Small UAS for Emergency Management

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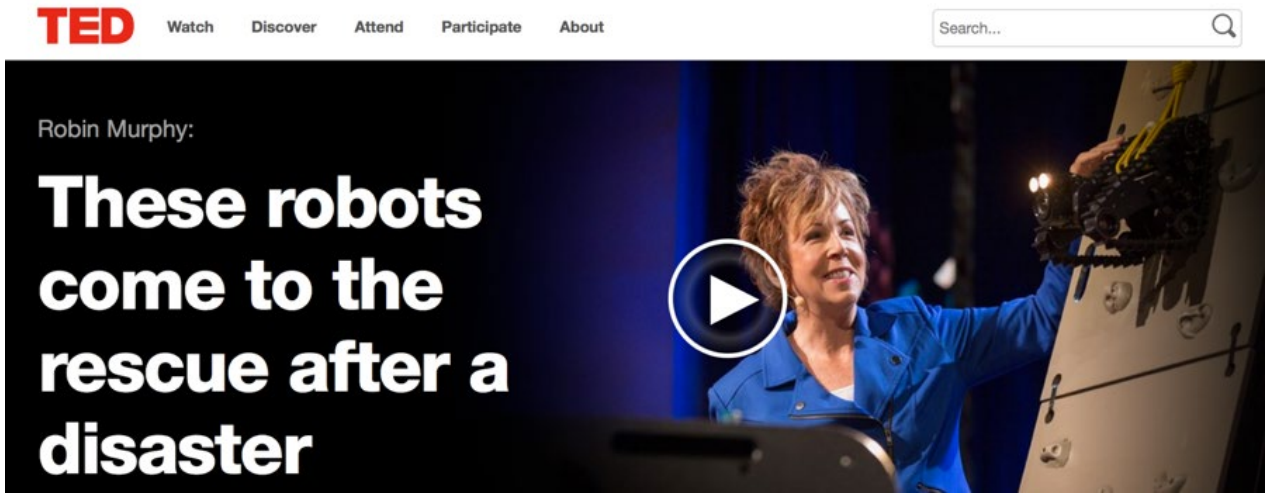
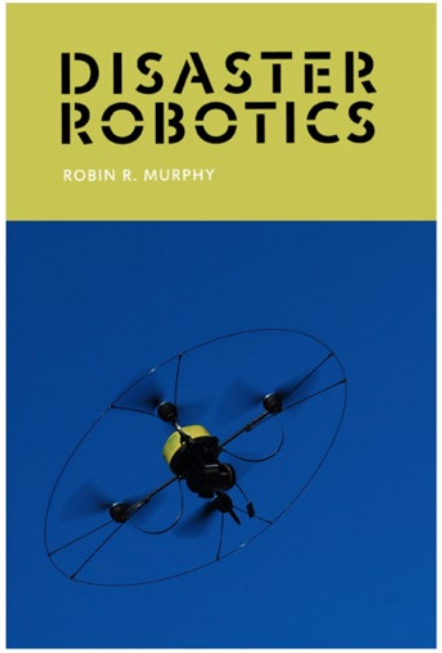
See: https://www.fhwa.dot.gov/uas/resources/hif19019.pdf

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


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

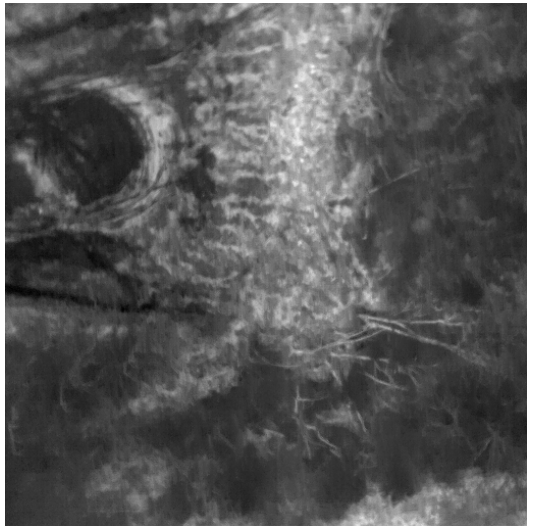

Hurricane Michael: 10 minutes, ~1 mile


Get creative: launch and land from airboats


MAVIC 2

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 Inspect
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 Missions

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FPV, mapping

7 Missions

Maybe thermal, mapping

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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
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7 Missions

