



# UAS Safety and Risk Assessment

Presentation by : Guy Maalouf





# Airspeeder Mk II

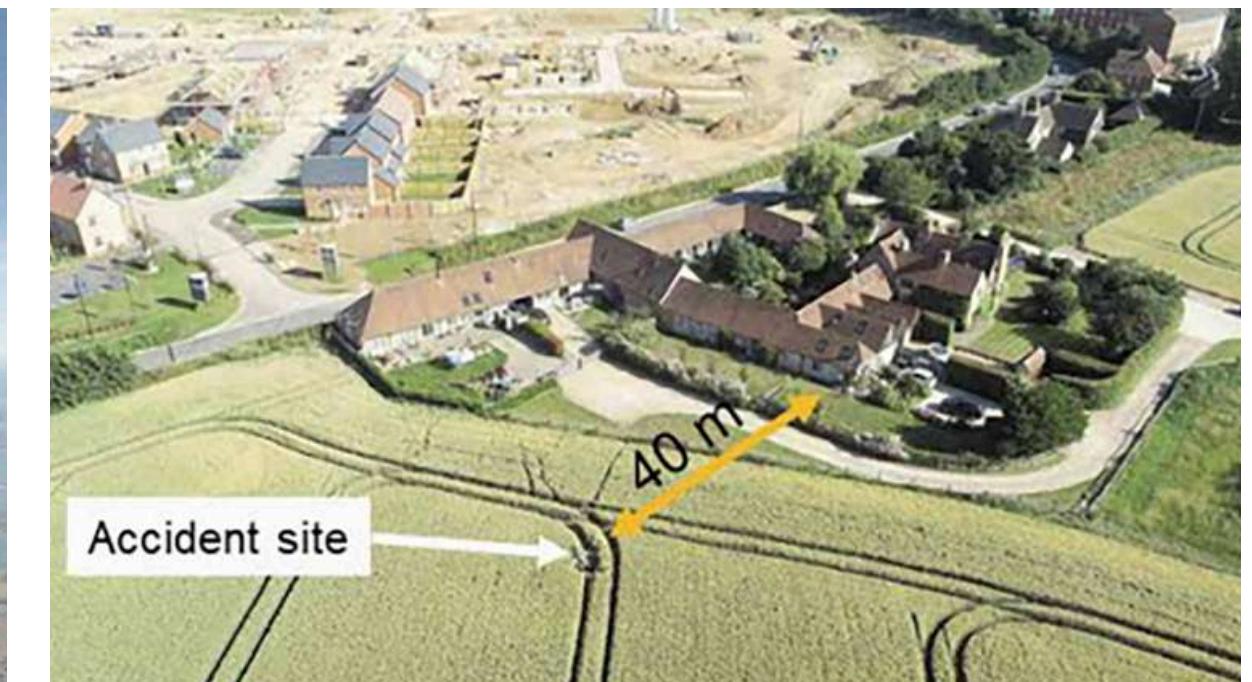
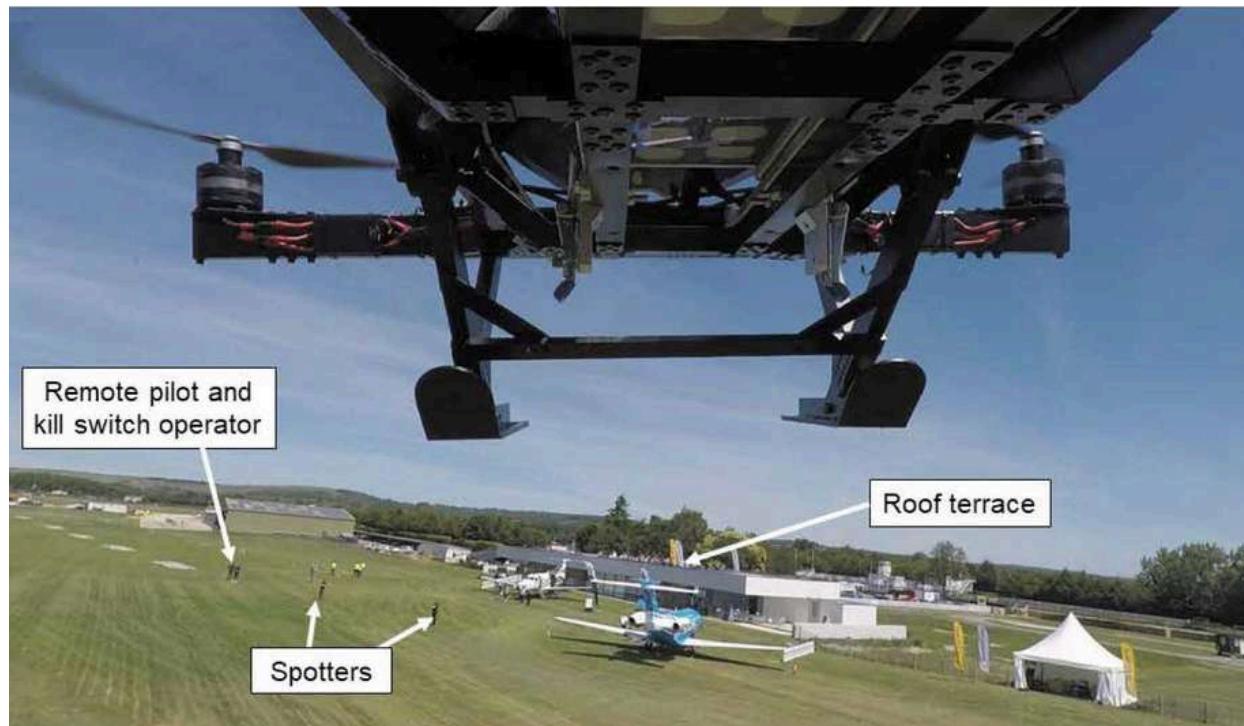
📍 Goodwood Aerodrome





# What happened?

- Footprint: 3m
- TOW: 95 kg
- Max alt: 8,000 ft
- Gatwick airport airspace intrusion



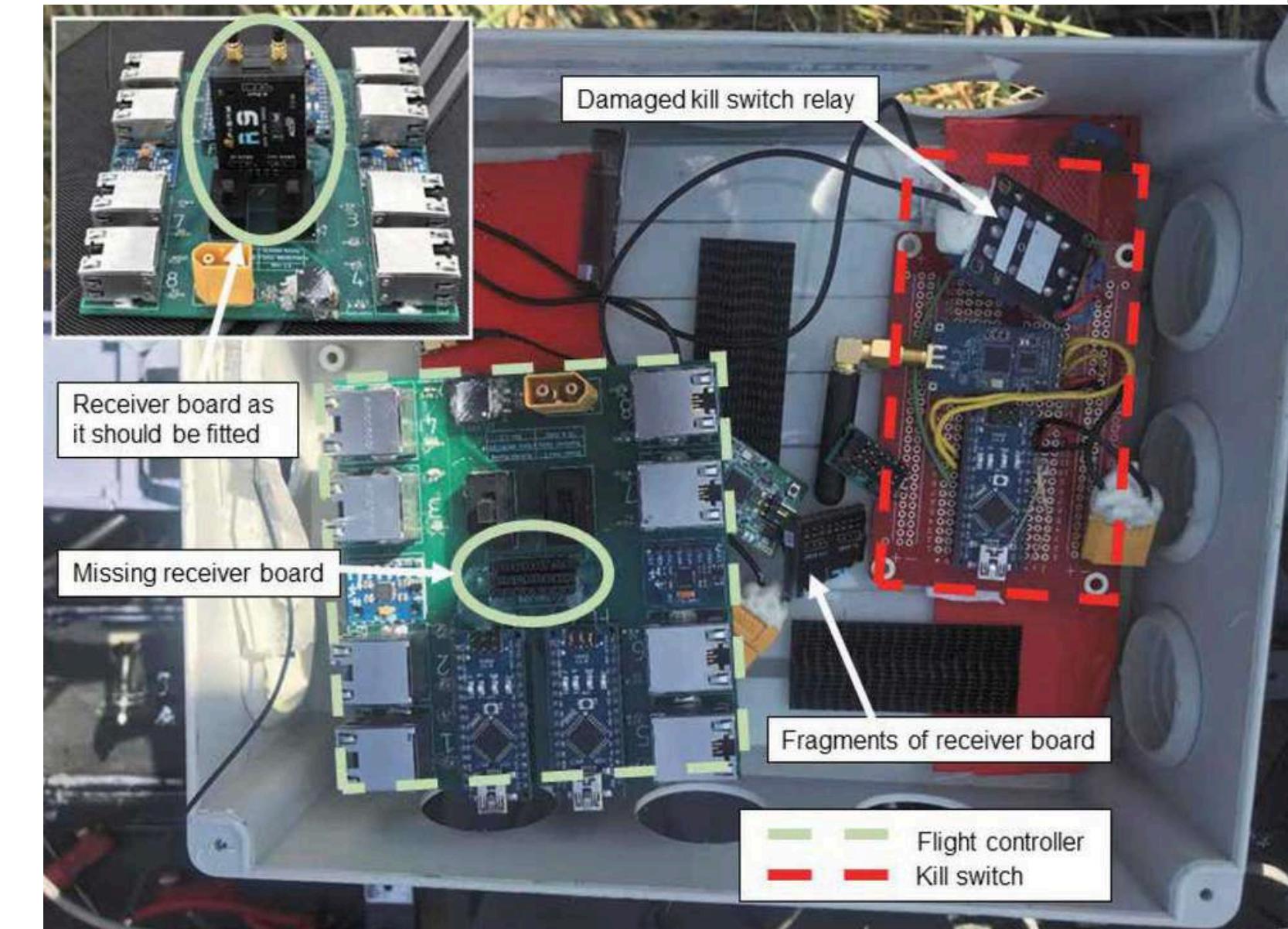


# How did it happen?

- Poor design & build quality
  - No Telemetry
  - No GNSS (No RTH or Geofence)
  - No on-board data recording
- Safety case misrepresentation
- Lack of testing
- Regulatory oversight
  - No inspection
- Software issues



← Kill Switch  
Flight Controller





*“How do we ensure incidents like this (or even worse) don’t happen?”*



*“How do we ensure incidents like this (or even worse) don’t happen?”*

## Safety & Risk Management



# Safety Theory

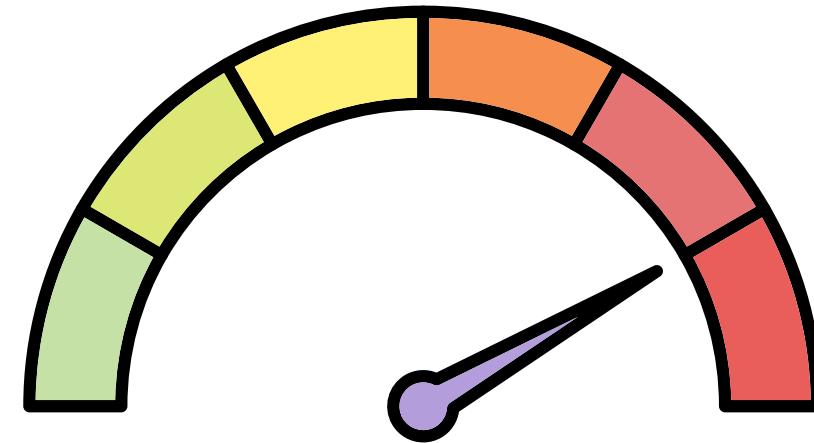




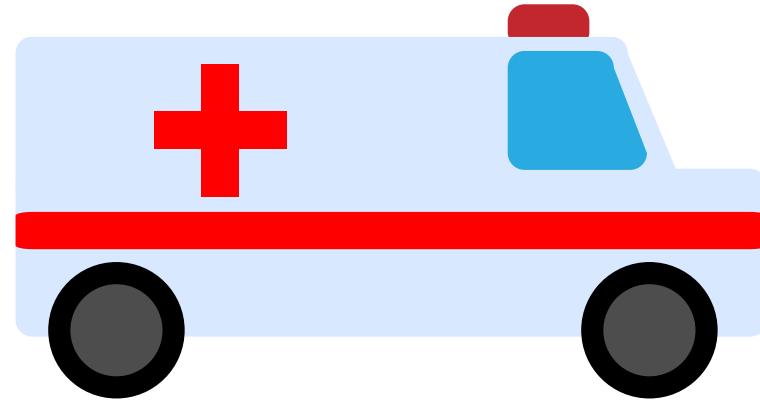
# Understanding safety concepts:



**Hazard**



**Risk**



**Incident**



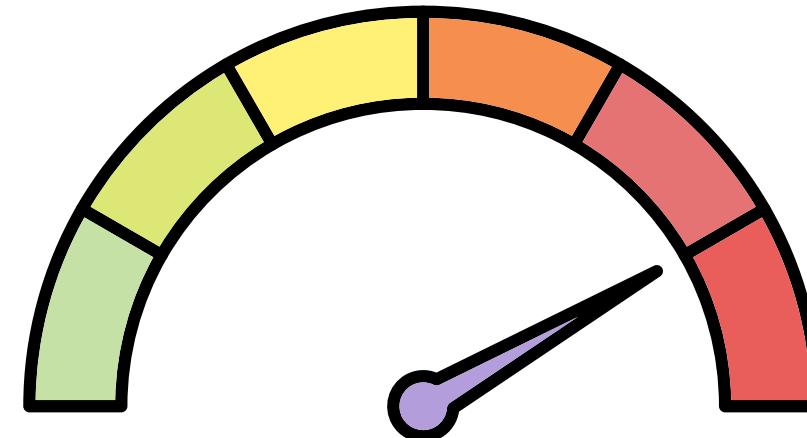
# Understanding safety concepts:



## Hazard

Source of potential harm

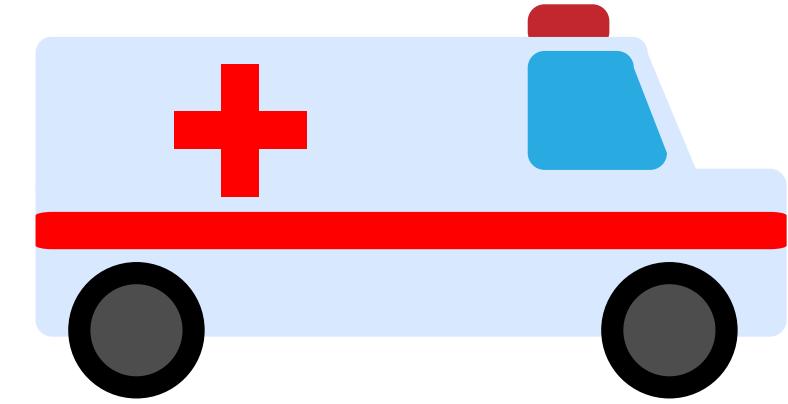
*ex: Loss of control*



## Risk

Likelihood x Severity

*ex: The likelihood of a drone falling and the severity of its impact.*



## Incident

Realisation of a hazard

*ex: The drone falls & kills someone*

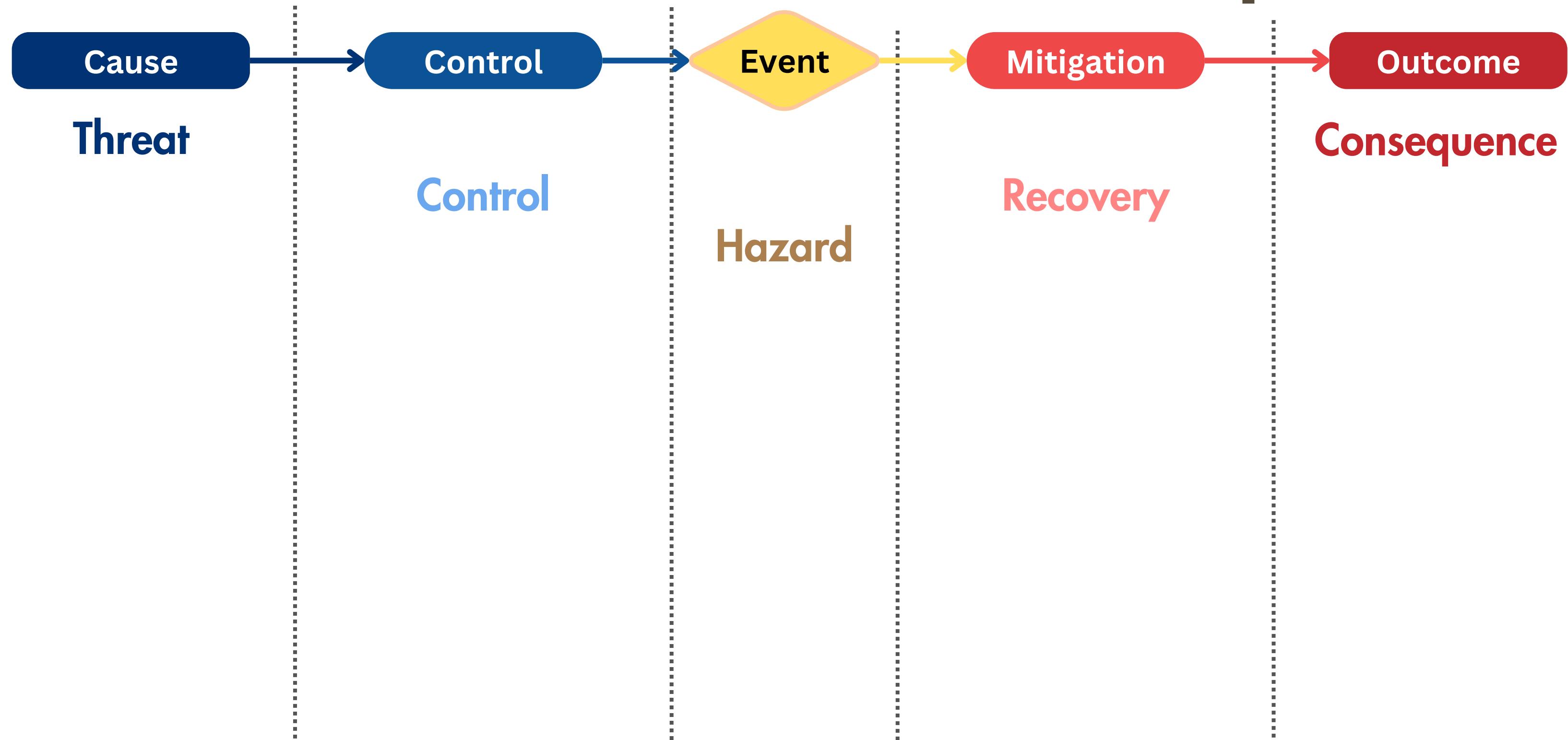


# The Bowtie Model: From Risk to Impact



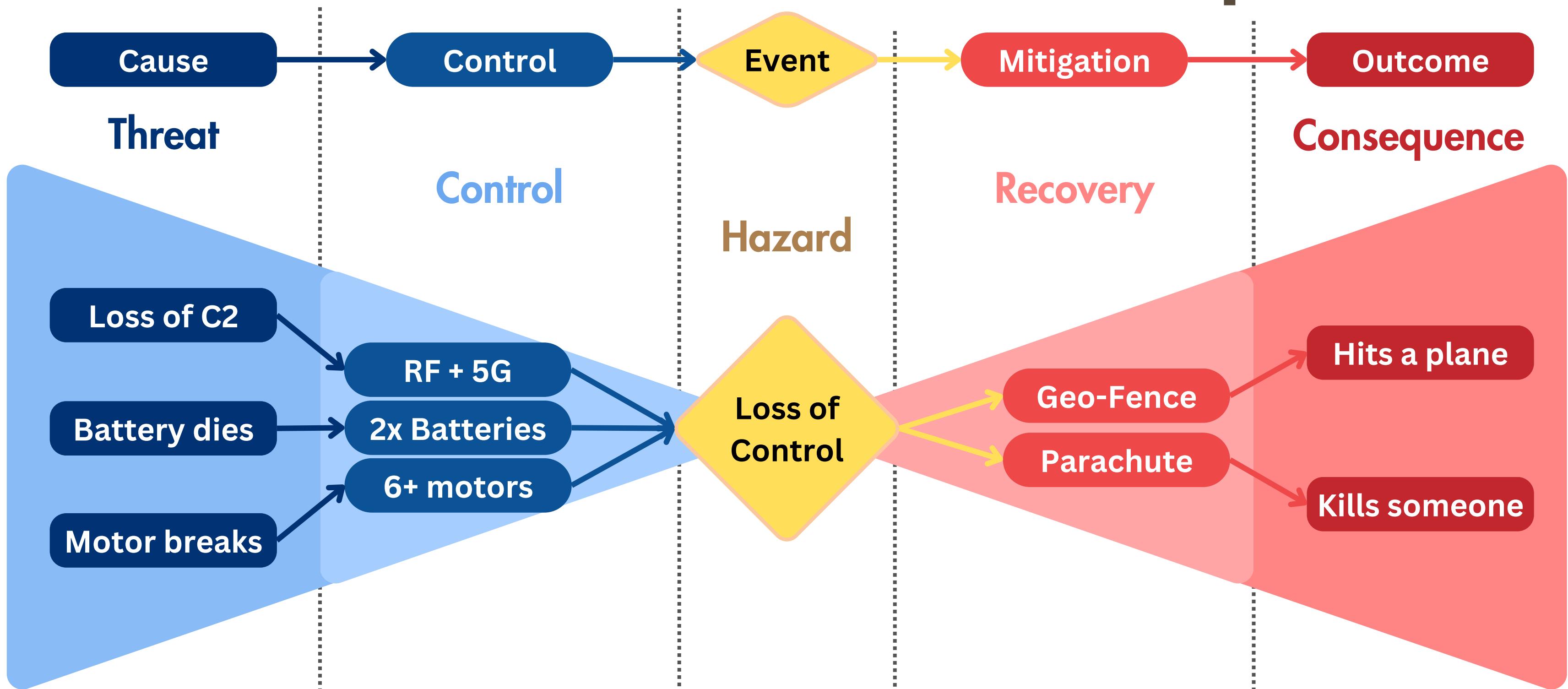


# The Bowtie Model: From Risk to Impact





# The Bowtie Model: From Risk to Impact





# Risk Assessment Matrix

		Severity			
		Negligible	Marginal	Critical	Catastrophic
		Improbable	Low	Low	Medium
		Remote	Low	Medium	Serious
		Probable	Medium	Serious	Serious
		Frequent	Medium	Serious	High



