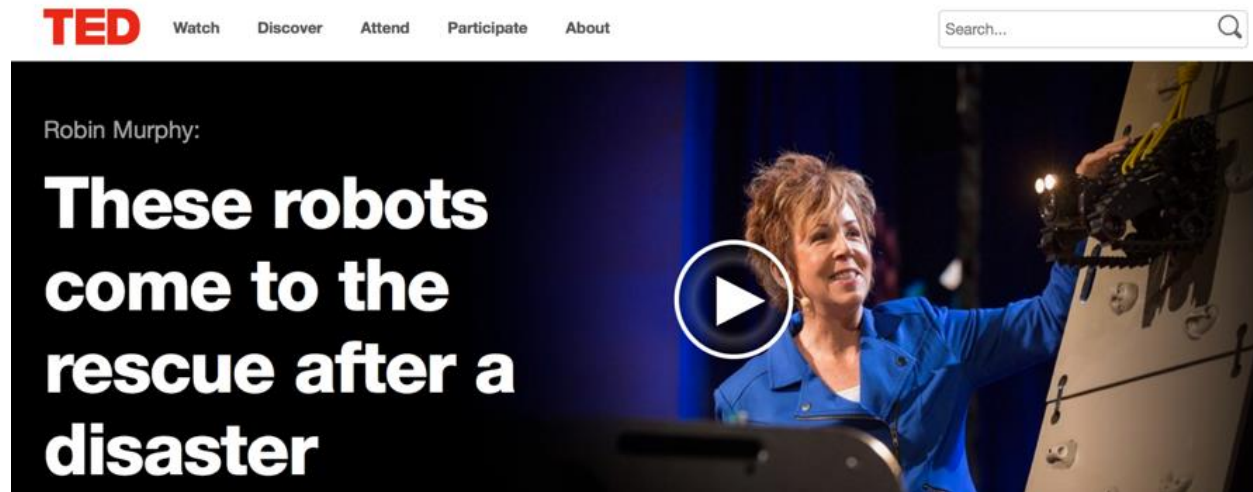
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Texas A&M University

Center for Robot-Assisted Search and Rescue

See: <https://www.fhwa.dot.gov/uas/resources/hif19019.pdf>

Background: Professor & Responder



- 29 deployments including 9/11 WTC, Katrina, Fukushima, Harvey, Kilauea
- First use of sUAS for a disaster (Katrina 2005)
- CRASAR (Center for Robot-Assisted Search and Rescue) has the largest number of deployments to disasters, starting in 2001, 30+ to 5 countries

Outline:

- The types of sUAS and sensors commonly used for natural disasters, especially flooding
- **Seven Missions** for sUAS for disasters
- **Four Guiding Principles** to help you decide when and how to use sUAS
- **Six Misconceptions** to avoid



7



4



6

Hurricane Harvey: Fort Bend County (SW Houston Metroplex)



Hurricane Harvey: 9 Models of UAS, most between \$1K-\$5K





Tactical: what roads are open?



Hurricane Harvey: Bridge inspection



Bridge inspection- above bridge



Real benefit was looking directly under bridge



Real benefit was looking directly under bridge

Hurricane Michael: 10 minutes, ~1 mile

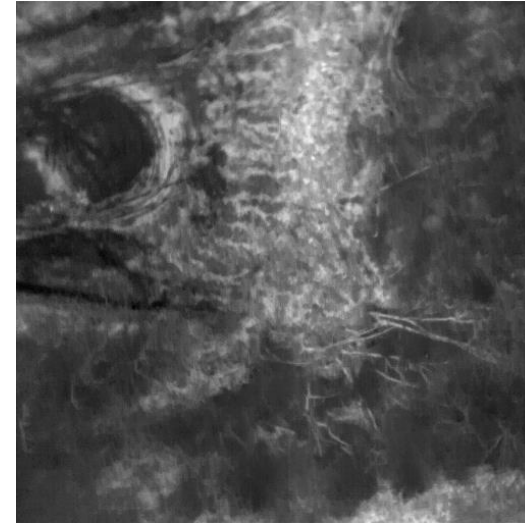


An aerial photograph showing a narrow river or canal that has been completely flooded. The water is a murky, brownish-grey color. On the left side of the river, there is a dense line of green trees. On the right side, there are more trees, some of which are partially submerged. In the center of the river, an airboat is moving away from the viewer, leaving a wide, white wake behind it. The airboat is small and dark, with a few people visible on board. In the background, the river continues towards a distant shoreline where some buildings and more trees are visible under a clear sky. The overall scene depicts a flooded area, likely due to heavy rain or a storm.