Maybe thermal, mapping

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2. Detailed or Structural Inspection
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4. **Water Search and Rescue**
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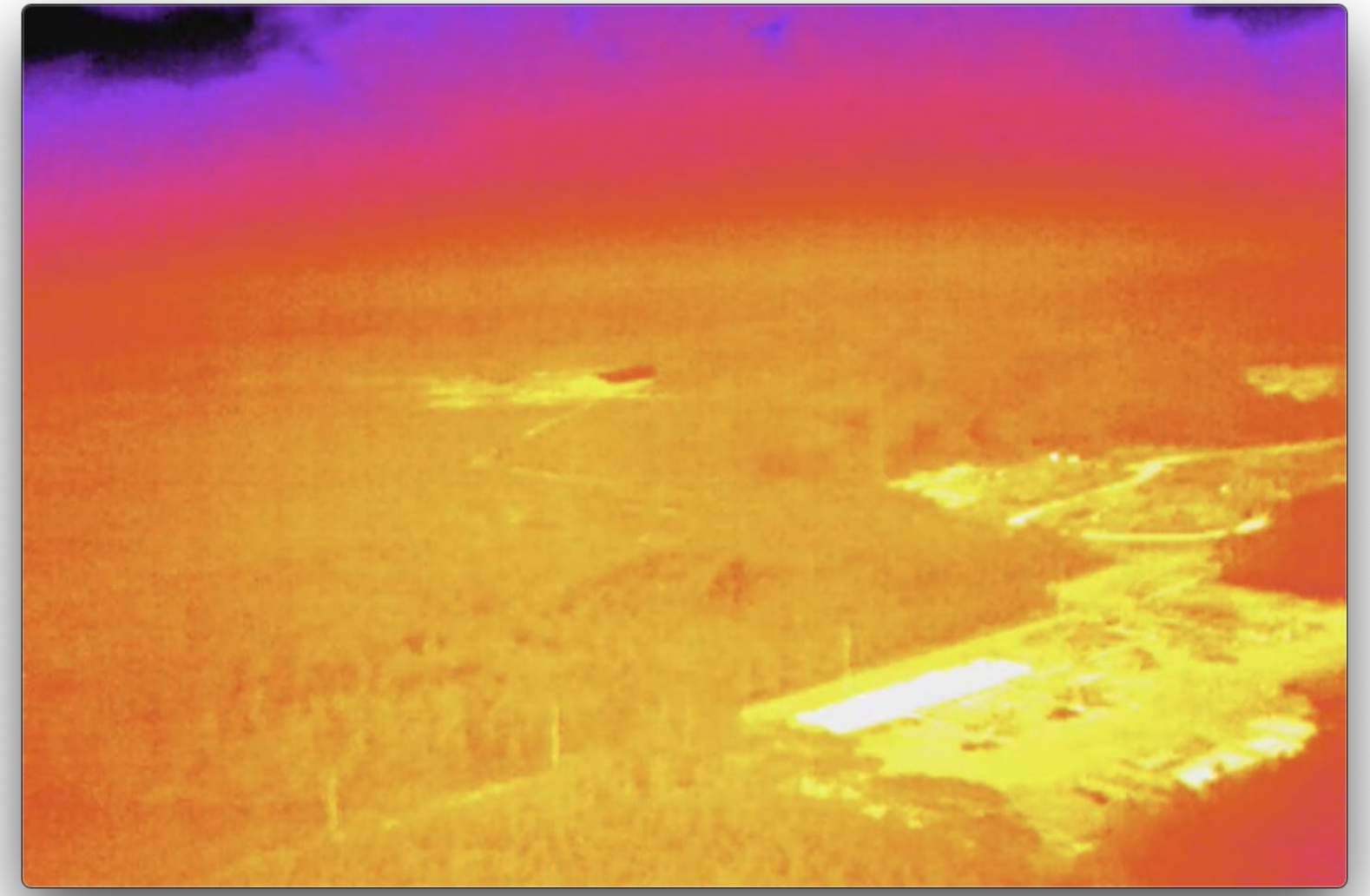
Thermal: fuzzy, body heat hidden by foliage



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

7 Missions

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   Reconnaissance
2. Detailed or Structural Inspection
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4. Water Search and Rescue
5. **Debris, flood estimation, and damage assessment**
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FPV, panoramas, mapping later

7 Missions

FPV

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   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

7 Missions

https://www.ehstoday.com/safety-technology/article/21125416/drone-delivery-is-critical-to-crisis-management