# UAS Regulations



# Regulations in Kenya

- Category A (low risk)
- Category B (medium risk/regulated lower risk)
- Category C (high risk/manned aviation approach)

*Regulations can be found here:*

[www.kcaa.or.ke/safety-security-oversight/unmanned-aircraft-systems](http://www.kcaa.or.ke/safety-security-oversight/unmanned-aircraft-systems)





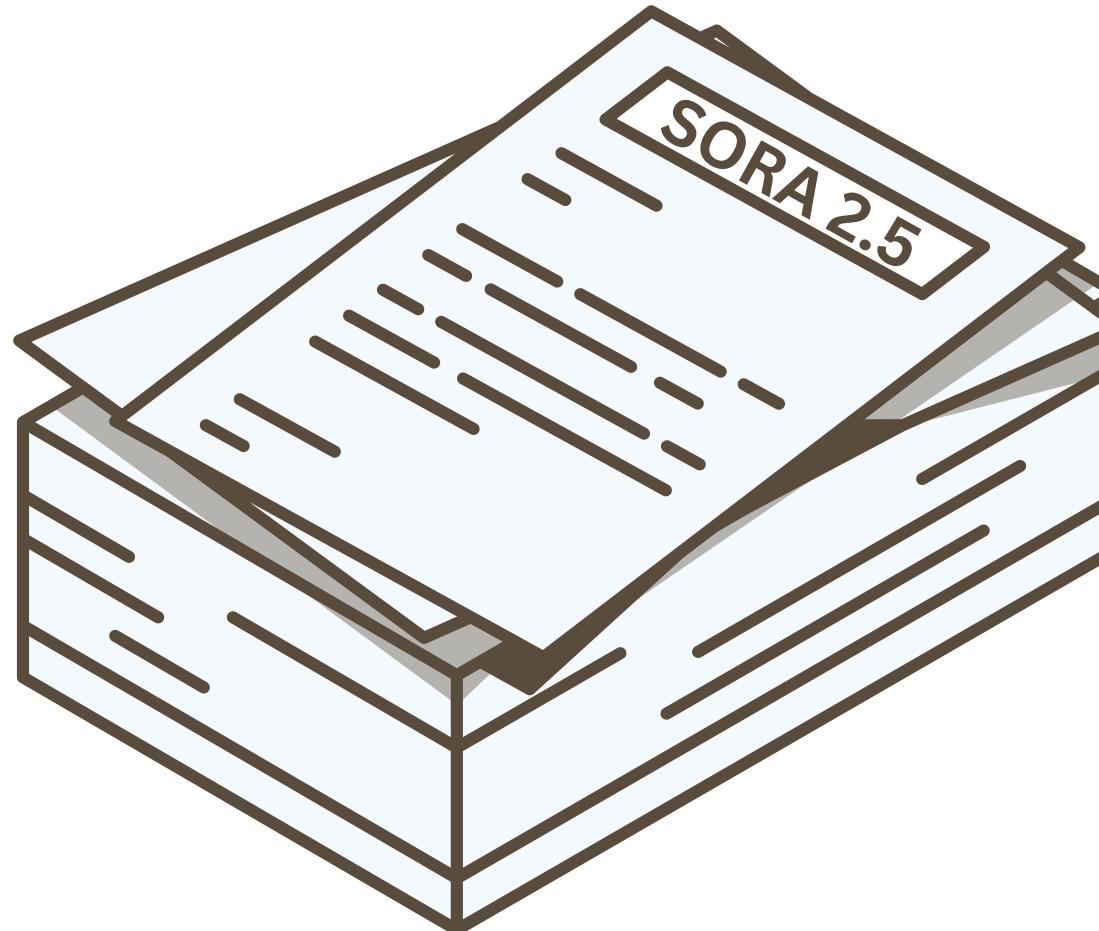
# Category A (low risk)

- Max altitude of **400 ft AGL** (Above Ground Level)
- Within **unassisted Visual Line of Sight** (VLoS ~500m)
- Min **50 m from uninvolved** people, vehicles, property
- Only in **segregated airspace**
- Max **25Kg MTOW** (Maximum Take-Off Weight)
- **RPA certificate**
- *All drones must be **registered***
- *The drone must be **marked** (display registration number)*
- **Insurance** might be required





# Specific Operation Risk Assessment (SORA)



Publication date: 13/5/24



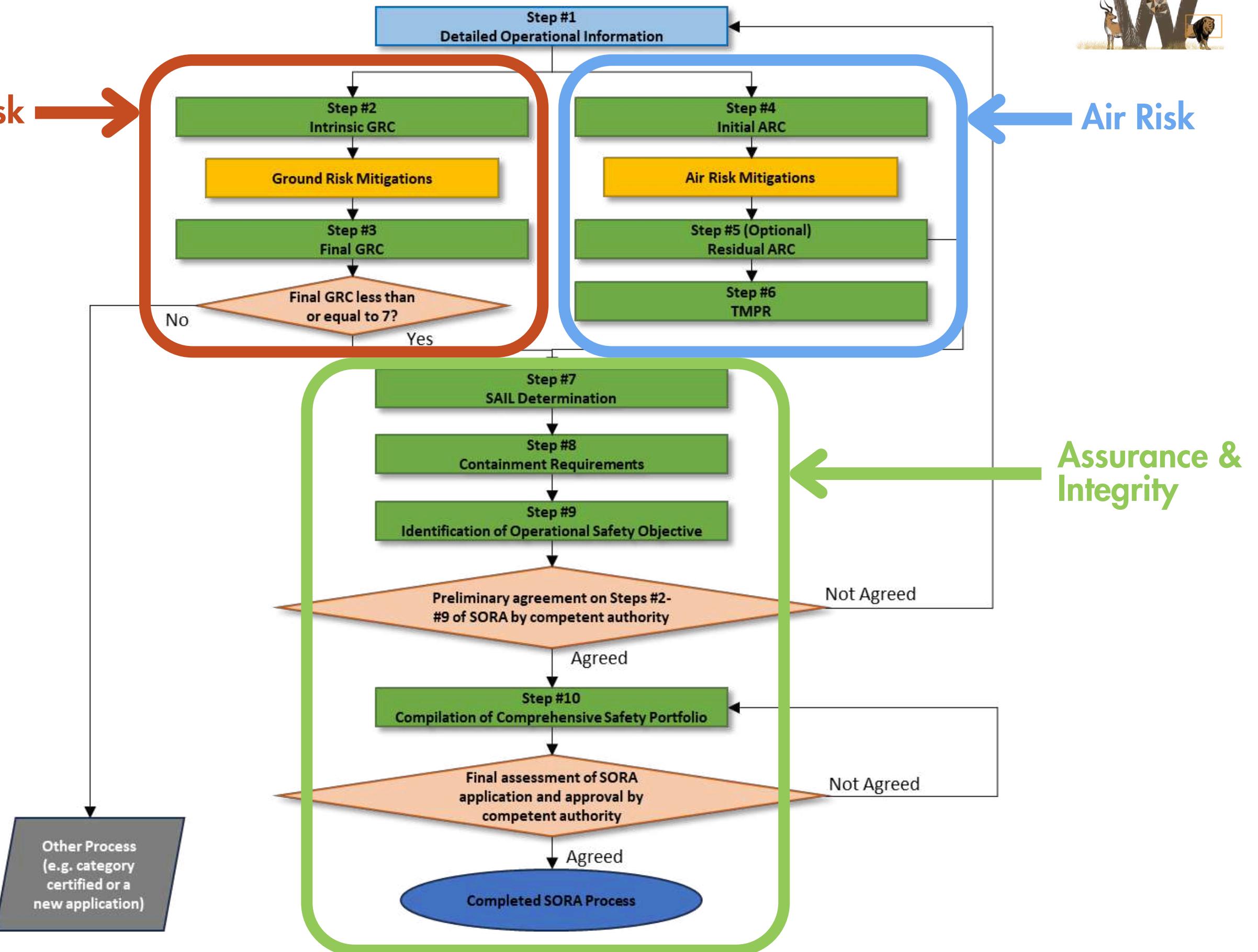
**Joint Authorities for  
Rulemaking on Unmanned  
Systems**

[jarus-rpas.org](http://jarus-rpas.org)



# SORA Methodology

**Ground Risk** →





# Example

## Mission:

The WildDrone team need to **study animals** at the Ol Pejeta Conservancy.

In order to be safe, and to efficiently gather data, they **need to fly BVLOS**.

Help the WildDrone team **carry a risk assessment** of the BVLOS operations that they will submit to the KCAA.