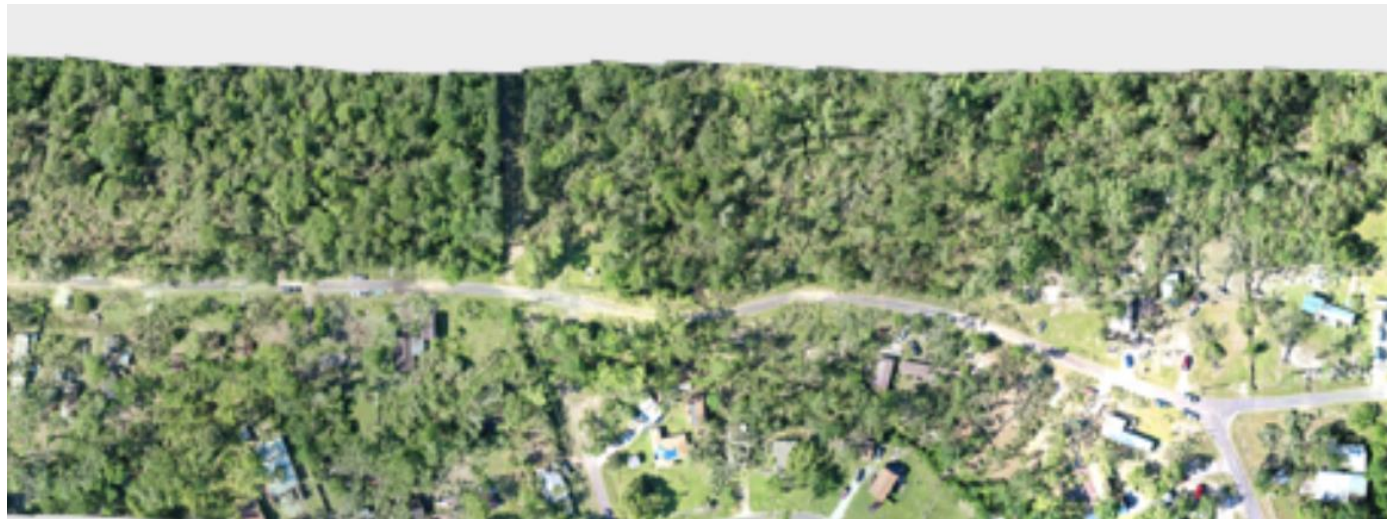
Get creative: launch and land from airboats



**Real-time images
and video**
*Good for tactical
operations, streaming if
internet permits*



Thermal Imaging
*But generally fuzzy, hard
to assess damage*



Maps of large areas
*A squad can cover ~175 acres in half a day, then 1 to
12 hours to create map*



7

**Missions that
you may be
asked to
support**

7

Missions

1. **Strategic Situation Awareness (SA), Survey, and Reconnaissance**
2. Detailed or Structural Inspection
3. Ground Search and Rescue
4. Water Search and Rescue
5. Debris, flood estimation, and
6. Tactical Situation Awareness
7. Delivery



*FPV, panoramas,
mapping later*

7

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5. Debris, flood estimation, and
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FPV, mapping



7

Missions

1. Strategic Situation Awareness
Reconnaissance
2. Detailed or Structural Inspection
3. **Ground Search and Rescue**
4. Water Search and Rescue
5. Debris, flood estimation, and damage assessment
6. Tactical Situation Awareness
7. Delivery