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**

special skill

4

Principles to help you decide when, what, how

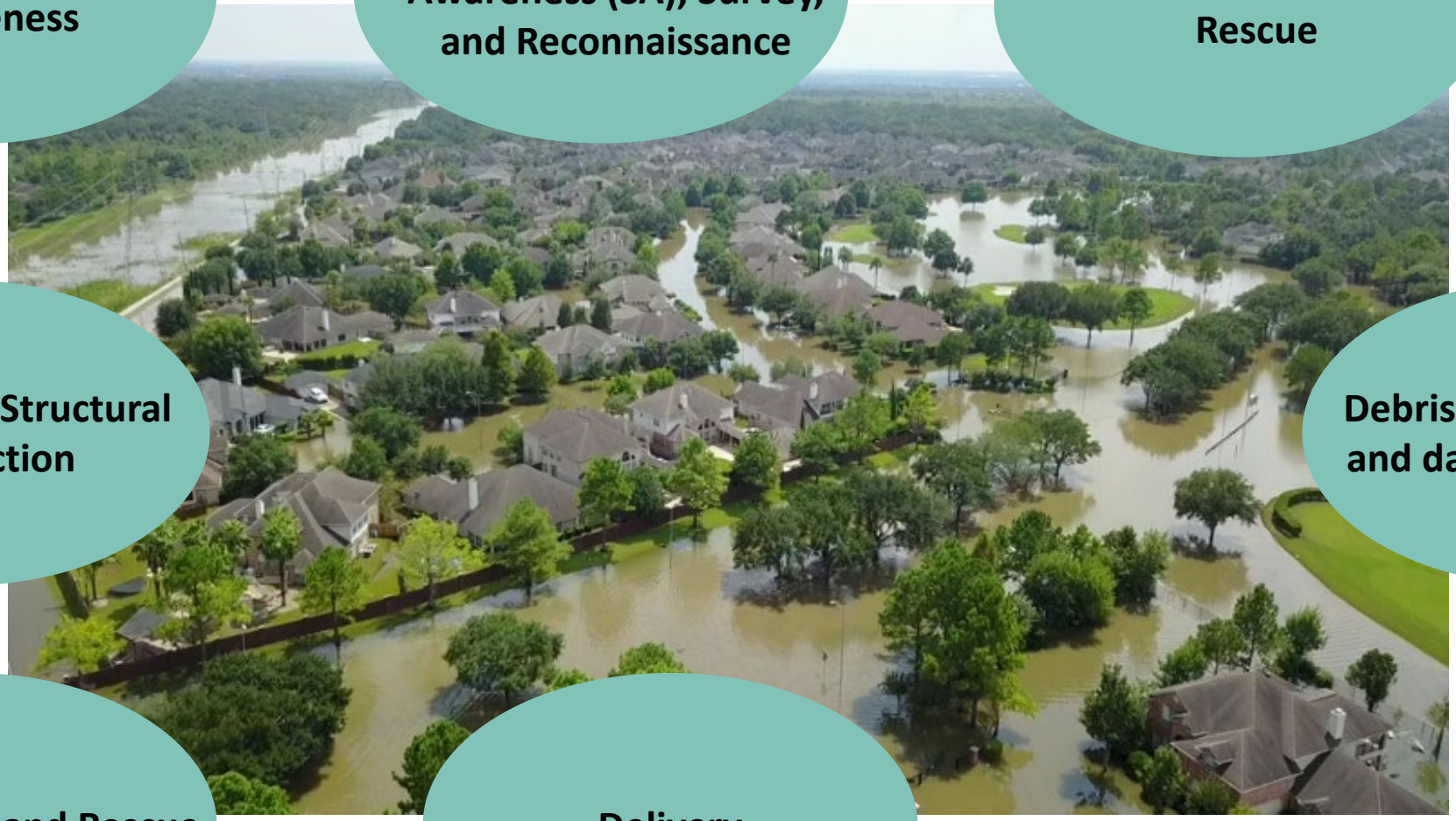
4 Principles

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

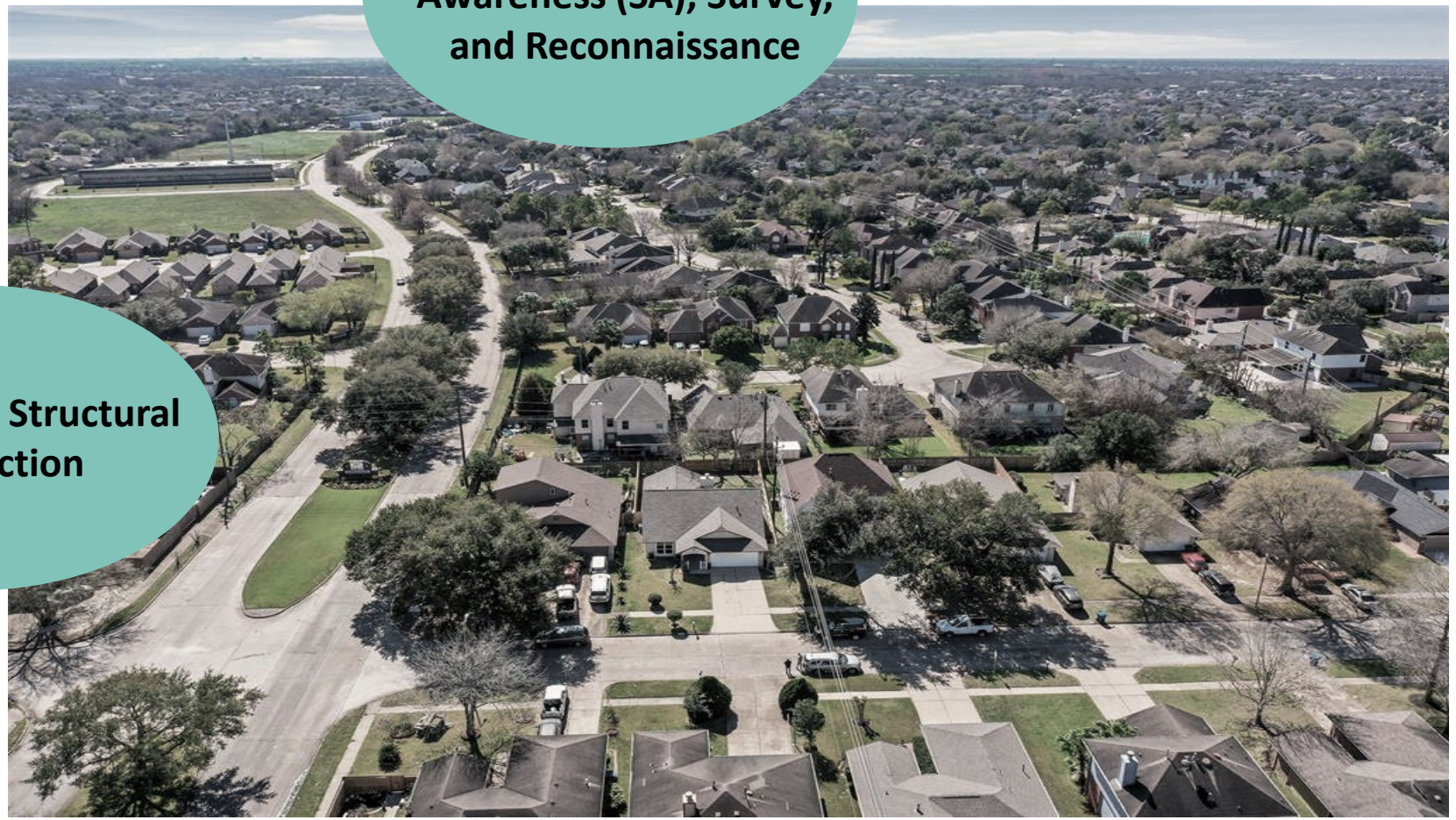
Water Search and Rescue

Delivery

DURING

response and mitigation

Strategic Situation Awareness (SA), Survey, and Reconnaissance



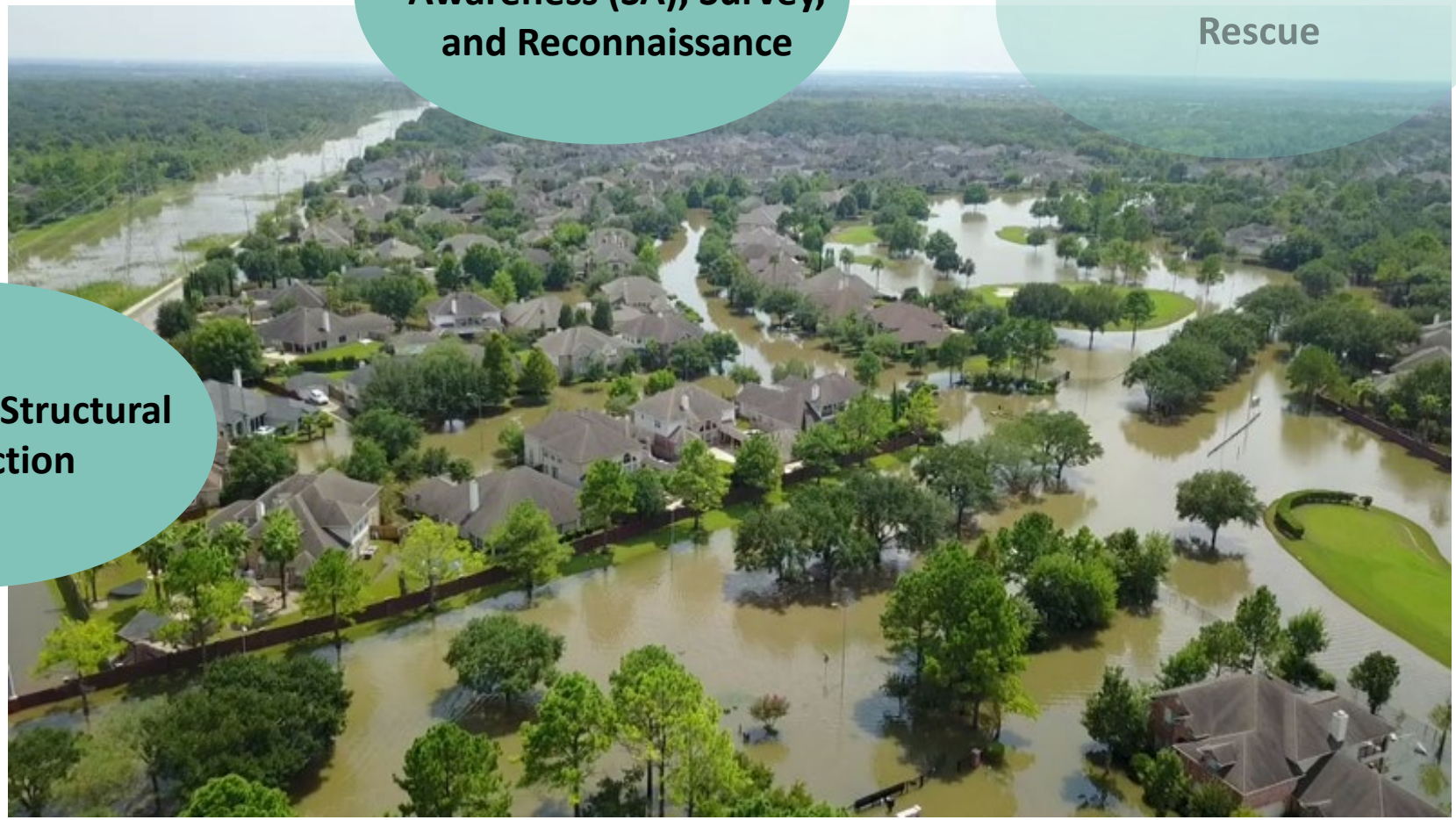
Detailed or Structural Inspection

BEFORE

prevention/preparedness