# 1- Documentation of Proposed Operations

**What you want to do?**

**Where you want to fly?**

**Which UAS you intend to use?**



# 1- Documentation of Proposed Operations

**What you want to do?**

BVLOS for wildlife conservation

**Where you want to fly?**

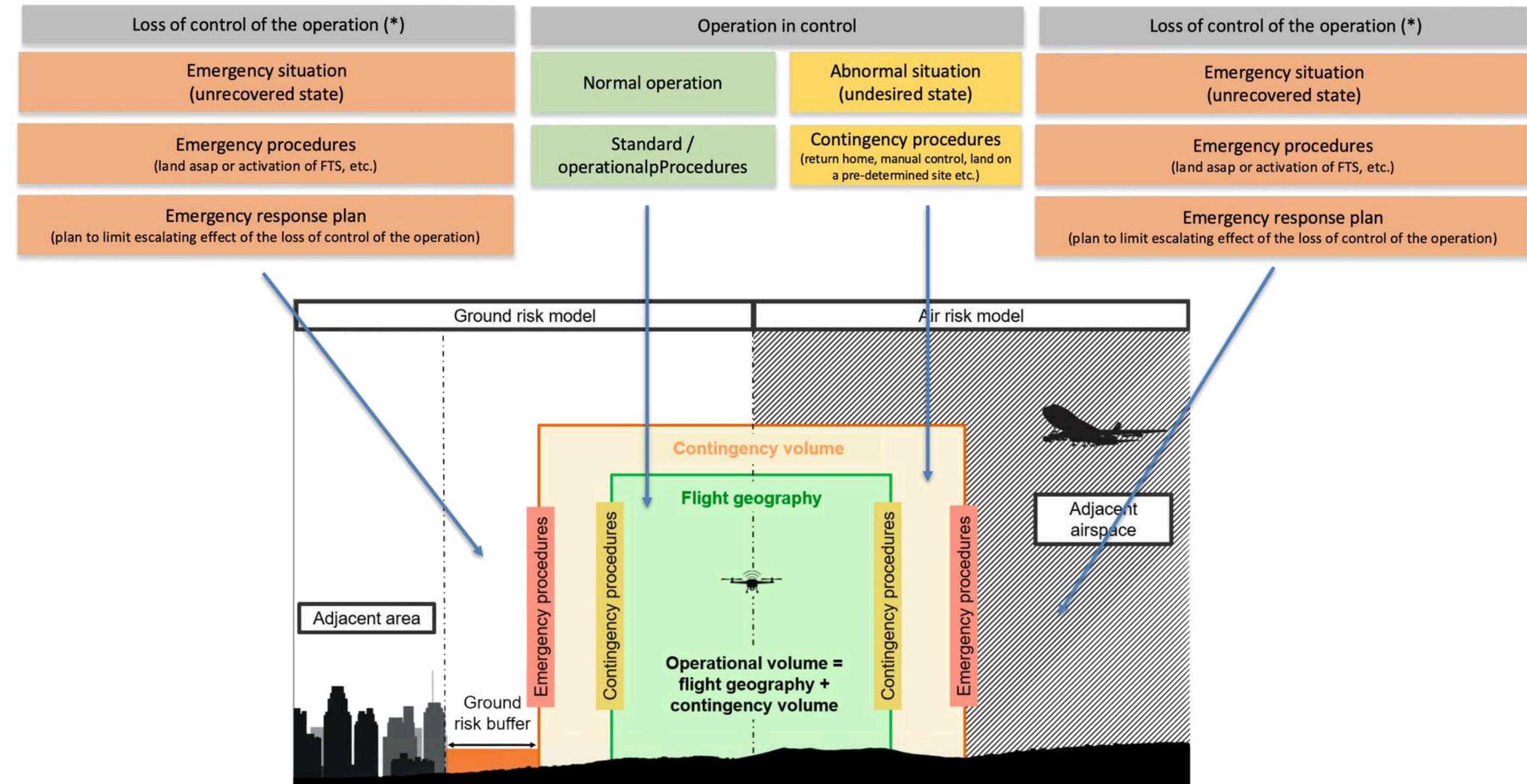
Ol Pejeta Conservancy, Kenya

**Which UAS you intend to use?**

DJI Mavic 3 Pro

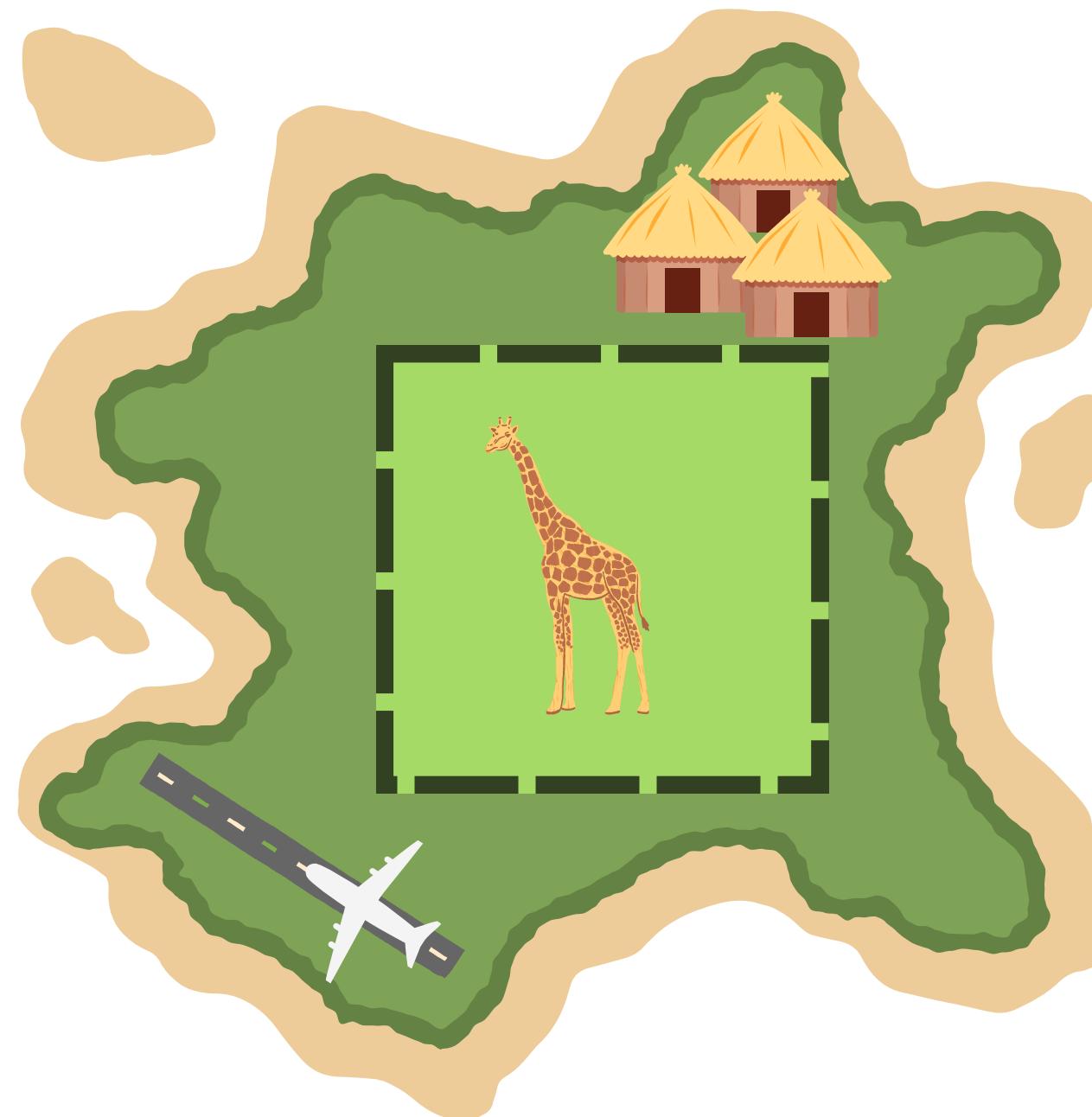


# SORA semantic model

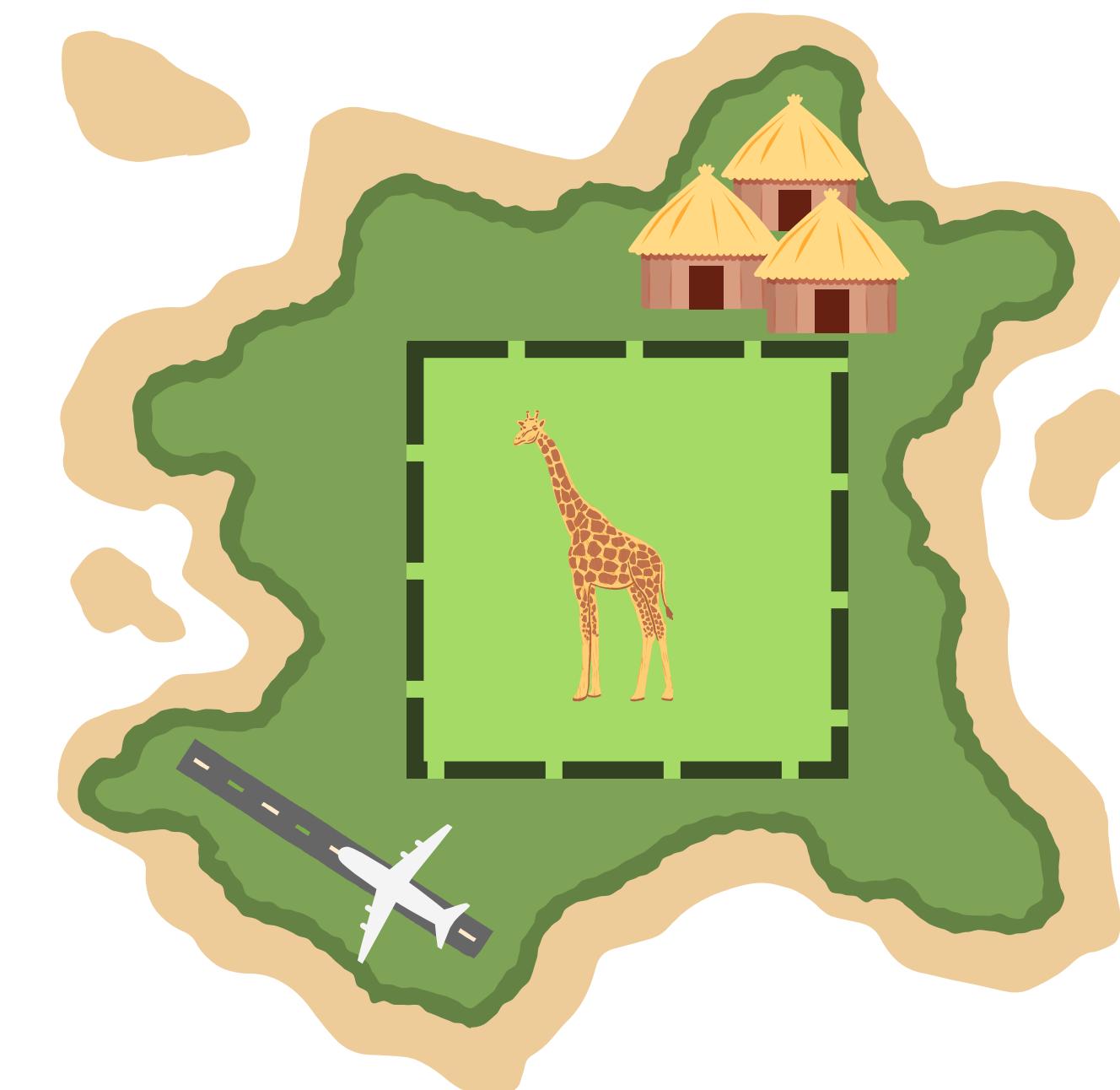




# Top-down vs Bottom up approach



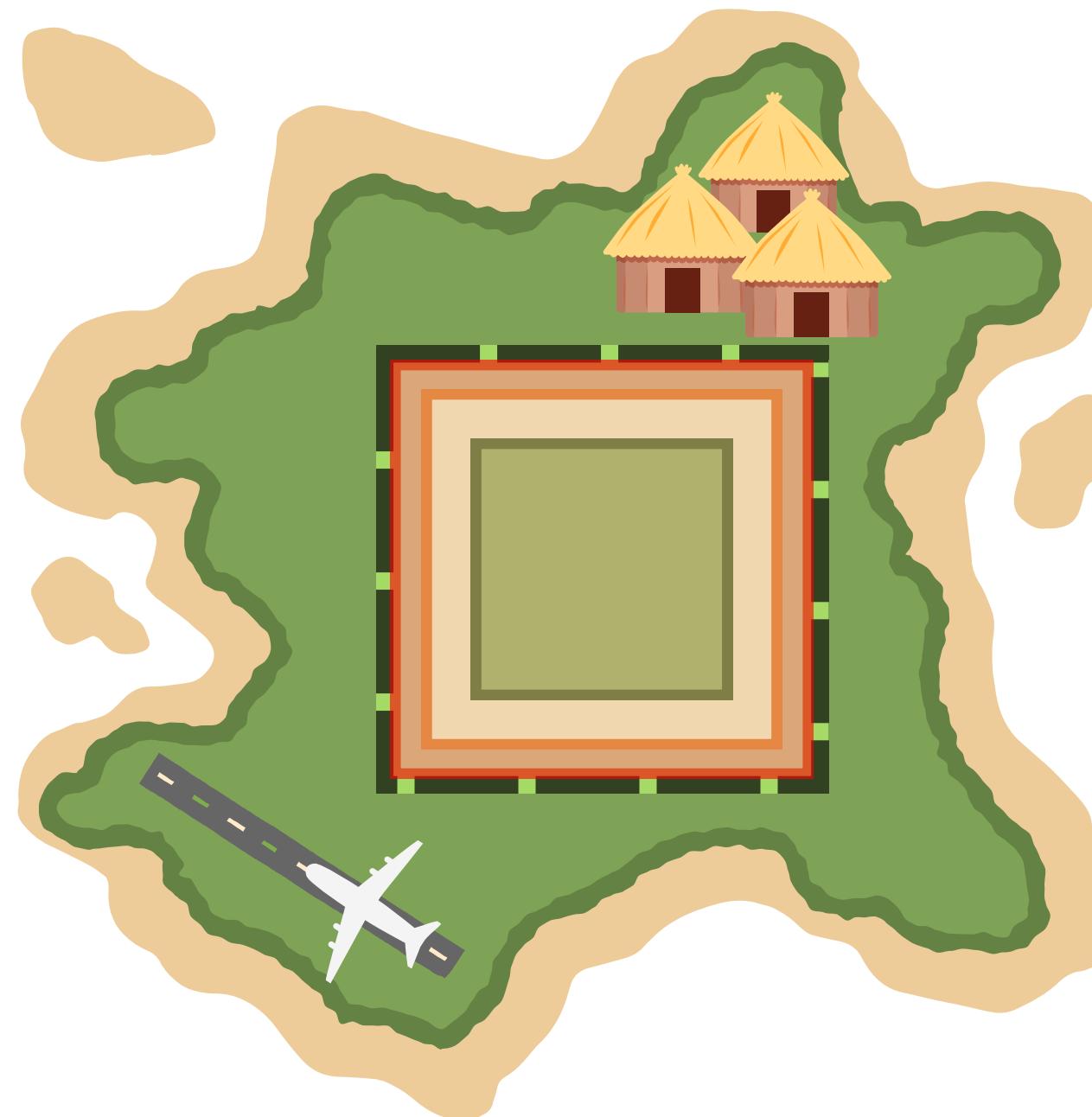
Top-down



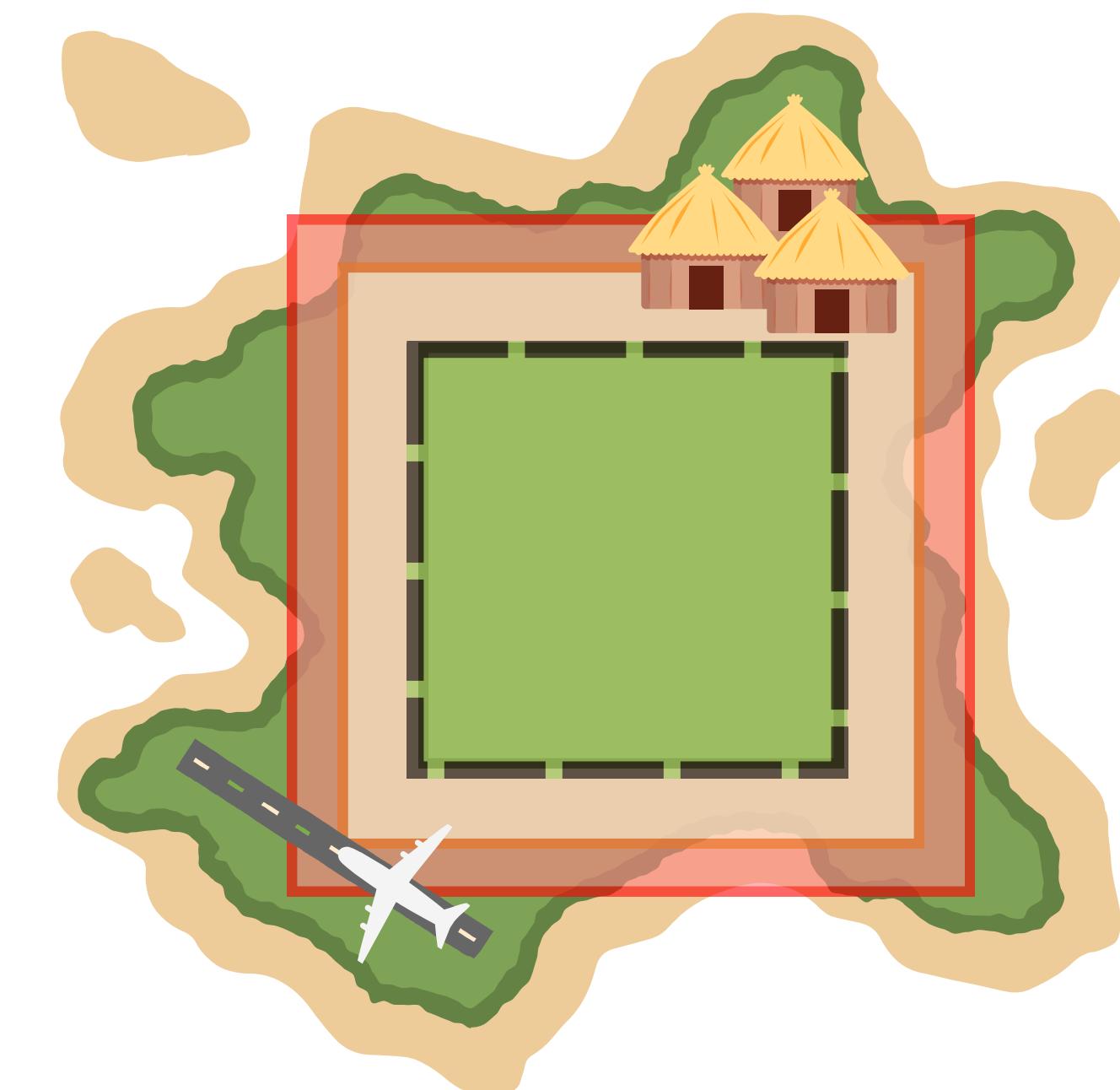
Bottom-up



# Top-down vs Bottom up approach



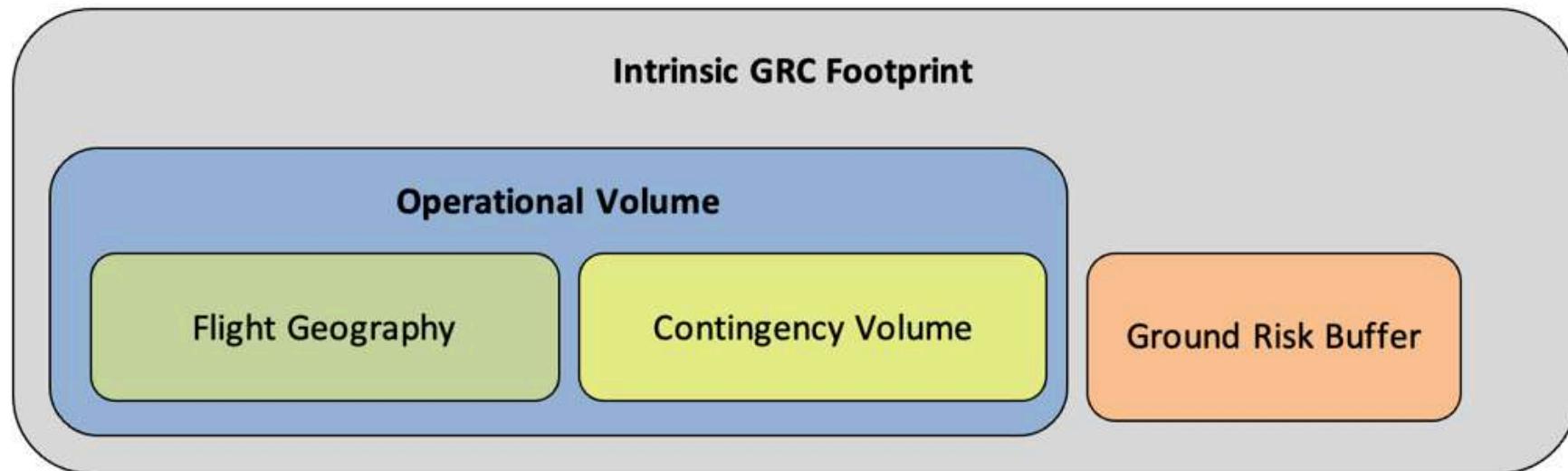
Top-down



Bottom-up



# 2- intrinsic Ground Risk Class (iGRC)



**Alternatively, use the equations described in Annex F  
(python package, online calculator)**

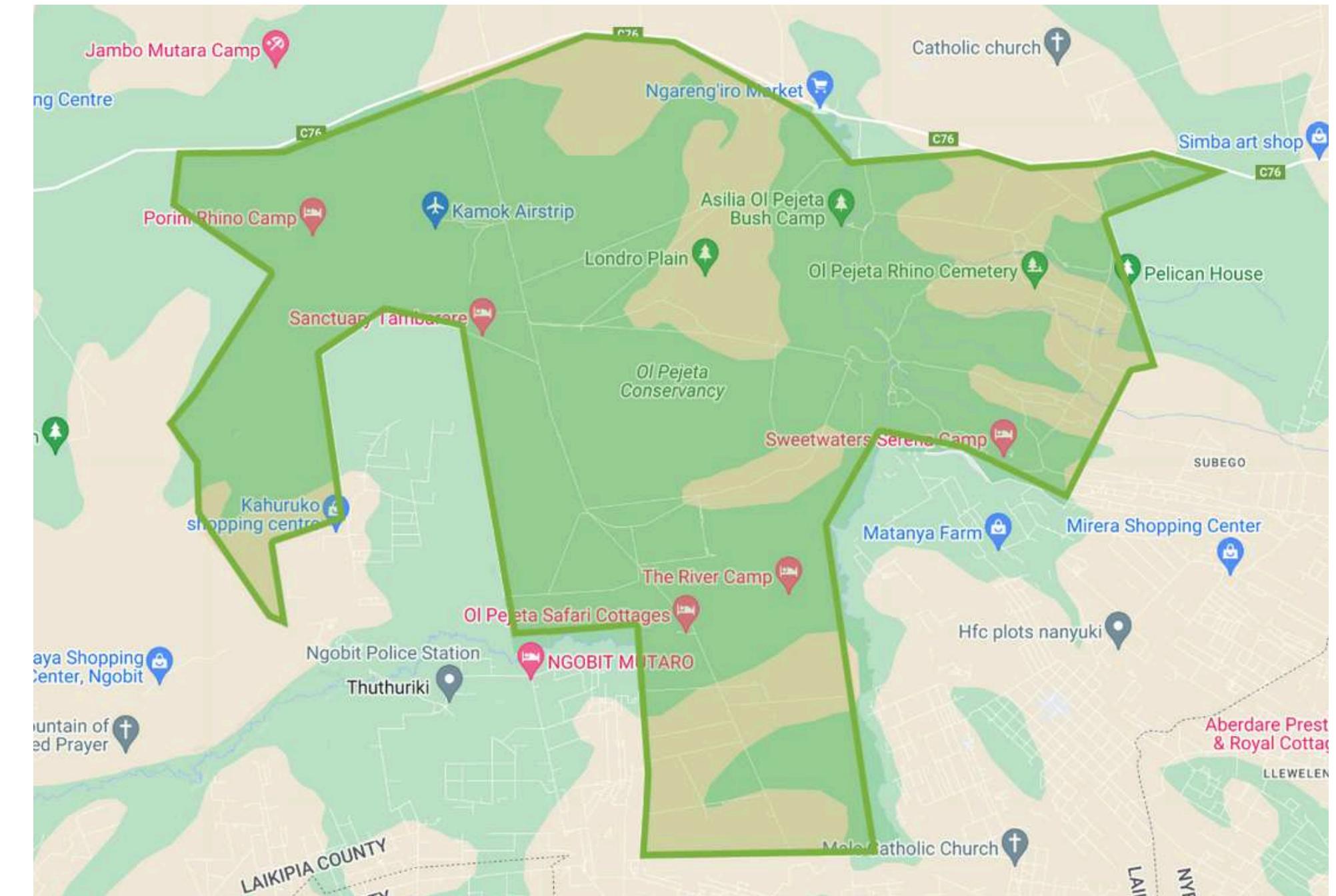
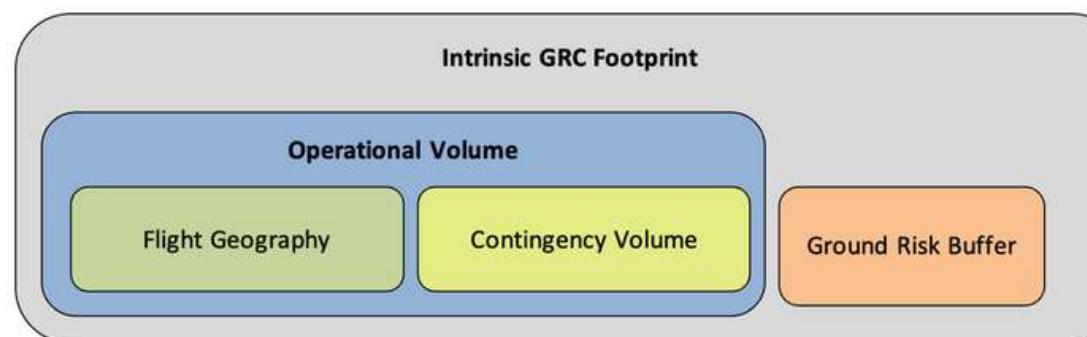
		Intrinsic UAS Ground Risk Class					
Maximum UA characteristic dimension		1m / approx. 3 ft	3 m / approx. 10 ft	8 m / approx. 25 ft	20 m / approx. 65 ft	40 m / approx. 130 ft	
Maximum speed		25 m/s	35 m/s	75 m/s	120 m/s	200 m/s	
Maximum iGRC population density (people/km <sup>2</sup> )	Controlled Ground Area	1	1	2	3	3	
	< 5	2	3	4	5	6	
	< 50	3	4	5	6	7	
	< 500	4	5	6	7	8	
	< 5,000	5	6	7	8	9	
	< 50,000	6	7	8	9	10	
	> 50,000	7	8	Not part of SORA			

- A UA weighing less than or equal to 250 g and having a maximum speed less than or equal to 25 m/s is considered to have an iGRC of 1 regardless of population density.
- A UA expected to not penetrate a standard dwelling will get a -1 GRC reduction in Step 3 from the M1(A) sheltering mitigation when not overflying large open assemblies of people, see Annex B for additional details.