Maybe thermal, mapping

7

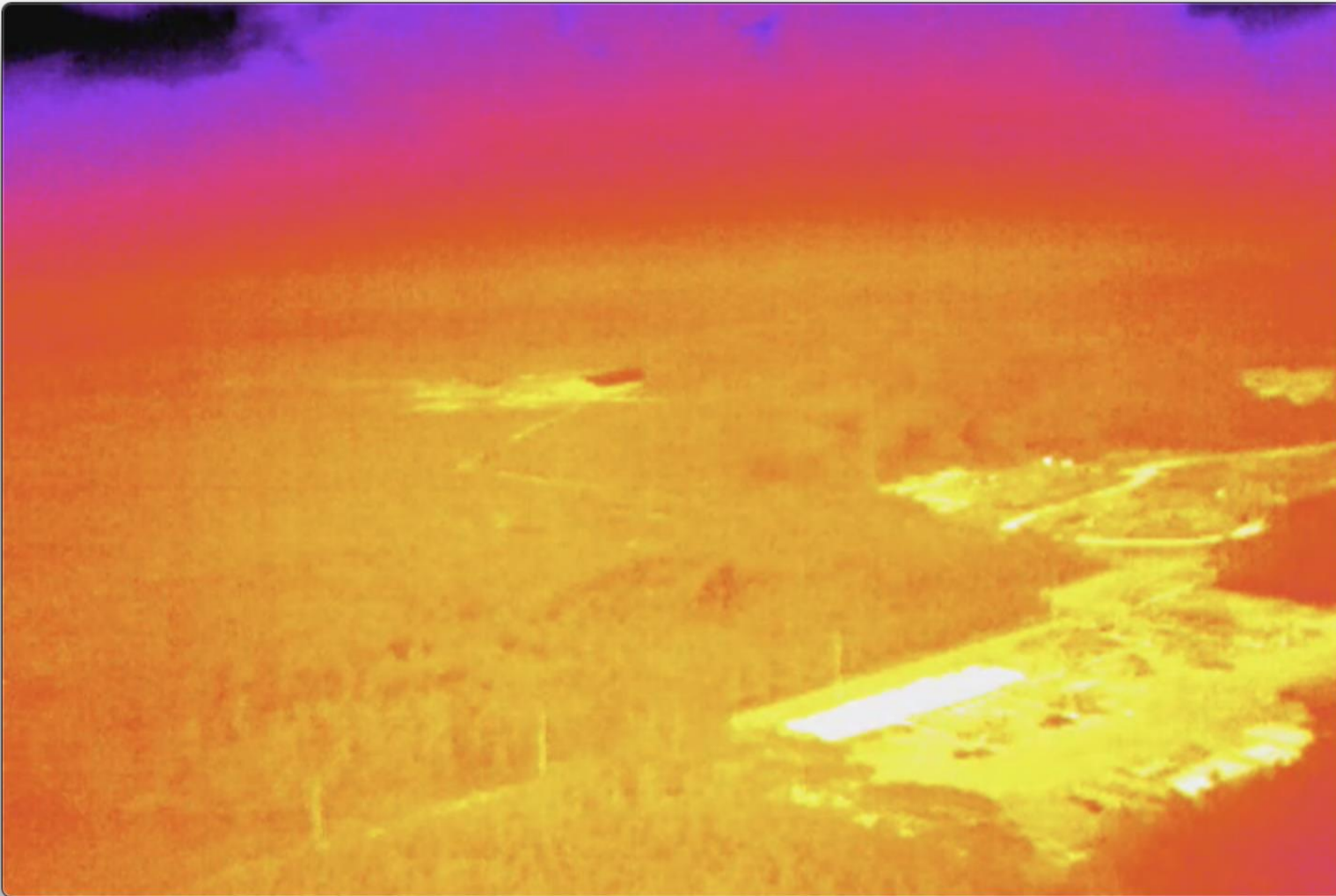
Missions

1. Strategic Situation Awareness
Reconnaissance
2. Detailed or Structural Inspection
3. Ground Search and Rescue
4. **Water Search and Rescue**
5. Debris, flood estimation, and damage assessment
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Maybe thermal, mapping

Thermal: fuzzy, body heat hidden by foliage



*Where's the lava
flow and
geothermal plant
in this picture?*

7

Missions

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Reconnaissance
2. Detailed or Structural Inspection
3. Ground Search and Rescue
4. Water Search and Rescue
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*FPV, panoramas,
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Missions

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FPV

7

Missions

1. Strategic Situation Awareness
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3. Ground Search and Rescue
4. Water Search and Rescue
5. Debris, flood estimation, and damage assessment
6. Tactical Situation Awareness
7. **Delivery**



<https://www.enr.com/safety-technology/article/2017/04/16/drone-delivery-is-critical-to-emergency-management>

special skill

A large, solid orange circle is positioned on the left side of the slide.