Strategic Situation Awareness (SA), Survey, and Reconnaissance

Ground Search and Rescue



Detailed or Structural Inspection

AFTER

reconstruction and recovery

4 Principles

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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

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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.

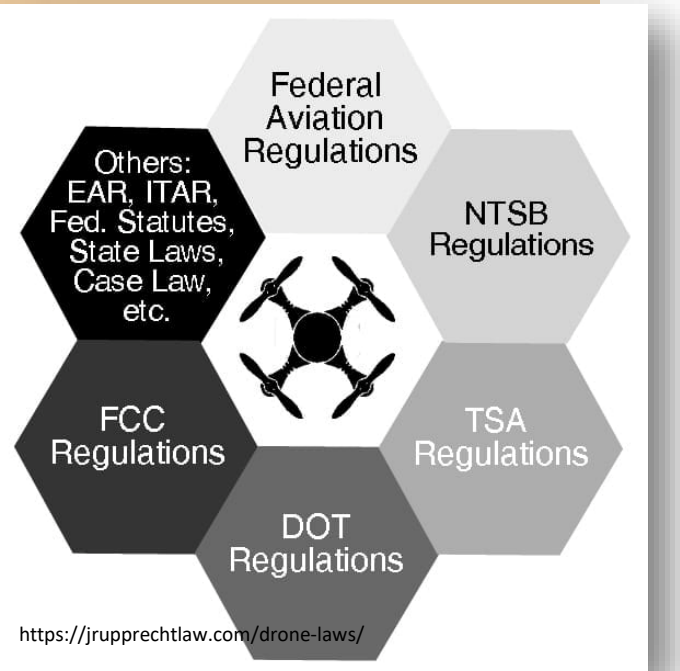
You can add a subfolder for other pictures (e.g., the landing zone location, selfies, damage that help document).

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 flig
   manned aviation crews
5. Streaming video is a silver bullet
6. Bigger and more expensive is better



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

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

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Our brains are wired for visual capture

6 Misconceptions

$1,000

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YOU GOT THIS!
memecrunch.com

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/