# Step 2: iGRC

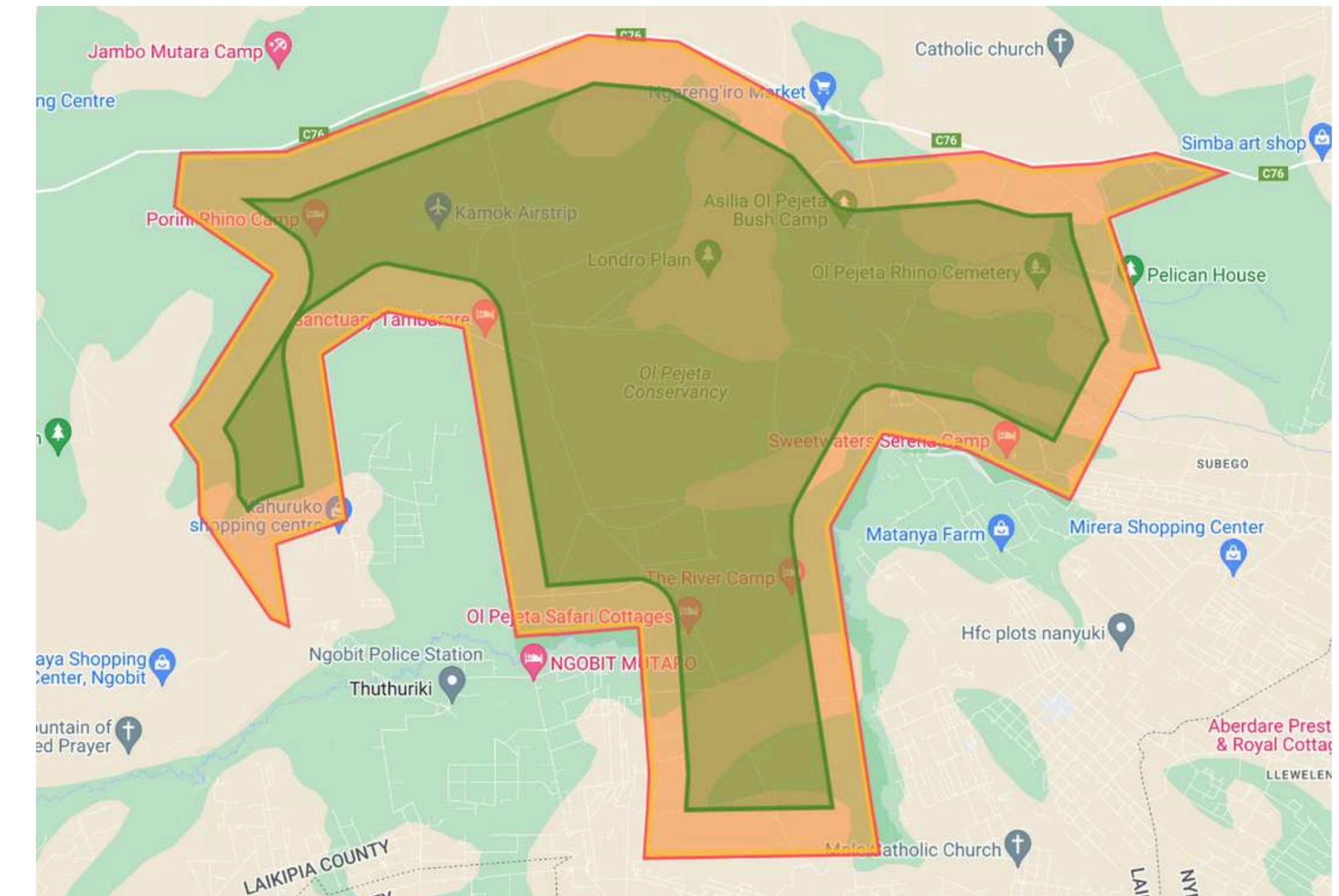
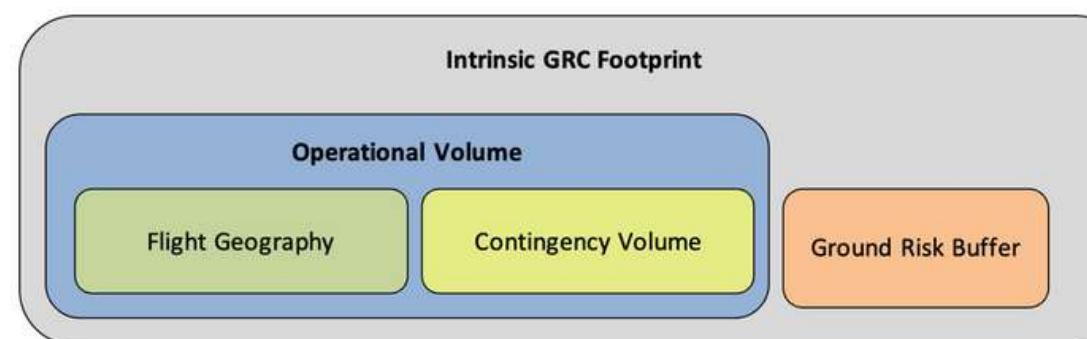
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# Step 2: iGRC

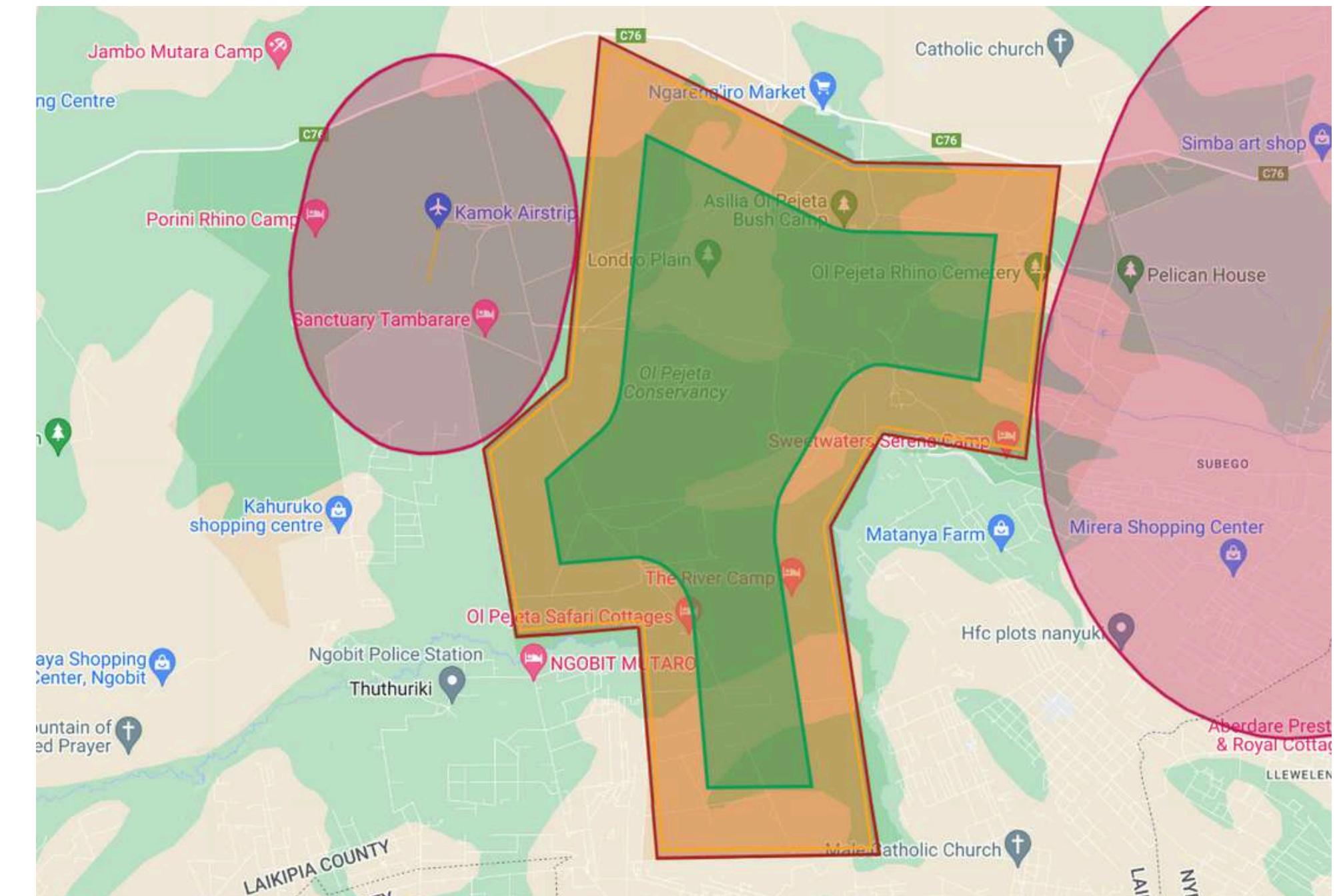
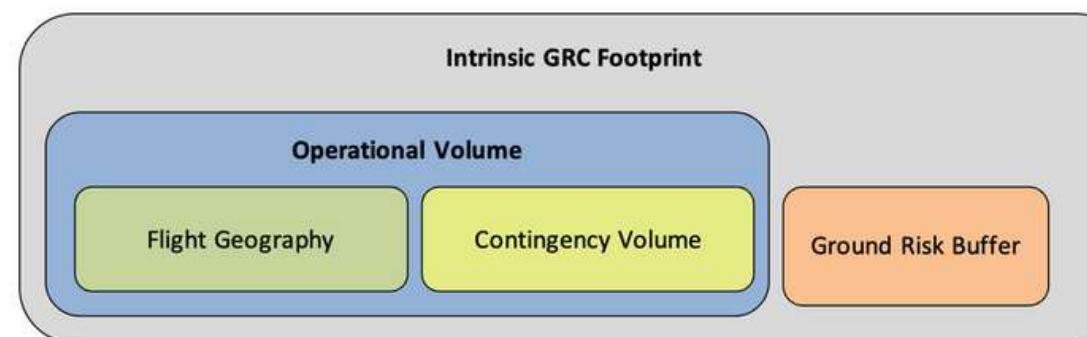
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# Step 2: iGRC

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# 3- Final Ground Risk Class (GRC)

<b>Mitigations for ground risk</b>	<b>Level of Robustness</b>		
	<b>Low</b>	<b>Medium</b>	<b>High</b>
M1(A) - Strategic mitigations - Sheltering	-1	-2	N/A
M1(B) - Strategic mitigations - Operational restrictions	N/A	-1	-2
M1(C) - Tactical mitigations - Ground observation	-1	N/A	N/A
M2 - Effects of UA impact dynamics are reduced	N/A	-1	-2



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M1(C) - Tactical mitigations - Ground observation	-1	N/A	N/A
M2 - Effects of UA impact dynamics are reduced	N/A	-1	-2

- No overflight of camps & lodges
- Perpendicular road crossings



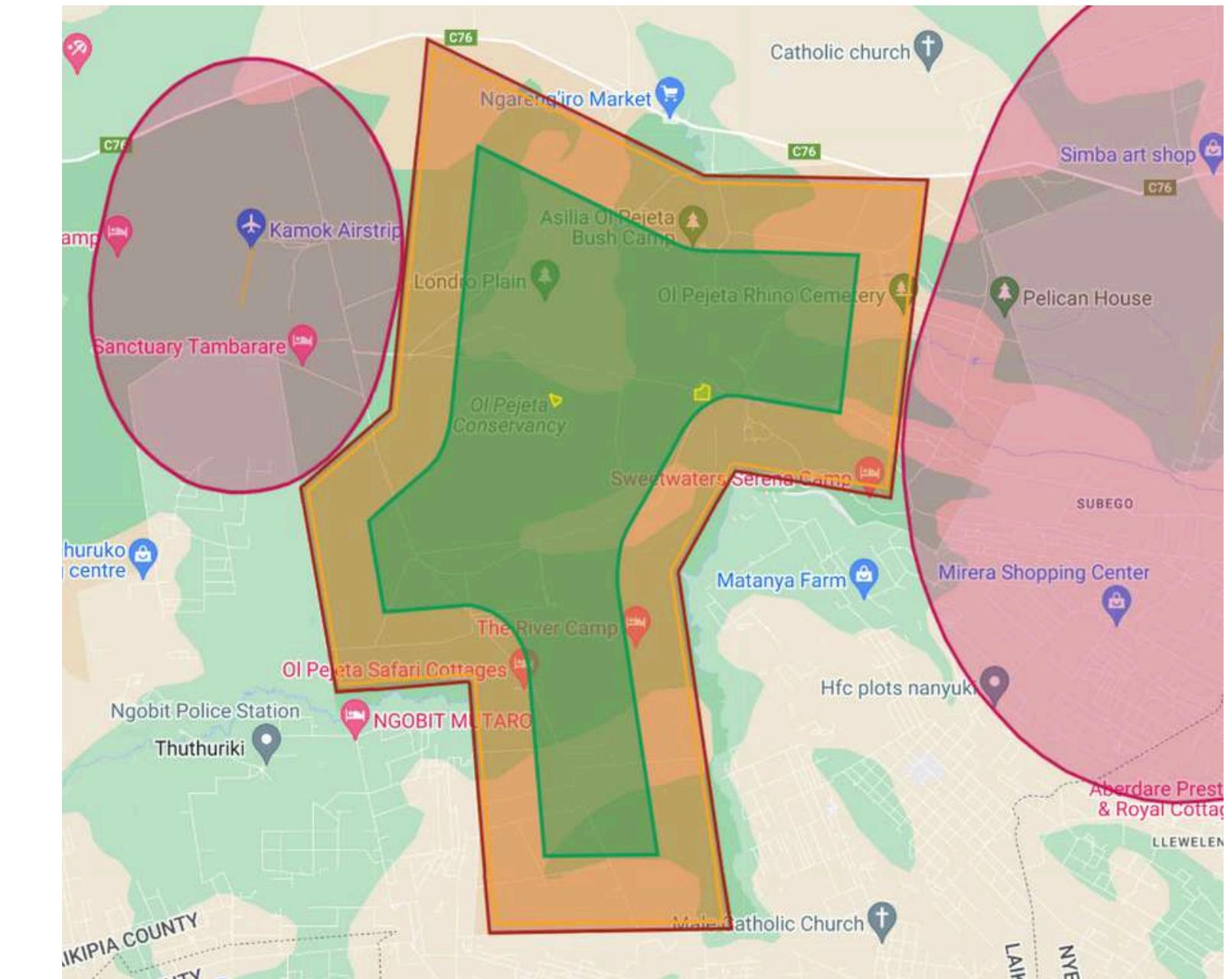
Campgrounds & Lodges



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**WILDDRONE**

# 4- Initial Air Risk Class (iARC)

## 1- Rural area

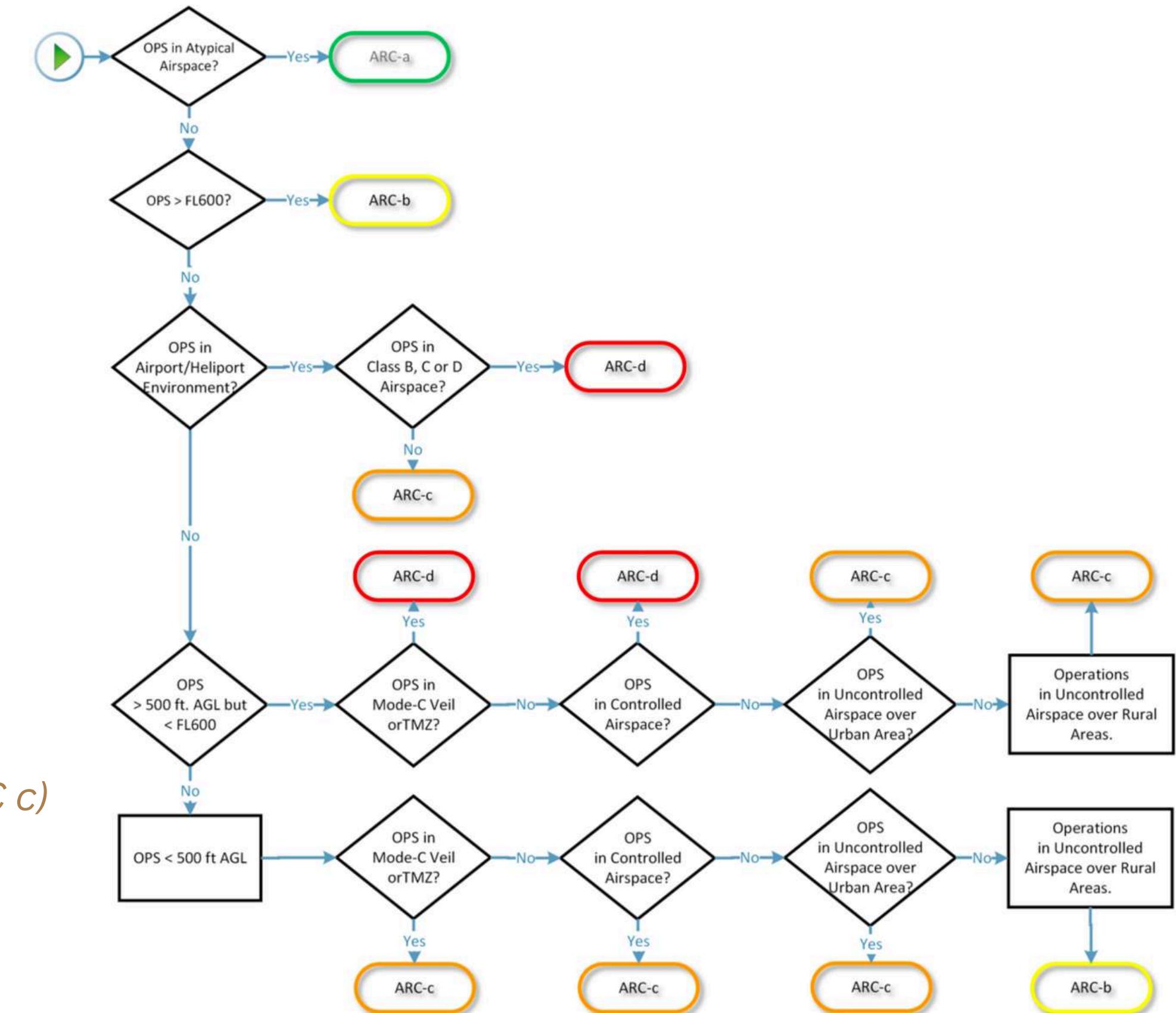
*Medium encounter rate above 150m (ARC c),  
lower below 150m (ARC b)*

## 2- Urban area

*Medium encounter rate even at low level (ARC c)*

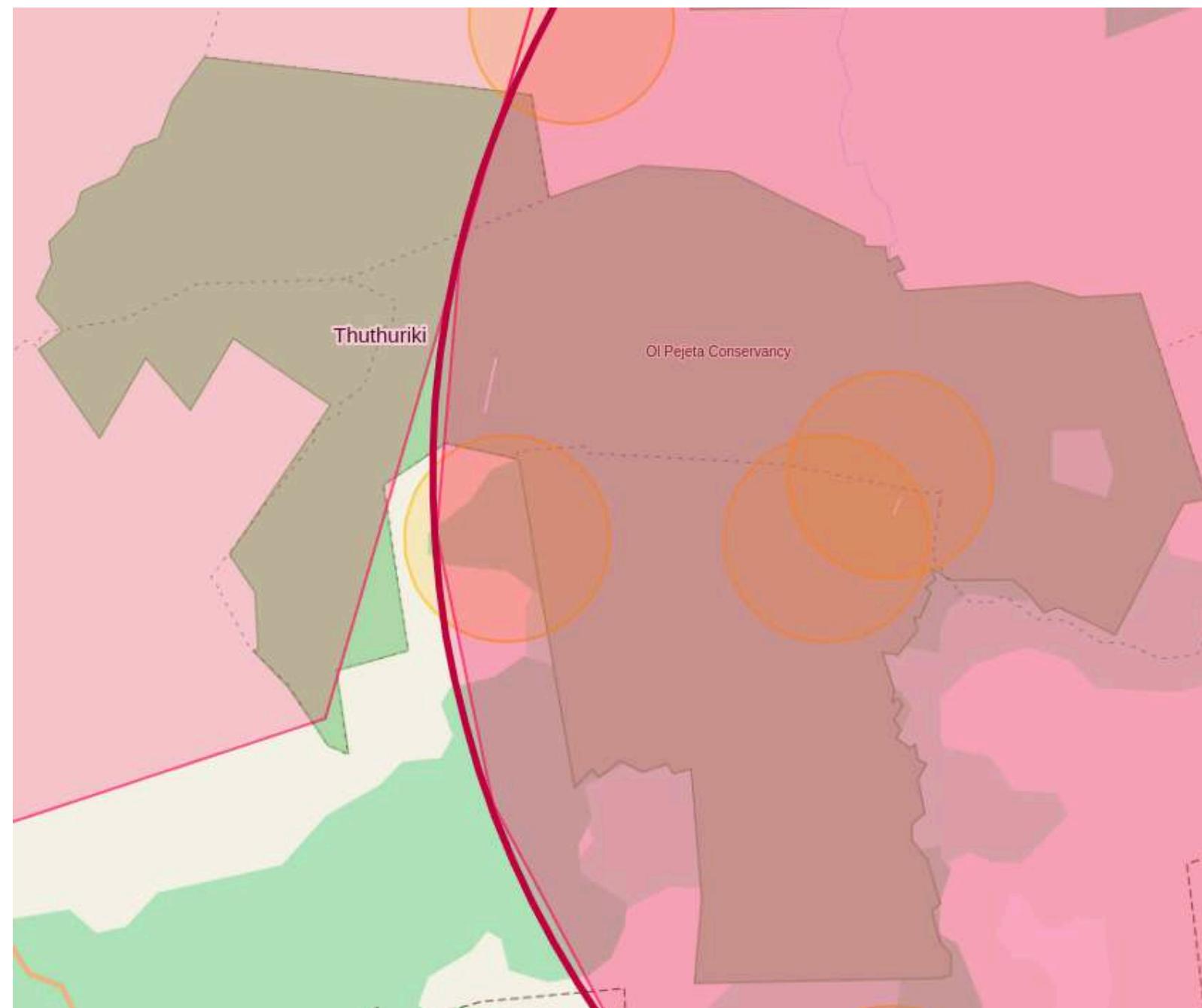
## 3- Proximity of airport

*Very high encounter rate (ARC d)*





# 4- Initial Air Risk Class (iARC)



## WHERE YOU CLICKED



AIRSPACE : Prohibited Area  
HKP2 NANYUKI

## SUMMARY

Red zones are regulated high-risk areas and operation of your drone may be hazardous or prohibited.