4

**Principles to
help you decide
when, what,
how**

4

Principles

- 1. Think of all the phases of the disaster, not just response and recovery**
- 2. Put 1 person in charge of all sUAS teams during a response**
- 3. Determine the missions first, then match the assets to the mission using COPIED**
- 4. It's all about the data, so make (and execute) explicit plans for collection, post-processing, curation**

**Tactical Situation
Awareness**

**Strategic Situation
Awareness (SA), Survey,
and Reconnaissance**

**Ground Search and
Rescue**

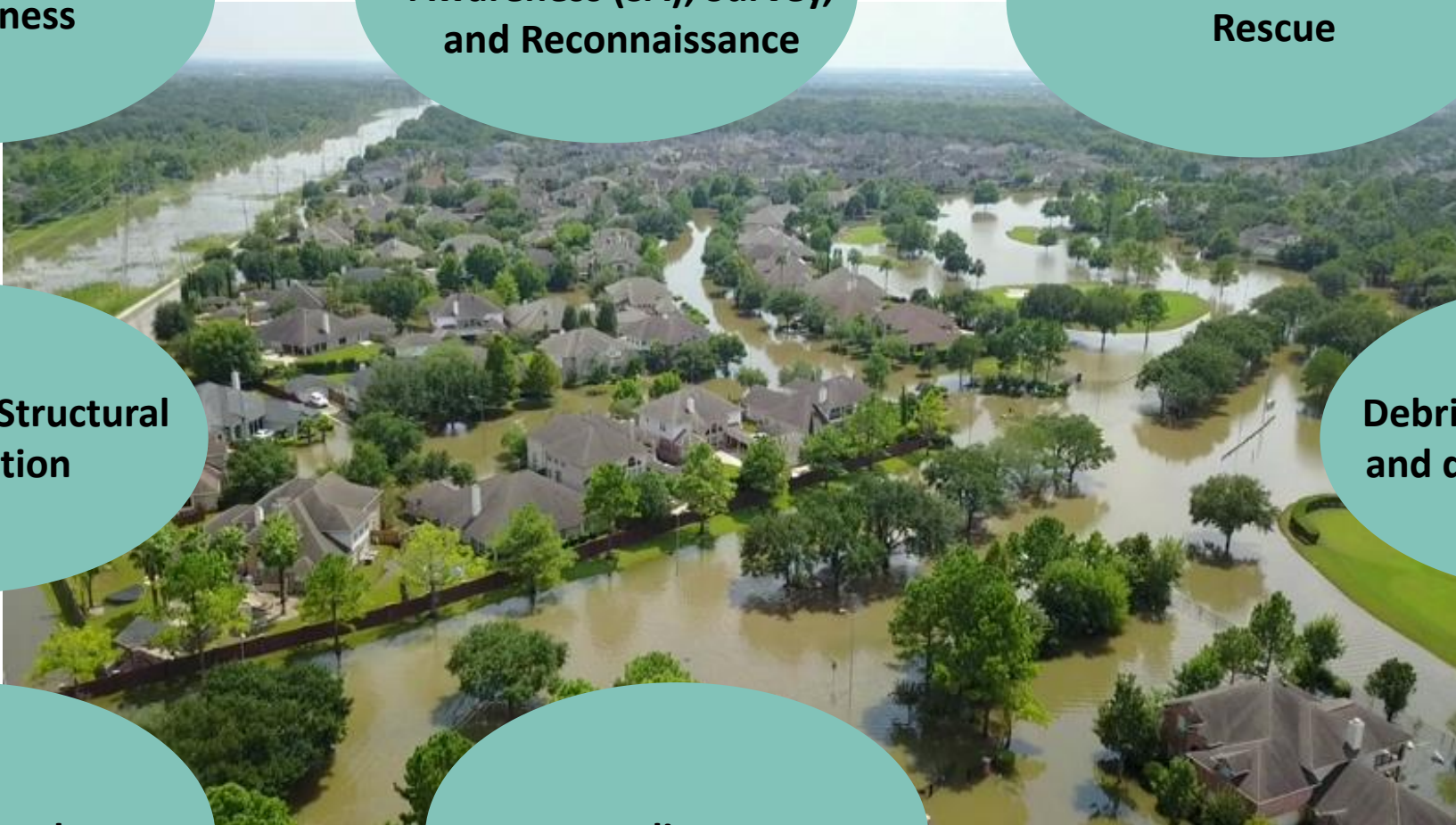
**Detailed or Structural
Inspection**

**Debris, flood estimation,
and damage assessment**

Water Search and Rescue

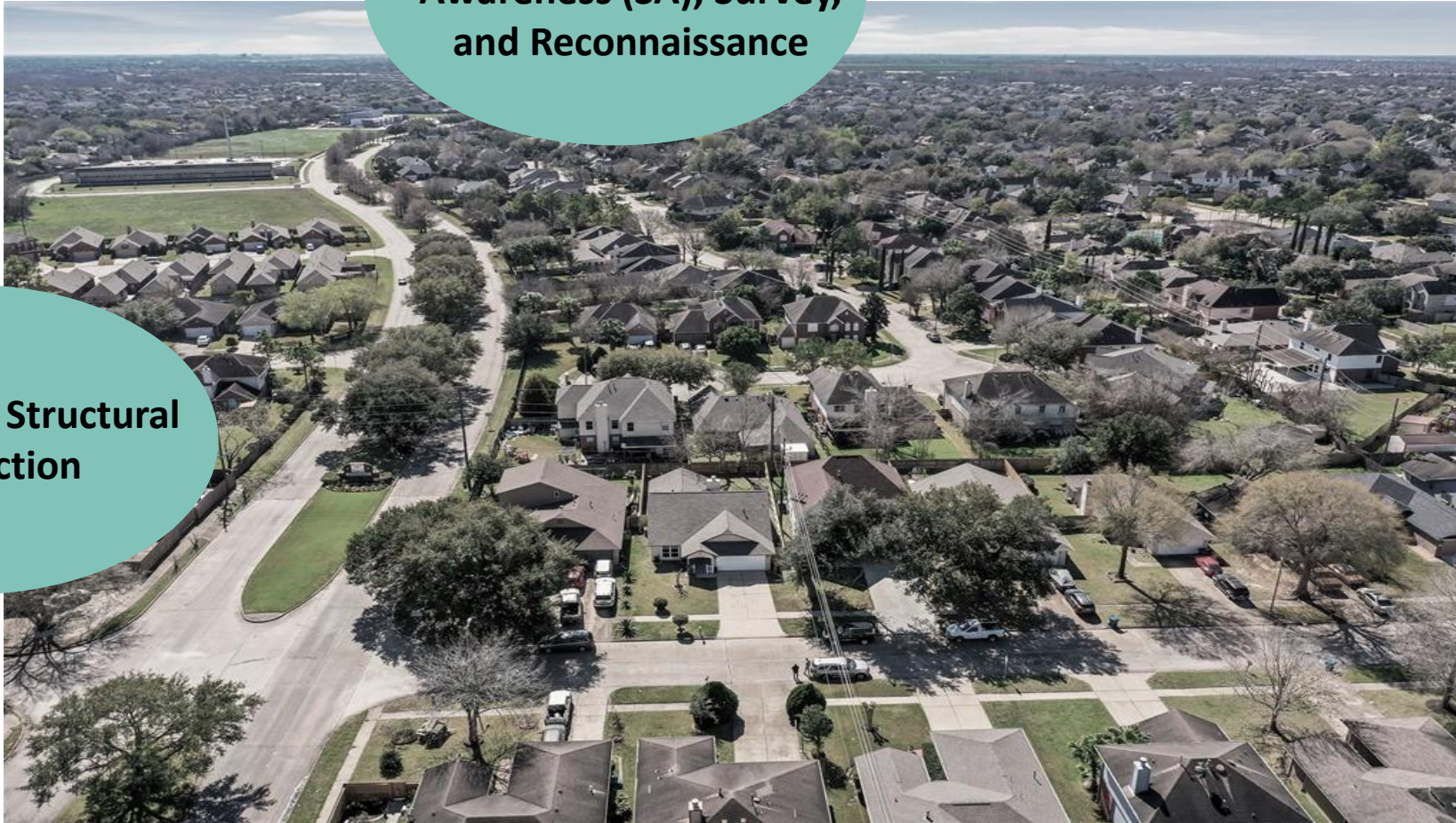
Delivery

DURING
response and mitigation



**Strategic Situation
Awareness (SA), Survey,
and Reconnaissance**

**Detailed or Structural
Inspection**



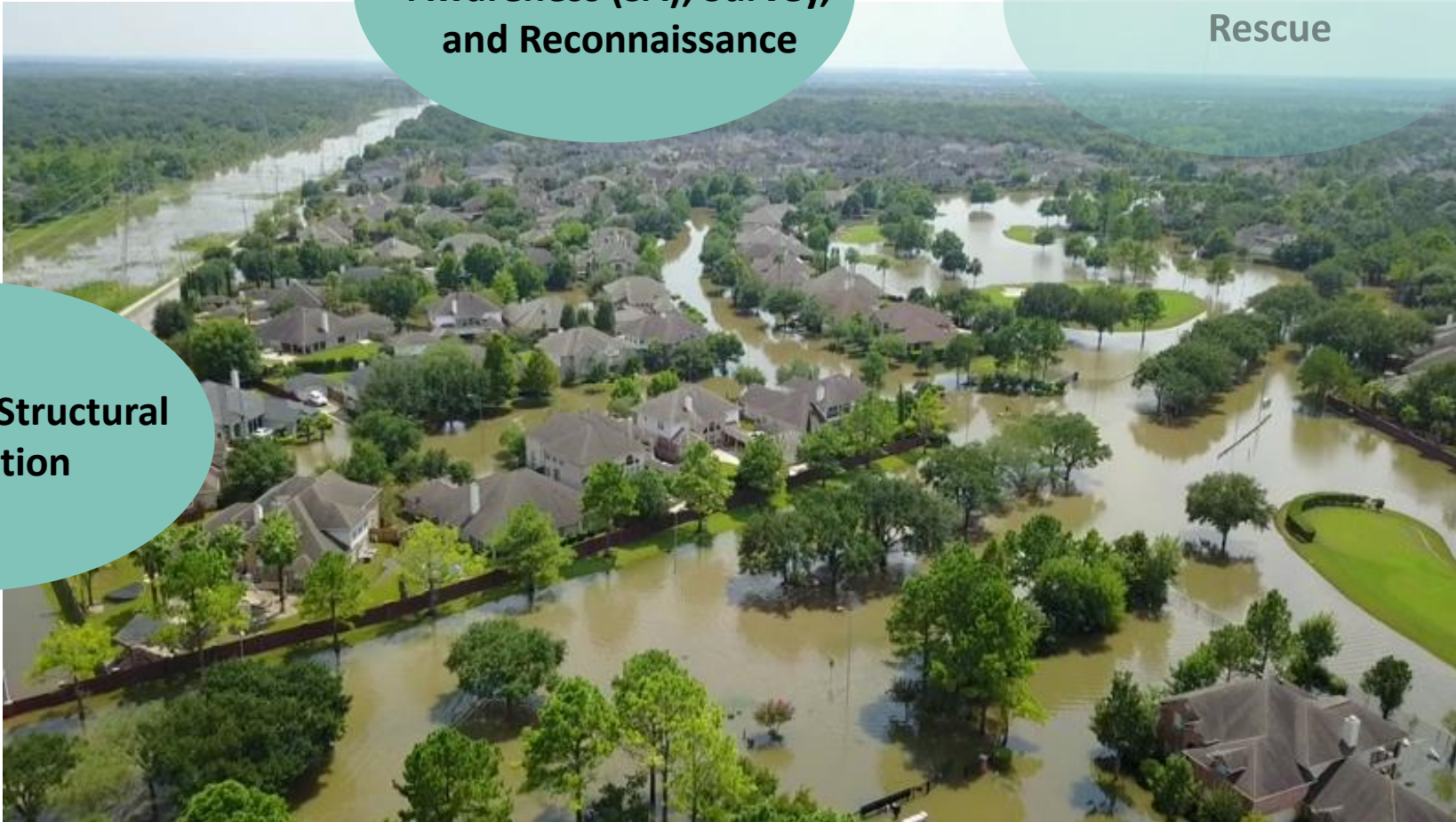
BEFORE

prevention/preparedness

**Strategic Situation
Awareness (SA), Survey,
and Reconnaissance**

**Ground Search and
Rescue**

**Detailed or Structural
Inspection**



AFTER

reconstruction and recovery

4

Principles

1. Think of all the phases of the disaster, not just response and recovery
2. Put 1 person in charge of all sUAS teams during a response
3. Determine the missions first, then run the mission using COPIED
4. It's all about the data, so make (and share) plans for collection, post-processing



4

Principles

1. Think of all the phases of the disaster, not just response and recovery
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C Constraints (day? altitude?)