## VERTICAL LIMITS

This piece of airspace is in effect between Surface and 99900ft SPS

## PROHIBITED AREA

The flight of aircraft within this area is prohibited. Danger, Prohibited and Restricted Areas are defined according to ICAO International Standards. Regulations governing the flight of drones vary from country-to-country, therefore these areas are included for your information. It is your responsibility to check the applicability of any local, state and/or national laws and regulations which may permit or otherwise restrict the operation of your drone in this area. Unless regulations in your region explicitly permit the operation of your drone in this area, we recommend you do not operate your drone here.



**WILDDRONE**

# 4- Initial Air Risk Class (iARC)

## 1- Rural area

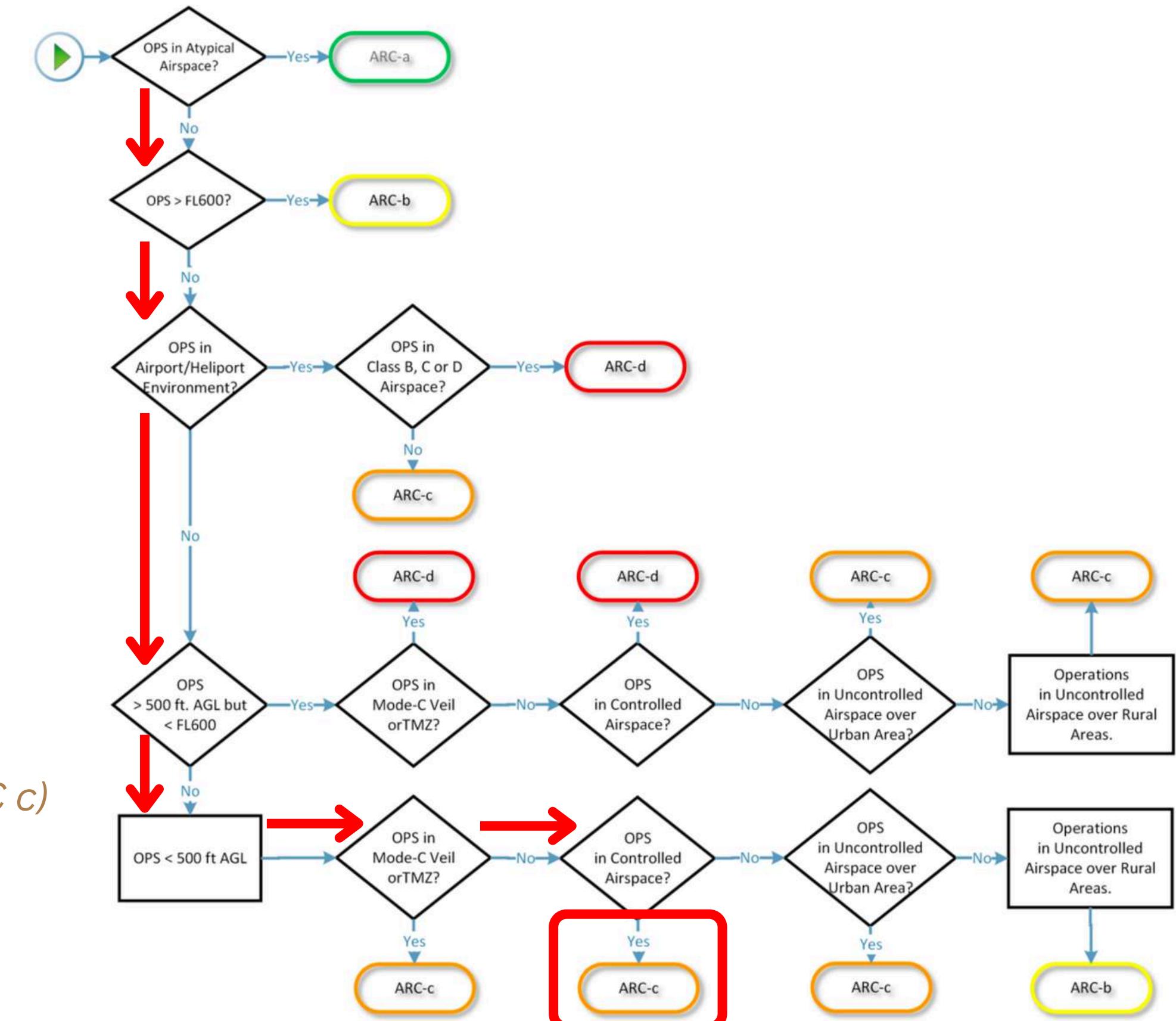
*Medium encounter rate above 150m (ARC c),  
lower below 150m (ARC b)*

## 2- Urban area

*Medium encounter rate even at low level (ARC c)*

## 3- Proximity of airport

*Very high encounter rate (ARC d)*





# 5- Strategic Mitigations

## 1. Operational Restrictions

- a. Boundary (i.e., low-altitude)
- b. Chronology (i.e., time of day)
- c. Exposure (i.e., high risk for a limited time)

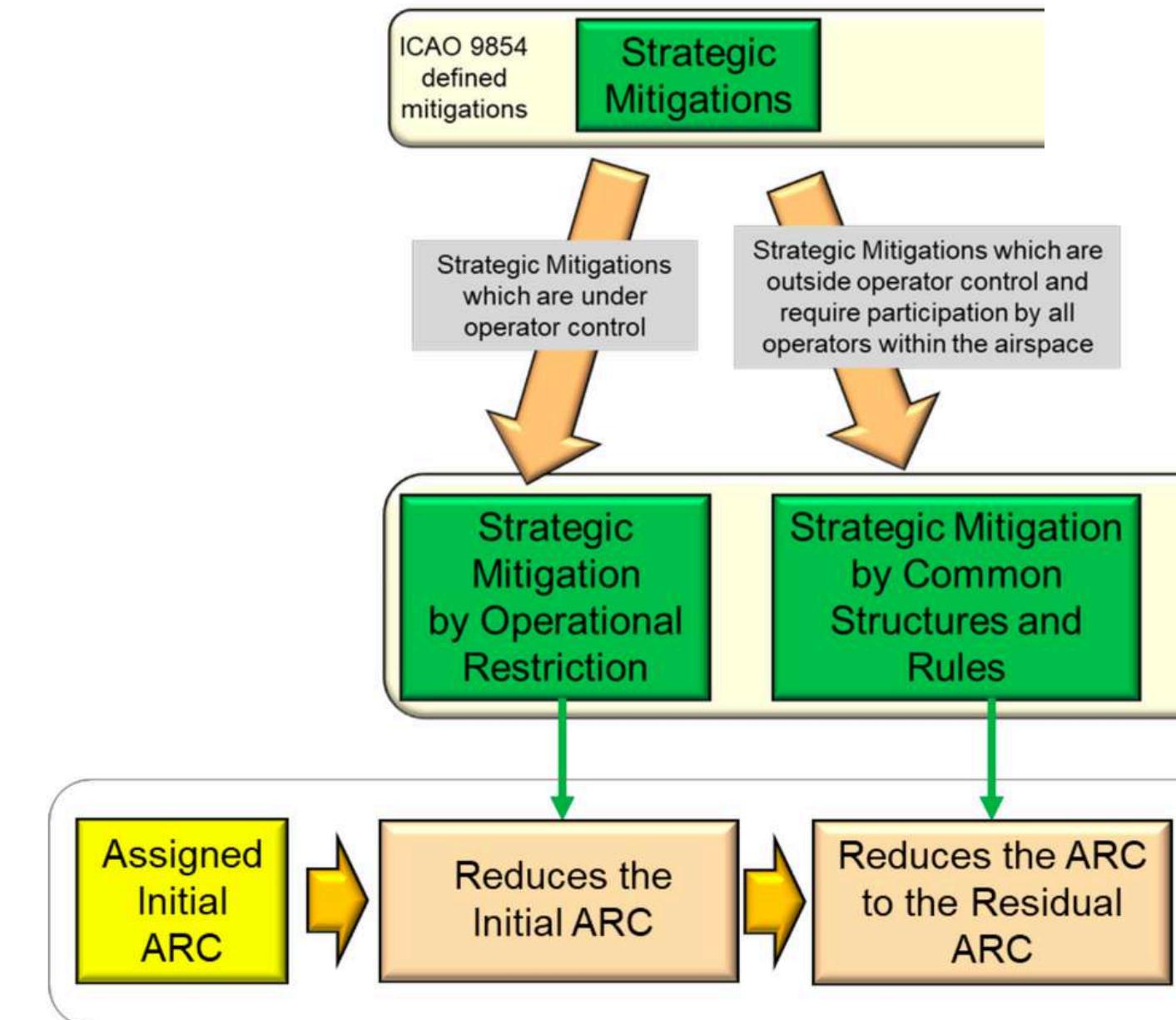
## 2.1. Common rules

- a. Electronic conspicuity
- b. Anti-collision lighting
- c. File a flight path (UTM/ANSP/...)

## 2.2. Airspace structures

- a. Drone corridors
- b. Procedural controls by UTM (take-off windows, reporting points, ...)

Strategic Mitigations are applied prior to takeoff and do not require a mitigating feedback loop





# 5- Strategic Mitigations

## 1. Operational Restrictions

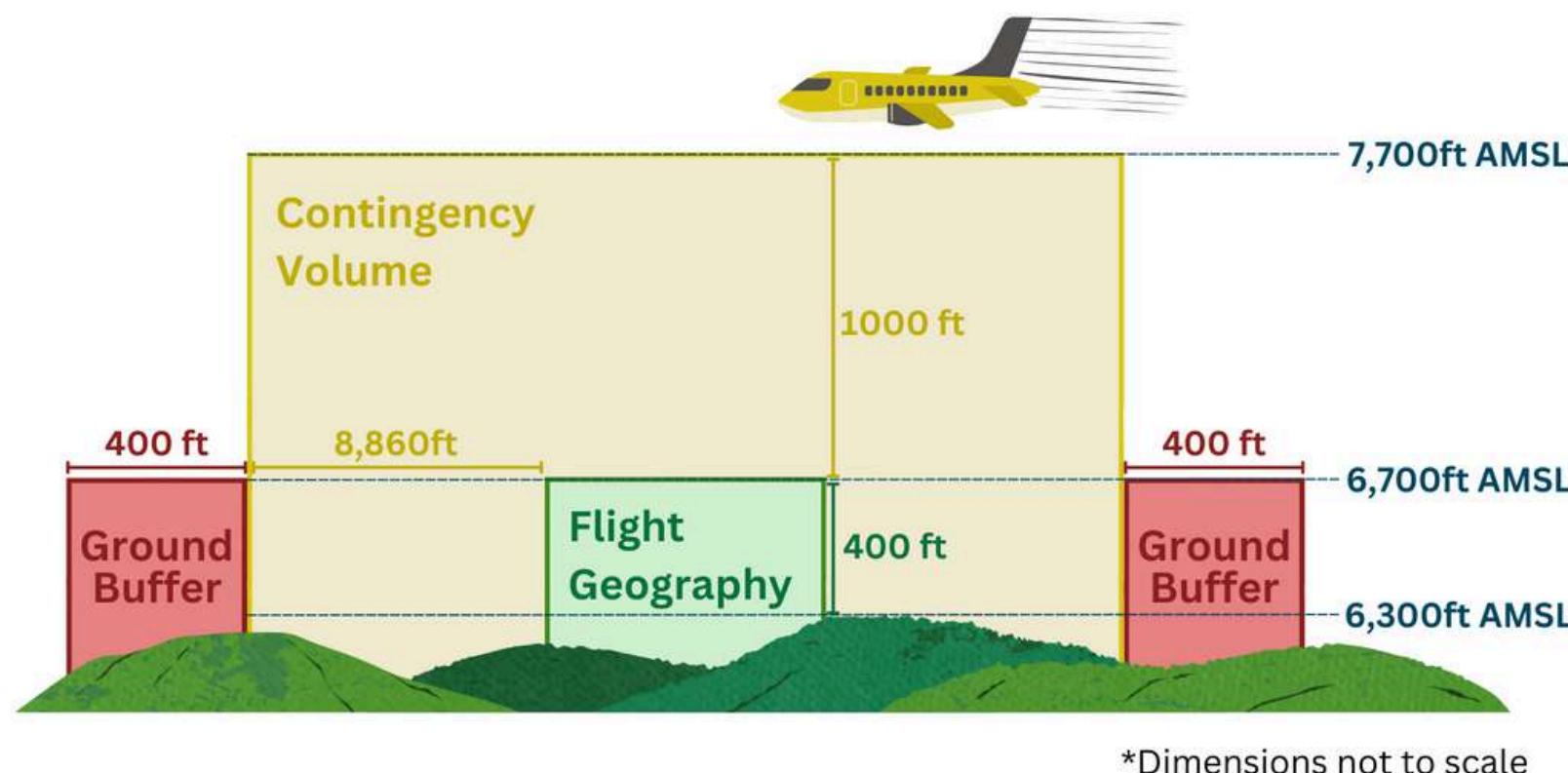
- a. Boundary (i.e., low-altitude) **Set flight-ceiling + buffer with ATC**
- b. Chronology (i.e., time of day)
- c. Exposure (i.e., high risk for a limited time)

## 2.1. Common rules

- a. Electronic conspicuity
- b. Anti-collision lighting
- c. File a flight path (UTM/ANSP/...)

## 2.2. Airspace structures

- a. Drone corridors
- b. Procedural controls by UTM (take-off windows, reporting points, ...)





# 5- Strategic Mitigations

## 1. Operational Restrictions

- a. Boundary (i.e., low-altitude) **Set flight-ceiling + buffer with ATC**
- b. Chronology (i.e., time of day) **5 km at night - 2 km during the day**
- c. Exposure (i.e., high risk for a limited time)

## 2.1. Common rules

- a. Electronic conspicuity
- b. Anti-collision lighting
- c. File a flight path (UTM/ANSP/...)

## 2.2. Airspace structures

- a. Drone corridors
- b. Procedural controls by UTM (take-off windows, reporting points, ...)





# 5- Strategic Mitigations

## 1. Operational Restrictions

- a. Boundary (i.e., low-altitude) **Set flight-ceiling + buffer with ATC**
- b. Chronology (i.e., time of day) **5 km at night - 2 km during the day**
- c. Exposure (i.e., high risk for a limited time)

## 2.1. Common rules

- a. Electronic conspicuity **Monitor ADS-B**
- b. Anti-collision lighting
- c. File a flight path (UTM/ANSP/...)

## 2.2. Airspace structures

- a. Drone corridors
- b. Procedural controls by UTM (take-off windows, reporting points, ...)





# 5- Strategic Mitigations

## 1. Operational Restrictions

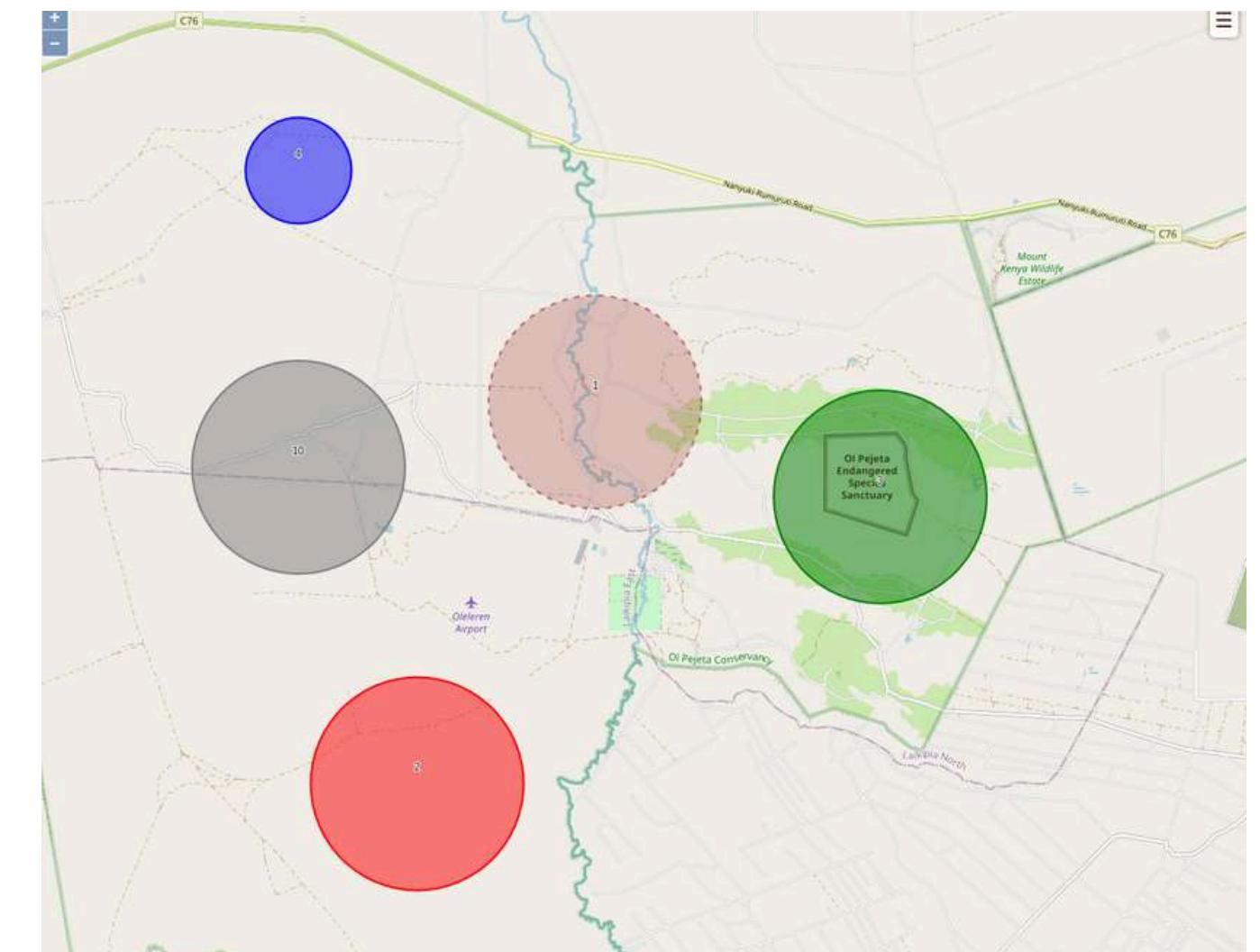
- a. Boundary (i.e., low-altitude) **Set flight-ceiling + buffer with ATC**
- b. Chronology (i.e., time of day) **5 km at night - 2 km during the day**
- ~~c. Exposure (i.e., high risk for a limited time)~~

## 2.1. Common rules

- a. Electronic conspicuity **Monitor ADS-B**
- ~~b. Anti-collision lighting~~
- c. File a flight path (UTM/ANSP/...) **Flight Cylinders**

## 2.2. Airspace structures

- a. Drone corridors
- b. Procedural controls by UTM (take-off windows, reporting points, ...)





# 5- Strategic Mitigations

## 1. Operational Restrictions

- a. Boundary (i.e., low-altitude) Set flight-ceiling + buffer with ATC
- b. Chronology (i.e., time of day) 5 km at night - 2 km during the day
- ~~c. Exposure (i.e., high risk for a limited time)~~

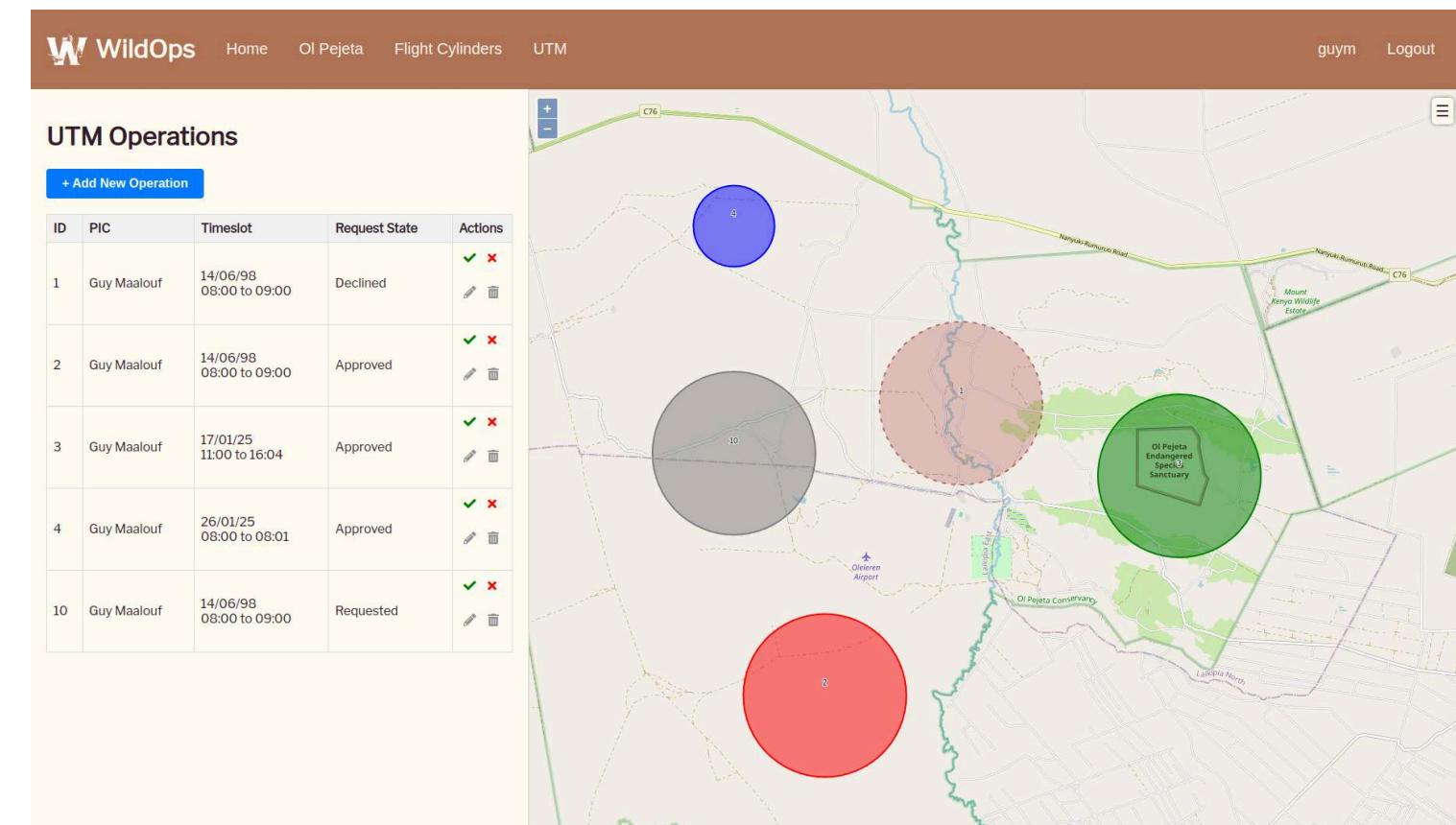
## 2.1. Common rules

- a. Electronic conspicuity Monitor ADS-B
- ~~b. Anti-collision lighting~~
- c. File a flight path (UTM/ANSP/...) Flight Cylinders

## 2.2. Airspace structures

- ~~a. Drone corridors~~
- b. Procedural controls by UTM (take-off windows, reporting points, ...) Flight Windows

ID	PIC	Timeslot	Request State	Actions
1	Guy Maalouf	14/06/98 08:00 to 09:00	Declined	✓ ✗
2	Guy Maalouf	14/06/98 08:00 to 09:00	Approved	✓ ✗
3	Guy Maalouf	17/01/25 11:00 to 16:04	Approved	✓ ✗
4	Guy Maalouf	26/01/25 08:00 to 08:01	Approved	✓ ✗
10	Guy Maalouf	14/06/98 08:00 to 09:00	Requested	✓ ✗





# 5- Strategic Mitigations

## 1. Operational Restrictions

- a. Boundary (i.e., low-altitude) Set flight-ceiling + buffer with ATC
- b. Chronology (i.e., time of day) 5 km at night - 2 km during the day
- ~~c. Exposure (i.e., high risk for a limited time)~~

## 2.1. Common rules

- a. Electronic conspicuity Monitor ADS-B
- ~~b. Anti-collision lighting~~
- c. File a flight path (UTM/ANSP/...) Flight Cylinders

## 2.2. Airspace structures

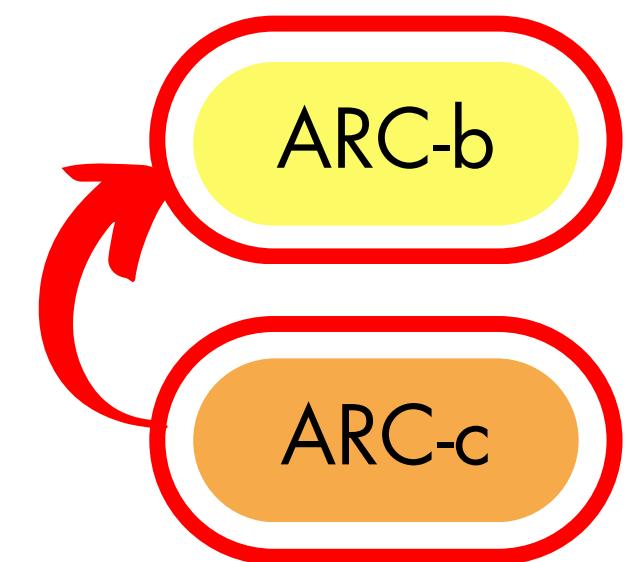
- ~~a. Drone corridors~~
- b. Procedural controls by UTM (take-off windows, reporting points, ...) Flight Windows

ARC-a

ARC-b

ARC-c

ARC-d

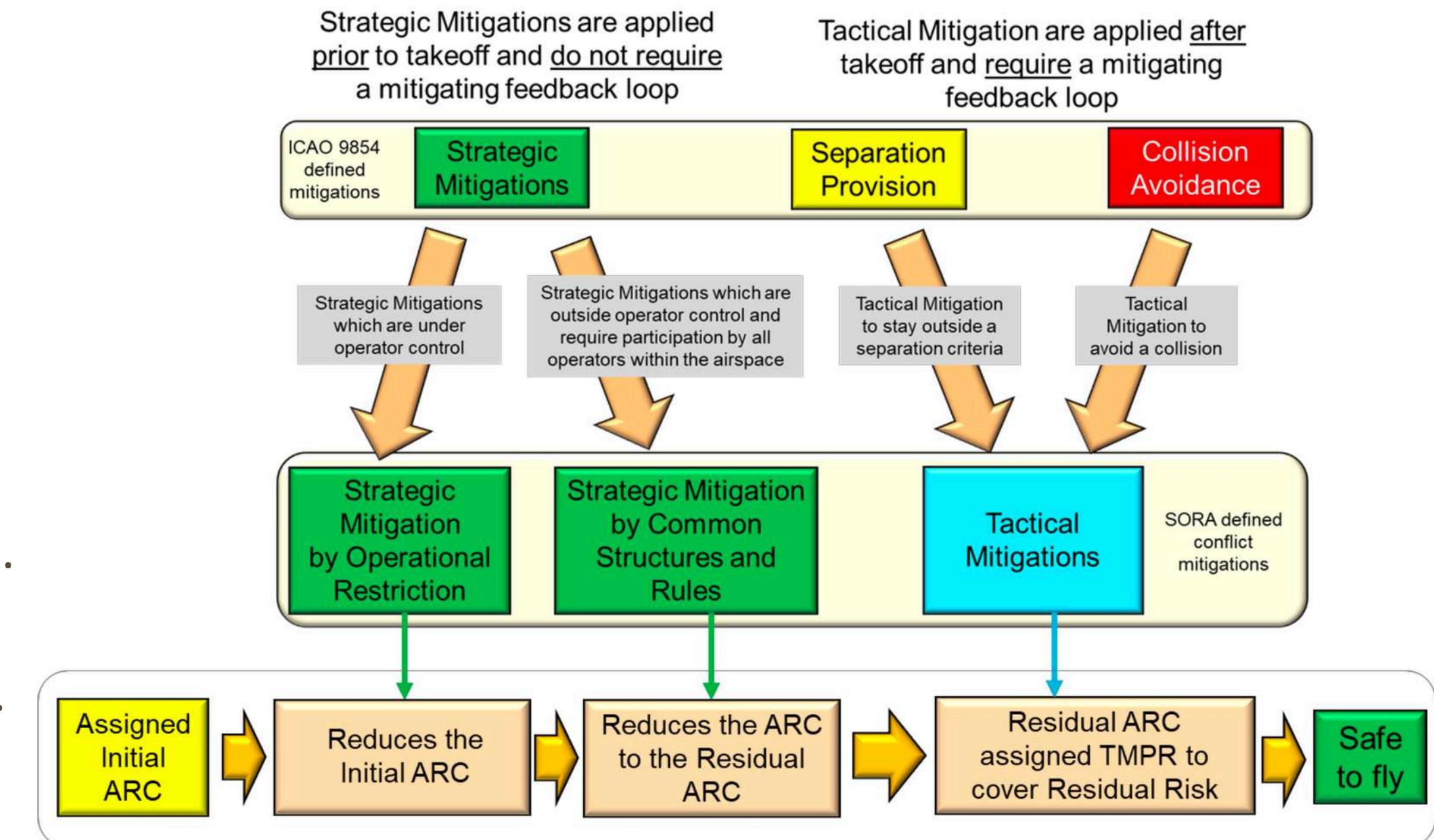




# 6- Tactical Mitigations

## Performance Requirements (TMPR)

- 1. Detect** other aircraft.
- 2. Decide** how to separate.
- 3. Command** the UA.
- 4. Execute** the separation.
- 5. Feedback loop.**





# 6- Tactical Mitigations

## Performance Requirements (TMPR)

- 1. Detect other aircraft.**
- 2. Decide how to separate.**
- 3. Command the UA.**
- 4. Execute the separation.**
- 5. Feedback loop.**

	Function	TMPR Level				
		VLOS	No Requirement (ARC-a)	Low (ARC-b)	Medium (ARC-c)	High (ARC-d)
Tactical Mitigation Performance Requirements (TMPR)	Detect <sup>1</sup>	No Requirement	No Requirement	<p>The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 50% of all aircraft in the detection volume<sup>2</sup>. This is the performance requirement in absence of failures and defaults.</p> <p>It is required that the applicant has awareness of most of the traffic operating in the area in which the operator intends to fly, by relying on one or more of the following:</p> <ul style="list-style-type: none"> <li>• Use of (web-based) real time aircraft tracking services</li> <li>• Use Low Cost ADS-B In /UAT/FLARM<sup>3</sup>/Pilot Aware<sup>3</sup> aircraft trackers</li> <li>• Use of UTM Dynamic Geofencing<sup>4</sup></li> <li>• Monitoring aeronautical radio communication (i.e. use of a scanner)<sup>5</sup></li> </ul>	<p>The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 90% of all aircraft in the detection volume<sup>2</sup>. To accomplish this, the applicant will have to rely on one or a combination of the following systems or services:</p> <ul style="list-style-type: none"> <li>• Ground based DAA /RADAR</li> <li>• FLARM<sup>3/6</sup></li> <li>• Pilot Aware<sup>3/6</sup></li> <li>• ADS-B In/ UAT In Receiver<sup>6</sup></li> <li>• ATC Separation Services<sup>7</sup></li> <li>• UTM Surveillance Service<sup>4</sup></li> <li>• UTM Early Conflict Detection and Resolution Service<sup>4</sup></li> <li>• Active communication with ATC and other airspace users<sup>5</sup>.</li> </ul> <p>The operator provides an assessment of the effectiveness of the detection tools/methods chosen.</p>	A system meeting RTCA SC-228 or EUROCAE WG-105 MOPS/MASPS (or similar) and installed in accordance with applicable requirements.





# Step 6: TMPRs

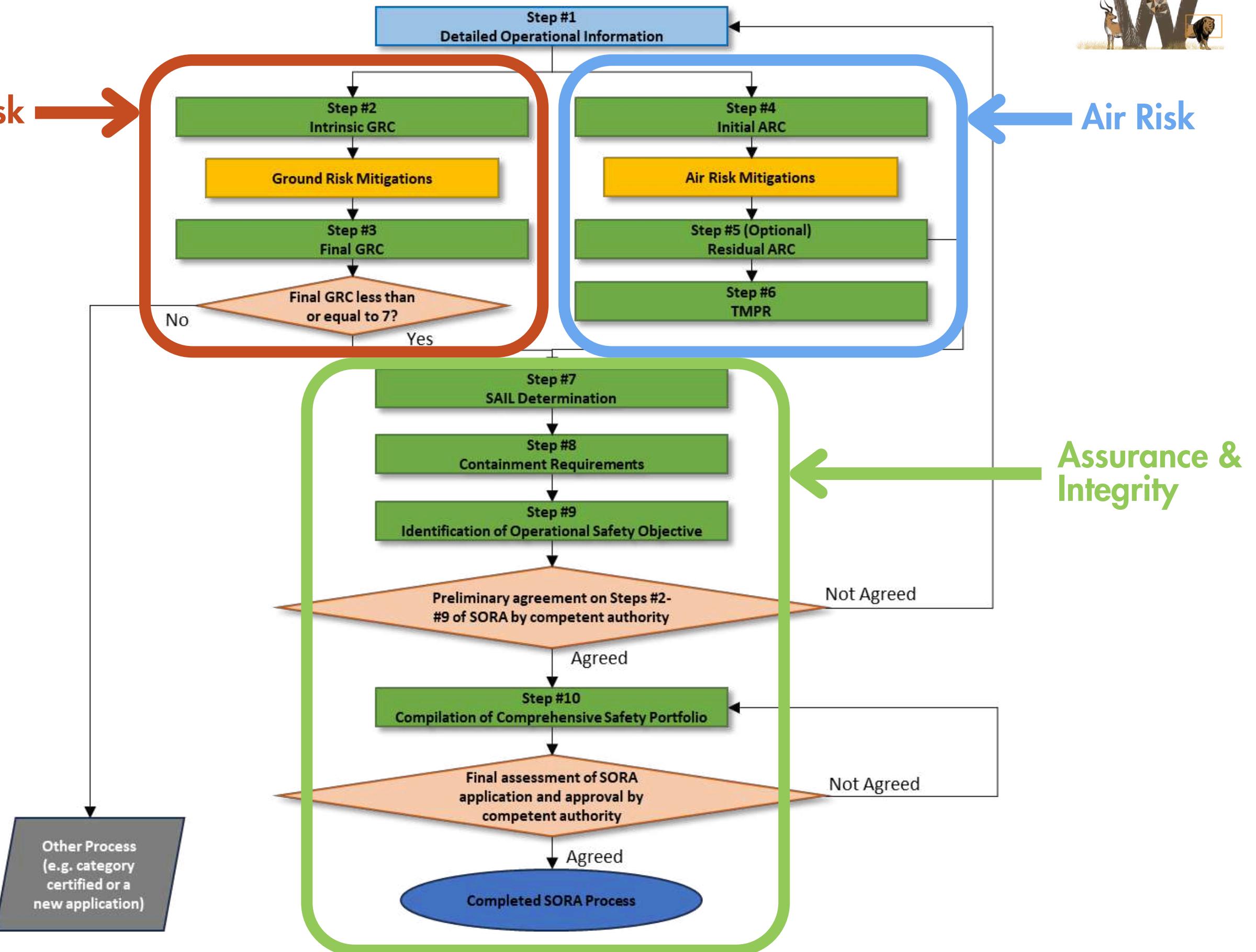
Detect	Decide	Command	Execute	Feedback loop
Low (ARC-b)	Low (ARC-b)	Low (ARC-b)	Low (ARC-b)	Low (ARC-b)
<p>The expectation is for the applicant's DAA Plan to enable the operator to detect approximately 50% of all aircraft in the detection volume<sup>2</sup>. This is the performance requirement in absence of failures and defaults. It is required that the applicant has awareness of most of the traffic operating in the area in which the operator intends to fly, by relying on one or more of the following:</p> <ul style="list-style-type: none"> <li>• Use of (web-based) real time aircraft tracking services</li> <li>• Use Low Cost ADS-B In /UAT/FLARM<sup>3</sup>/Pilot Aware<sup>3</sup> aircraft trackers</li> <li>• Use of UTM Dynamic Geofencing<sup>4</sup></li> <li>• Monitoring aeronautical radio communication (i.e. use of a scanner)<sup>5</sup></li> </ul>	<p>The operator must have a documented de-confliction scheme, in which the operator explains which tools or methods will be used for detection and what the criteria are that will be applied for the decision to avoid incoming traffic. In case the remote pilot relies on detection by someone else, the use of phraseology will have to be described as well.</p> <p>Examples:</p> <ul style="list-style-type: none"> <li>• The operator will initiate a rapid descend if traffic is crossing an alert boundary and operating at less than 1000ft.</li> <li>• The observer monitoring traffic uses the phrase: 'DESCEND!, DESCEND!, DESCEND!'. </li> </ul>	<p>The latency of the whole command (C2) link, i.e. the time between the moment that the remote pilot gives the command and the airplane executes the command must not exceed 5 seconds.</p>	<p>UAS descending to an altitude not higher than the nearest trees, buildings or infrastructure or ≤ 60 feet AGL is considered sufficient. The aircraft should be able to descend from its operating altitude to the 'safe altitude' in less than a minute.</p>	<p>Where electronic means assist the remote pilot in detecting traffic, the information is provided with a latency and update rate for intruder data (e.g. position, speed, altitude, track) that support the decision criteria.</p> <p>For an assumed 3 NM threshold, a 5 second update rate and a latency of 10 seconds is considered adequate (see example below).</p>





# SORA Methodology

**Ground Risk** →





# 7- SAIL

(Specific Assurance  
and Integrity Levels)

The SAIL represents the **level of confidence** that the UAS operation **will stay under control**.