O Operator factors (training, fatigue)

P Penetration or distance

I Information to whom and when

E Envelope the robot works in

D Duration

4

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Harvey: ~6500 images and ~100 videos over 11 days with 13 pilots

Number of Pictures		Before		Incident		Response				Recovery				
Mission Type	Primary Objective	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	1-Sep	2-Sep	3-Sep	4-Sep	Total	Grand Total
Debris/Damage/Flood Estimation	Mapping	0	0	0	0	0	0	0	0	191	2471	1209	3871	3909
	Visual Assessment	0	0	0	0	0	0	23	0	0	0	0	23	
	Tornado Impact	0	15	0	0	0	0	0	0	0	0	0	15	
Inspection	Levee or Dam	0	0	0	0	0	0	0	3	0	2409	0	2412	2580
	Bridge Inspection	0	0	0	0	0	33	6	2	0	0	126	167	
	Building Inspection	0	0	0	0	0	0	1	0	0	0	0	1	
Strategic SA/Recon/Survey	Public Information	0	0	0	0	0	0	0	0	0	0	0	0	0
Tactical SA	Route or Transportation Survey	0	0	0	0	0	0	2	1	0	0	0	0	0
	Overwatch	0	0	0	0	0	0	0	0	0	0	0	0	
Grand Total	Total	0	15	0	0	0	33	30	5	191	4880	1335	6489	

Number of Videos		Before		Incident		Response				Recovery				
Mission Type	Primary Objective	25-Aug	26-Aug	27-Aug	28-Aug	29-Aug	30-Aug	31-Aug	1-Sep	2-Sep	3-Sep	4-Sep	Total	Grand Total
Inspection	Bridge Inspection	0	0	1	0	0	3	4	14	5	0	0	27	51
	Levee or Dam	0	0	0	0	0	0	2	14	6	1	0	23	
	Building Inspection	0	0	0	0	0	0	1	0	0	0	0	1	
Debris/Damage/Flood Estimation	Visual Assessment	0	0	4	0	0	0	17	9	0	4	0	34	38
	Tornado Impact	0	4	0	0	0	0	0	0	0	0	0	4	
	Mapping	0	0	0	0	0	0	0	0	0	0	0	0	
Strategic SA/Recon/Survey	Public Information	0	0	0	0	0	0	0	3	7	0	0	10	10
Tactical SA	Route or Transportation Survey	0	0	0	0	0	0	2	4	0	0	0	6	7
	Overwatch	0	0	0	0	0	0	0	0	0	1	0	1	
Grand Total	-	0	4	5	0	0	3	26	44	18	6	0	106	

OUR GOAL IS
GETTING THE RIGHT DATA TO THE RIGHT PEOPLE FAST

DATE:

SQUAD NAME:

MISSION NAME:

Use this name as is for your folder!

PLEASE, PLEASE, PLEASE FILL IN SO WE CAN PASS ON DATA AND FIND IT AGAIN

Platform, altitude:

#Sorties:

List any important file names and findings to pass on:

5 STEP DATA COLLECTION DIRECTIONS

1. **Format memory card prior to the first mission.**
 - Know that the data manager will delete it once he/she is done copying (unless pilot uses different memory cards for different missions)
2. **Check the data after each sortie.** This quality control check is really important
3. **Rename your folders (and images).** After each mission, before handing the data to the data manager (this can be done in the car on the way back).
 - **Top Folder: MISSION NAME, Sub Folders: SORTIE NUMBER PLATFORM**
 - Example
 - Sector Alpha
 - Sortie 1 DJI Mavic
 - DJIimage0001.jpg
 - Sortie 2 DJI Inspire
 - If possible, add the N W S E to image file names indicating direction UAS was facing
4. **Fill in the front side of the card.** Highlight any info that needs to be passed on and report any problems with data when giving it to the data manager to add to the notes
5. **Turn in SD card or thumb drive to data manager with this card.**

While not essential, it would be helpful if you kept additional information about missions for further analysis: arrival time, take off, landing, depart time. You can share this with the data manager.