		SAIL Determination			
		Residual ARC			
		a	b	c	d
Final GRC	$\leq 2$	I	II	IV	VI
	3	II	II	IV	VI
	4	III	III	IV	VI
	5	IV	IV	IV	VI
	6	V	V	V	VI
	7	VI	VI	VI	VI
	>7	Category C (Certified) operation <sup>10</sup>			



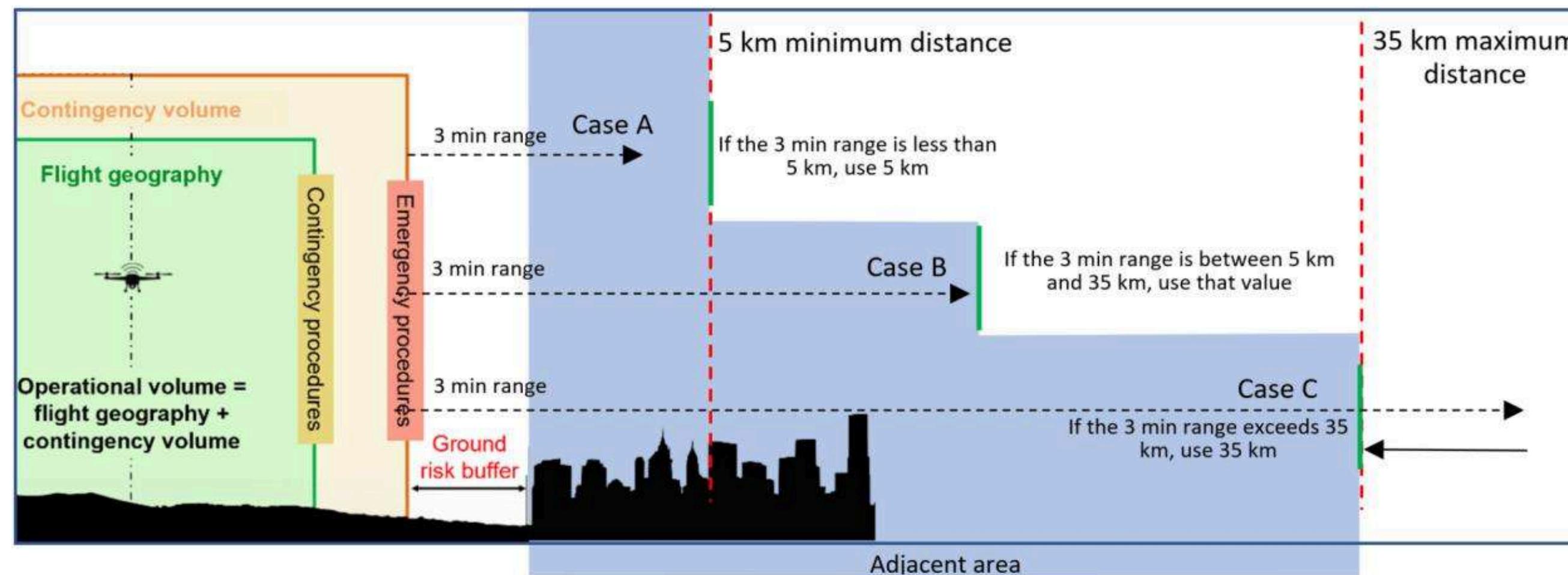
# Step 7: SAIL

		SAIL Determination			
		Residual ARC			
Final GRC		a	b	c	d
<b>≤2</b>		I	II	IV	VI
3		II	II	IV	VI
4		III	III	IV	VI
5		IV	IV	IV	VI
6		V	V	V	VI
7		VI	VI	VI	VI
<b>&gt;7</b>		Category C (Certified) operation <sup>10</sup>			



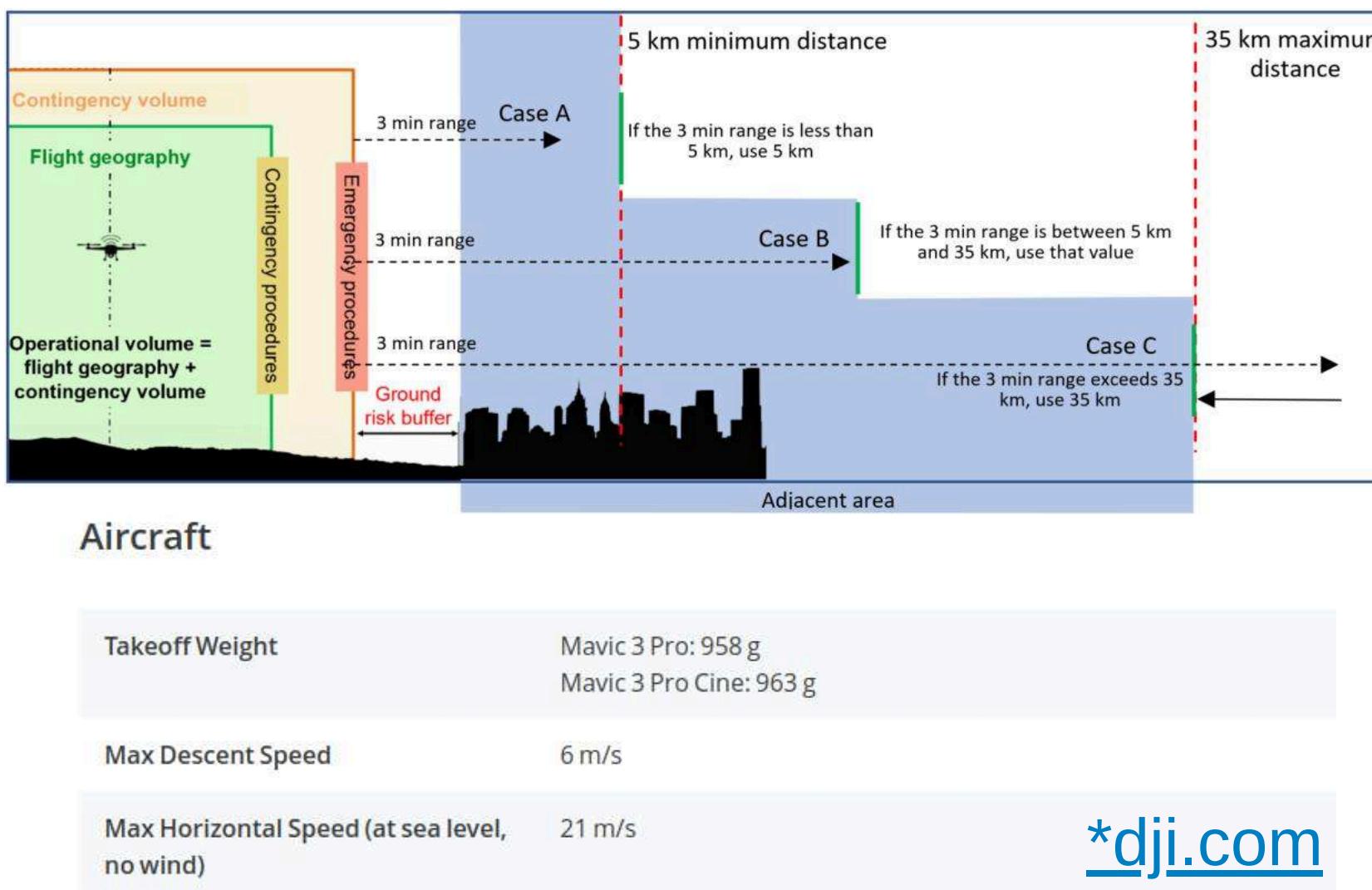
# 8- Containment Requirement

The containment requirements ensure that the **target level of safety** can be met for both ground and air risk in the **adjacent area**.





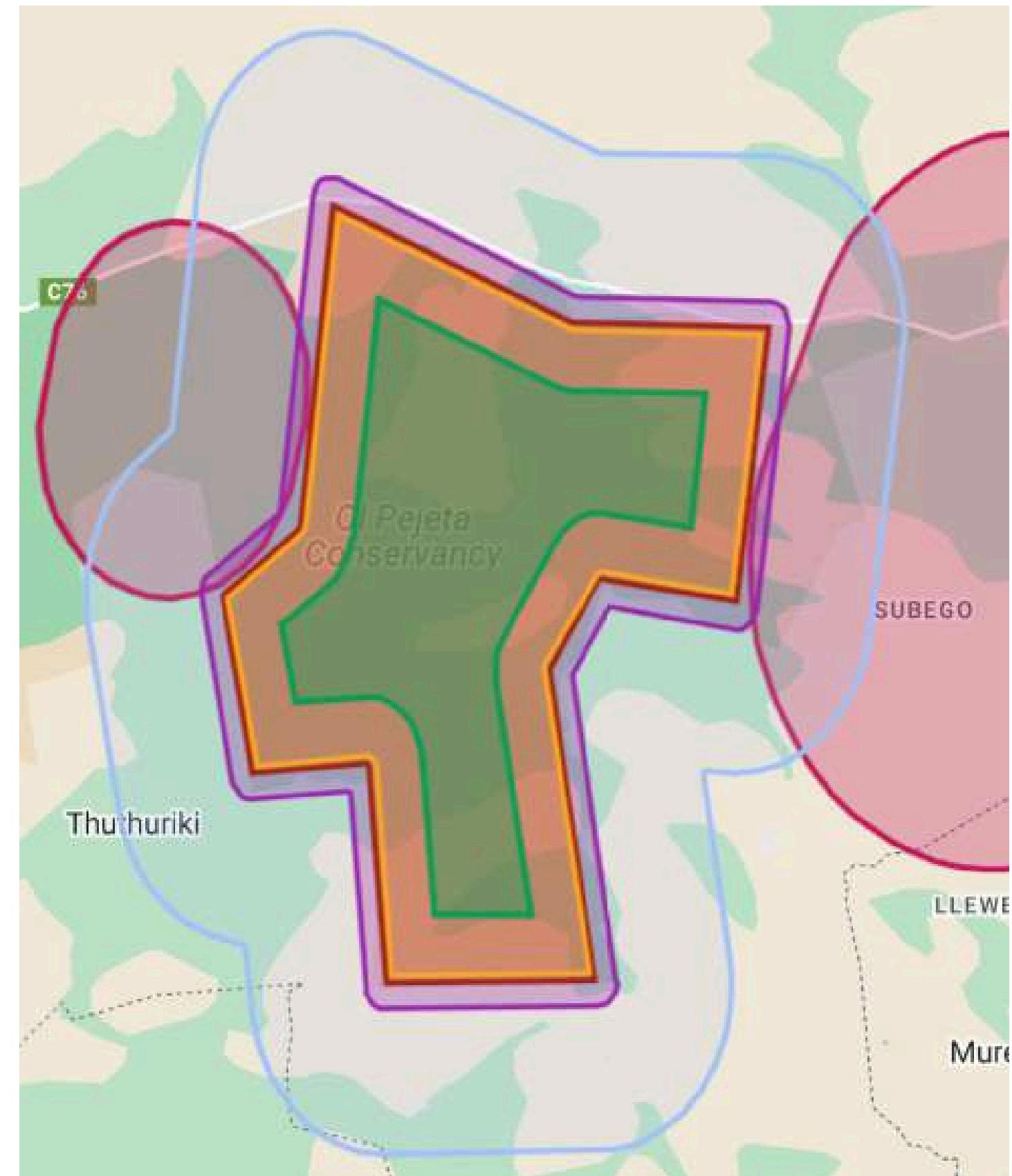
# 8- Containment Requirement



$$3 \text{ min range} = 3\text{m} * 60\text{s} * 21\text{m/s} = 3,780\text{m}$$

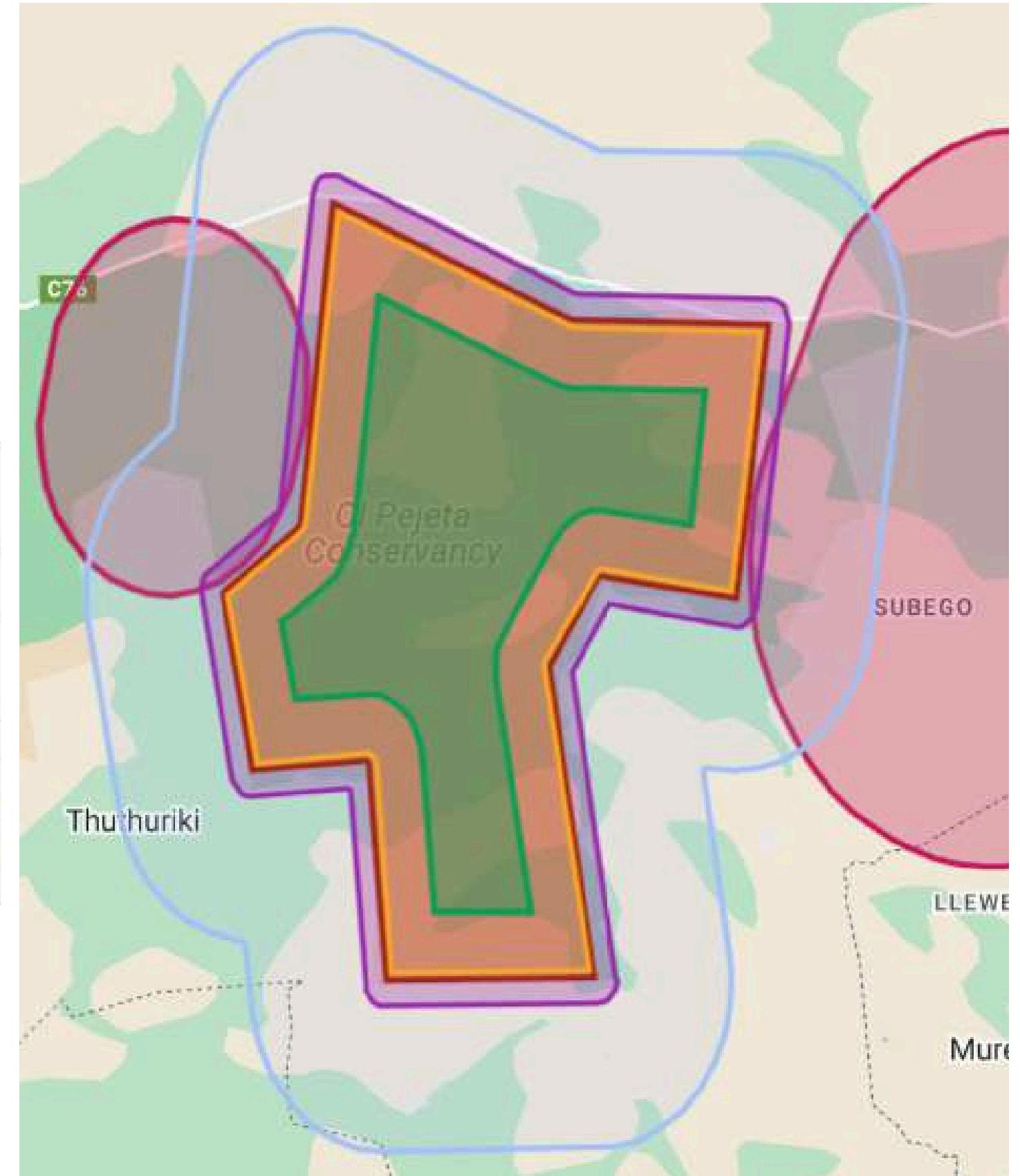
3.78Km < 5Km --> **Case A: Use 5Km**

[\\*dji.com](http://dji.com)



# 8- Containment Requirement

1 m UA (< 25 m/s)			
Sheltering assumed applicable for the UA in the adjacent area			
Average Population density allowed	No Upper Limit		< 50,000 ppl/km <sup>2</sup>
Outdoor Assemblies allowed within 1km of the OPS volume	> 400k	Assemblies of 40k to 400k	Assemblies < 40k
SAIL			
I & II	High	Medium	Low
III	Medium	Low	Low
IV - VI	Low	Low	Low
V-VI	Low	Low	Low





# 8- Containment Requirement

Containment	LEVEL OF INTEGRITY		
	Low	Medium	High <sup>2</sup>
Criterion #1 (Operational Volume Containment)	(Qualitative) No <b>probable</b> <sup>1</sup> single failure of the UAS or any external system supporting the operation shall lead to operation outside of the operation volume.  OR  (Quantitative) The probability of the failure condition "UA leaving the operational volume" shall be less than 10-3/Flight Hour (FH).		(Qualitative) No <b>remote</b> <sup>3</sup> single failure of the UAS or any external system supporting the operation shall lead to operation outside of the operational volume.  OR  (Quantitative) The probability of the failure condition "UA leaving the operational volume" shall be less than 10-4/FH.
Comments	<p><sup>1</sup> Failures anticipated to occur one or more times during the entire operational life of an item.</p> <p><sup>2</sup> This may be achieved by a tether that prevents the drone from exiting the operational volume.</p> <p><sup>3</sup> Failures unlikely to occur with each UA during its operational life but that may occur several times when considering the total operational life of a number of UA of this type.</p>		



# 9- OSOs (Operational Safety Objectives)

OSO ID	Operational Safety Objective	SAIL						Dependencies (Crit. references as per Annex E)		
		I	II	III	IV	V	VI	Operator	Training org	Designer
OSO#01	Ensure the Operator is competent and/or proven	NR	L	M	H	H	H	x		
OSO#02	UAS manufactured by competent and/or proven entity	NR	NR	L	M	H	H			x
OSO#03	UAS maintained by competent and/or proven entity	L	L	M	M	H	H	Crit. 1 Crit. 2		Crit. 1
OSO#04	UAS components essential to safe operations are designed to an Airworthiness Design Standard (ADS)	NR	NR	NR	L	M	H			x
OSO#05	UAS is designed considering system safety and reliability	NR	NR <sup>(c)</sup>	L	M	H	H			x
OSO#06	C3 link characteristics are appropriate for the operation	NR	L	L	M	H	H	x		x
OSO#07	Conformity check of the UAS configuration	L	L	M	M	H	H	Crit. 1 Crit. 2		Crit. 1
OSO#08	Operational procedures are defined, validated and adhered to	L	M	H	H	H	H	x		Crit. 1
OSO#09	Remote crew trained and current	L	L	M	M	H	H	x	x	
OSO#13	External services supporting UAS operations are adequate to the operation	L	L	M	H	H	H	x		
OSO#16	Multi crew coordination	L	L	M	M	H	H	Crit. 1 Crit. 3	Crit. 2	
OSO#17	Remote crew is fit to operate	L	L	M	M	H	H	x		
OSO#18	Automatic protection of the flight envelope from human errors	NR	NR	L	M	H	H			x
OSO#19	Safe recovery from human error	NR	NR	L	M	M	H			x
OSO#20	A Human Factors evaluation has been performed and the HMI found appropriate for the mission	NR	L	L	M	M	H	x		x
OSO#23	Environmental conditions for safe operations defined, measurable and adhered to	L	L	M	M	H	H	x		x
OSO#24	UAS designed and qualified for adverse environmental conditions	NR	NR	M	H	H	H			x



# 9- OSOs (Operational Safety Objectives)

TECHNICAL ISSUE WITH THE UAS		LEVEL OF INTEGRITY		
		Low (SAIL II)	Medium (SAIL III)	High (SAIL IV to VI)
<b>OSO #01</b> <i>Ensure the Operator is competent and/or proven</i>	Criterion	<p>The applicant is knowledgeable of the UAS<sup>1</sup> being used and <i>as a minimum has the following relevant operational procedures<sup>2</sup>:</i></p> <ul style="list-style-type: none"> <li>• <i>checklists,</i></li> <li>• <i>maintenance,</i></li> <li>• <i>training,</i></li> <li>• <i>responsibilities, and associated duties.</i></li> </ul>	<p>Same as Low. In addition, the applicant has an organization appropriate<sup>3</sup> for the intended operation, with at least the following in place:</p> <ul style="list-style-type: none"> <li>• a method to continuously evaluate whether the operator is operating according to the terms of the operational authorization and check whether the mitigations proposed as part of the operational authorization are still appropriate;</li> <li>• occurrence analysis procedures and reporting to the designer in case of design-related in-service events.</li> </ul>	<p>The applicant has a safety management system in place in line with ICAO Annex 19 principles.</p>
	Comments	<p><sup>1</sup> <i>Including monitoring of any related airworthiness directives or recommendations issued by National Aviation Authorities and designer recommendations (Service Bulletin, Service Information Letter, etc.)</i></p> <p><sup>2</sup> <i>Operational procedures (checklists, maintenance, training, etc.) can be justified in the context of other applicable OSO.</i></p>	<p><sup>3</sup> <i>For the purpose of this assessment appropriate should be interpreted as commensurate/proportionate with the size of the organization and the complexity of the operation.</i></p>	N/A