You can add a subfolder for other pictures (e.g., the landing zone location, selfies, damage that help document).



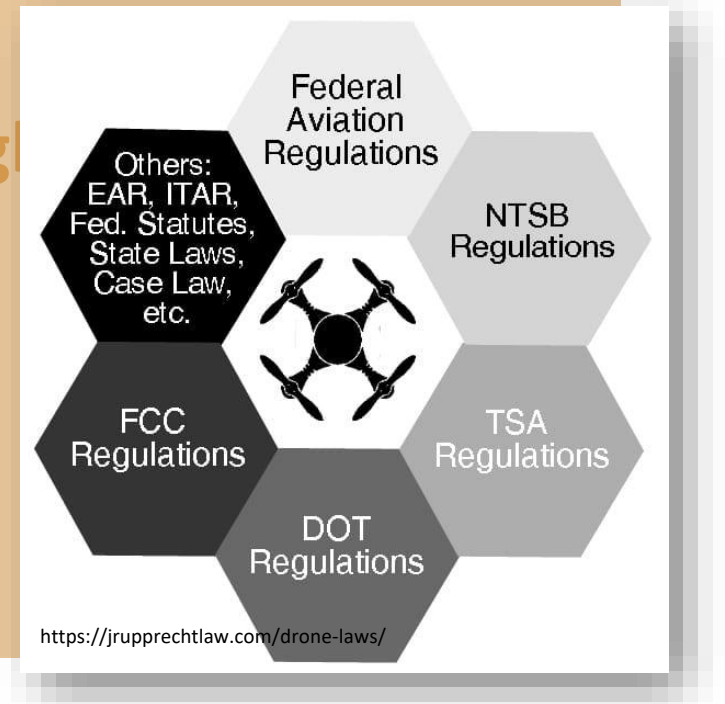
6

**Misconceptions
to avoid**

6

Misconceptions

1. **Regulations interfere with meeting goals**
2. sUAS reduce manpower
3. A pilot is a pilot is a pilot
4. sUAS crewing is different than life flight manned aviation crews
5. Streaming video is a silver bullet
6. Bigger and more expensive is better



6

Misconceptions

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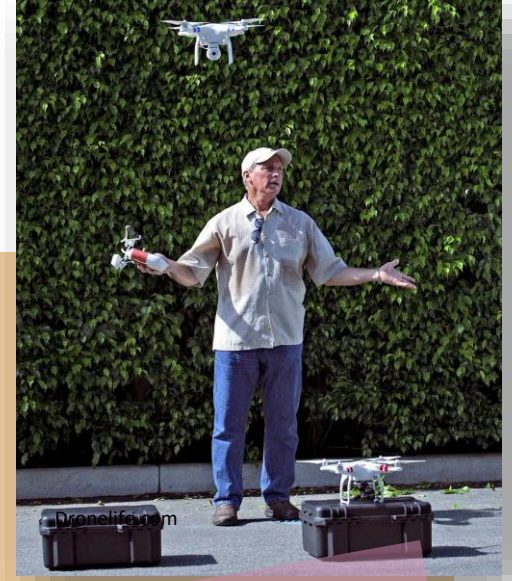
6. Bigger and more expensive is better

- Two pilots (+ expert) in field
- Two data managers to prep BEFORE handing off to GIS/Planning unit

6

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Able to fly FPV? Collect
AND process mapping
data? Daylight waiver? ICS
training?

6

Misconceptions

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Our brains are wired for visual capture

6

Misconceptions

\$1,000

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YOU GOT THIS!



7

4

6

For more information:

- <https://www.fhwa.dot.gov/uas/resources/hif19019.pdf>
- **CRASAR.org and CRASAR YouTube channel**
- **robin.r.murphy@tamu.edu**
- **@robinrmurphy**
- <https://www.linkedin.com/in/murphyrobin/>