TECHNICAL ISSUE WITH THE UAS		LEVEL OF ASSURANCE		
		Low (SAIL II)	Medium (SAIL III)	High (SAIL IV to VI)
<b>OSO #01</b> <i>Ensure the Operator is competent and/or proven</i>	Criterion	<i>The elements delineated in the level of integrity are available.</i>	Prior to the first operation, a competent third party performs an audit of the organization.	<p>The applicant holds an Organizational Operating Certificate or is/has a recognized flight test organization.</p> <p>In addition, a competent third party recurrently verifies the Operator's competence.</p>
	Comments	N/A	<p><i>Audits should be adapted to the size and scope of the organization and focus on items that can be connected to the applicable OSOs and their robustness depending on the SAIL of the operation. Audits can take the form of desk reviews, if deemed appropriate.</i></p>	



# 10- Comprehensive Safety Portfolio (CSP)

**01** Detailed operational description (Step #1)

**02** Safety claims

**03** Derived requirements

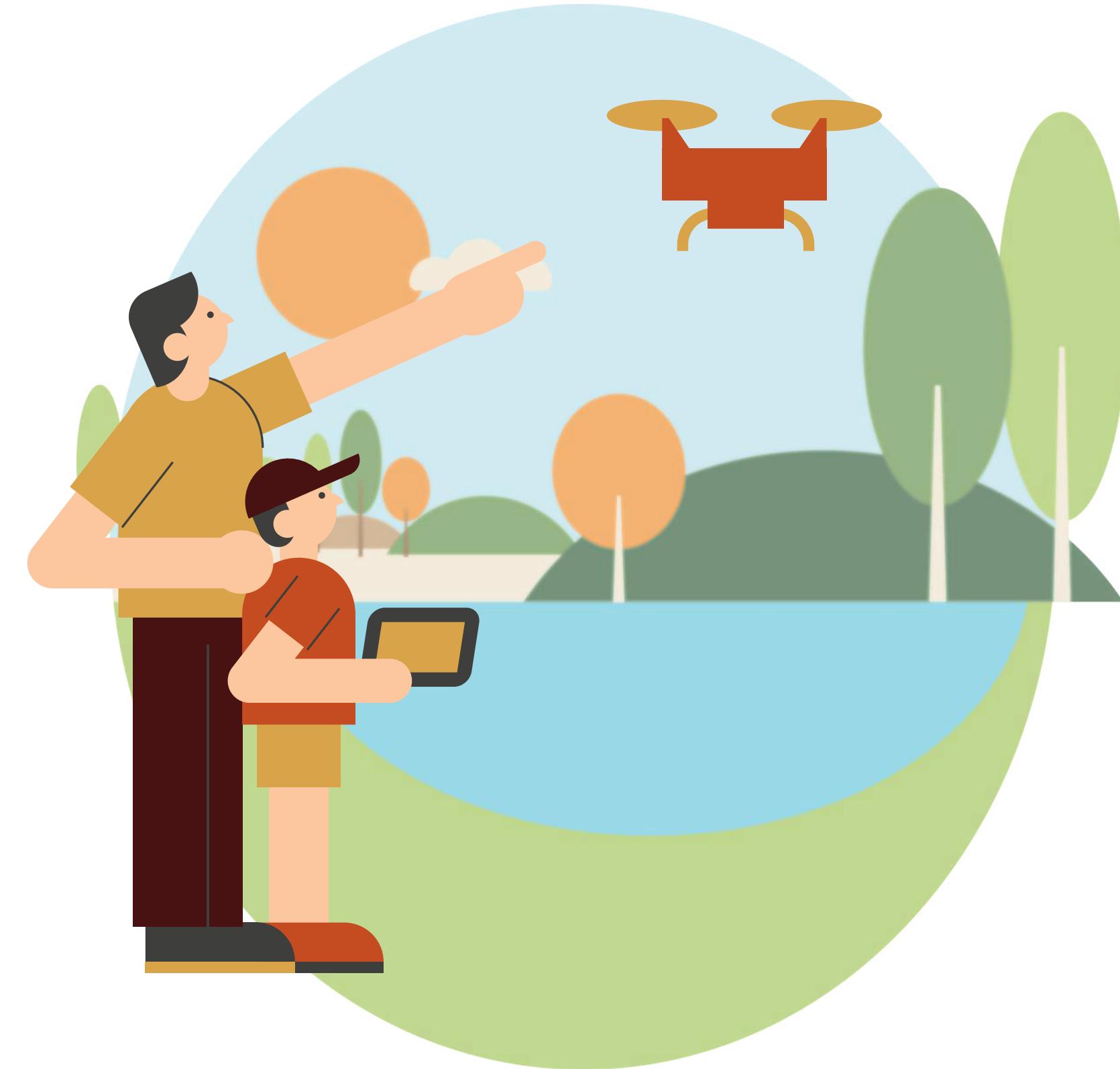
**04** Compliance evidence

**05** Justified safety case

**06** Compliance matrix



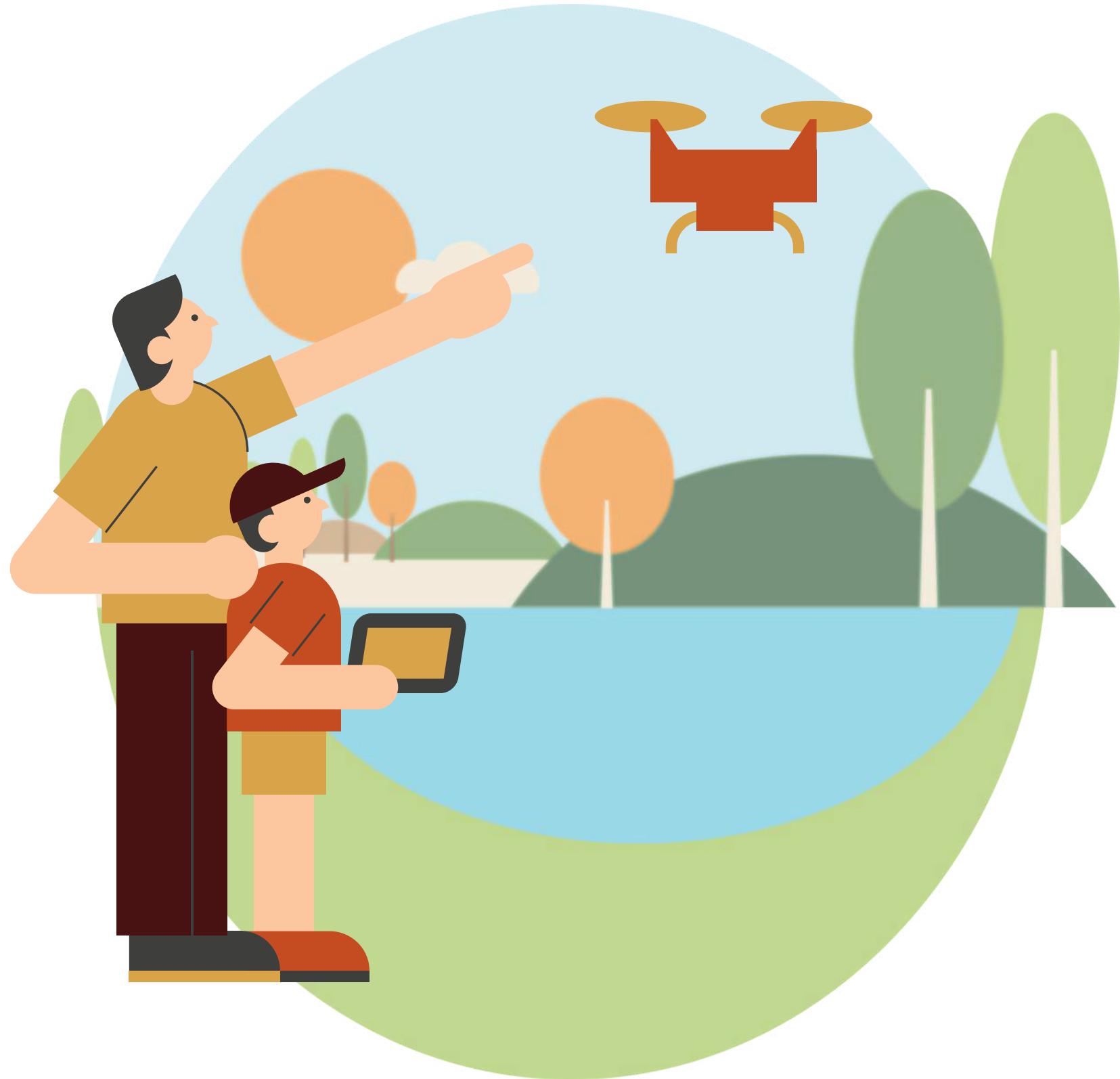
**Now you  
are ready to  
fly safely!**



**WILDDRONE**



**well ...  
almost**



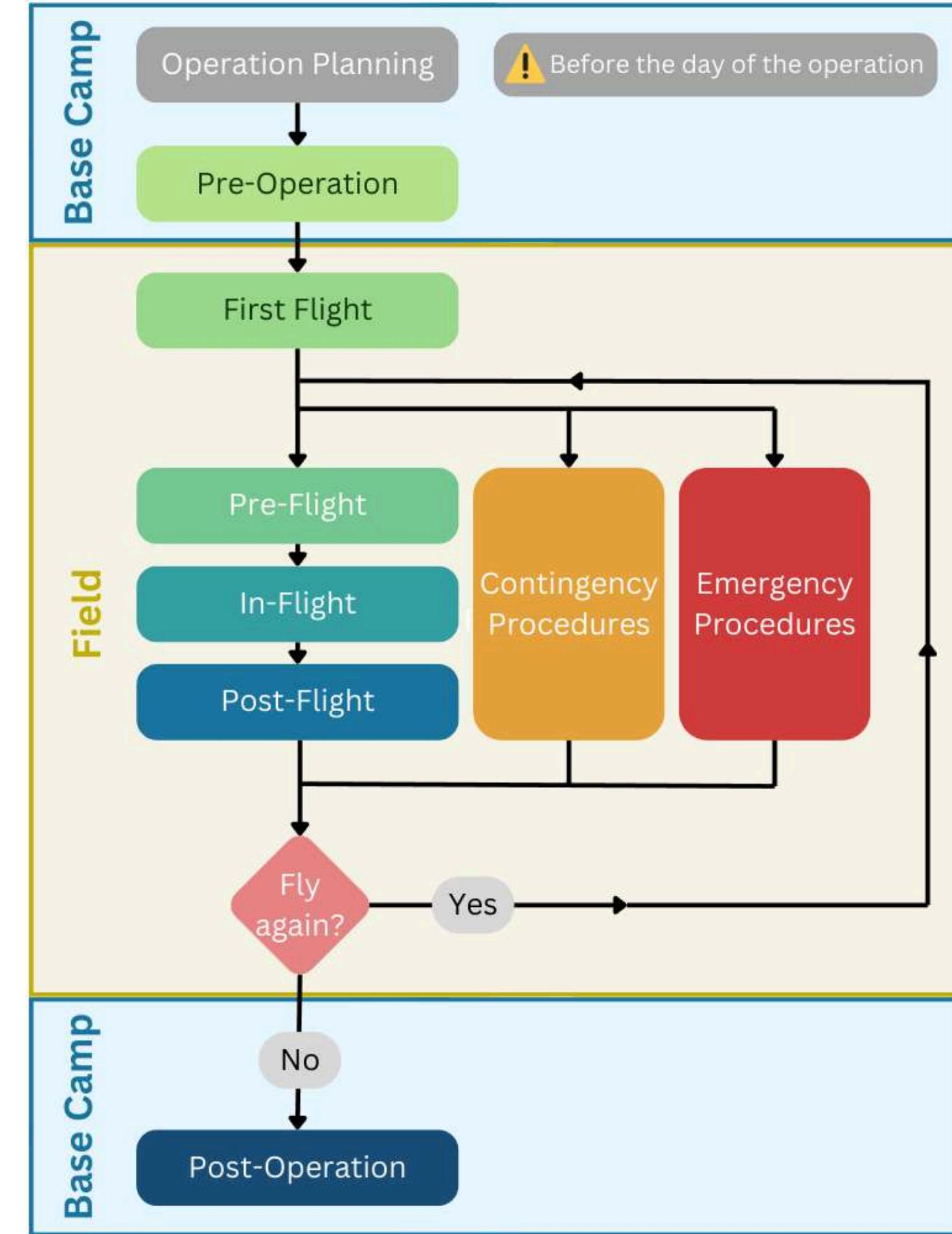


# Operational Procedures





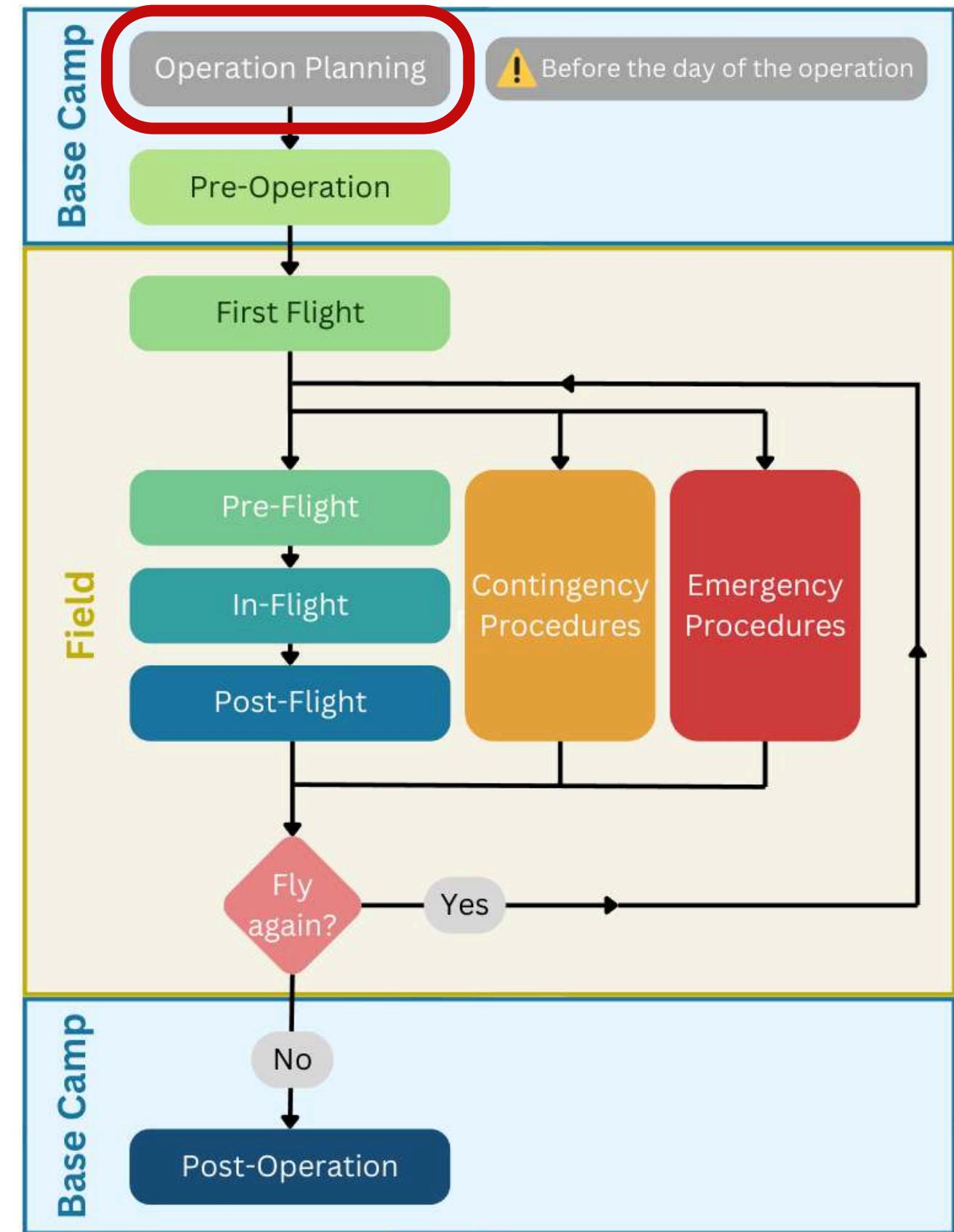
# Procedures Workflow





# Operation planning

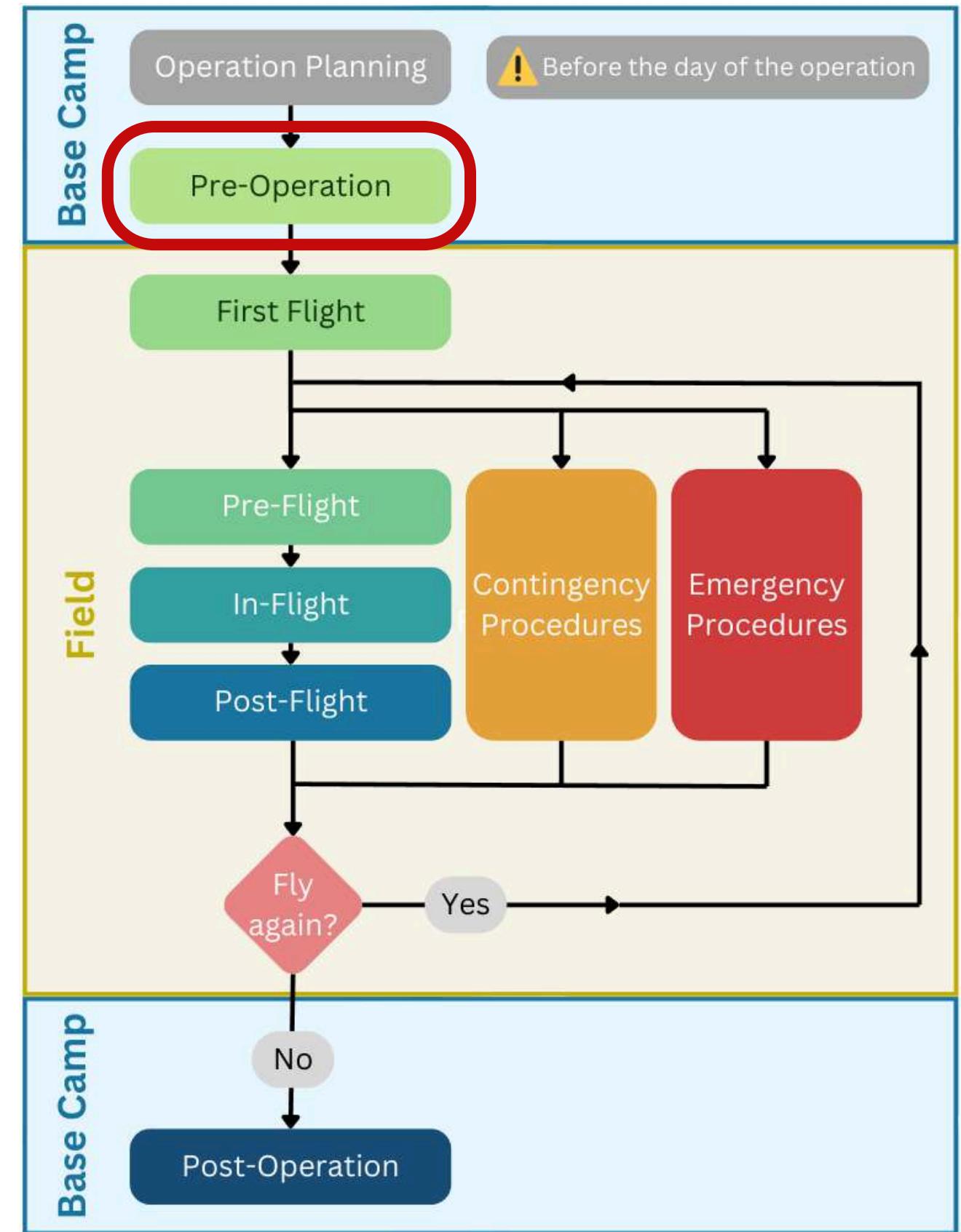
- **Operational environment**
  - No-fly zones
  - Weather
- **Crew**
  - Pilot with valid license
  - Book assistant
- **Regulations**
  - Operation falls under operational permit
- **Equipment**
  - Inspect
  - Pack





# Pre-Operation

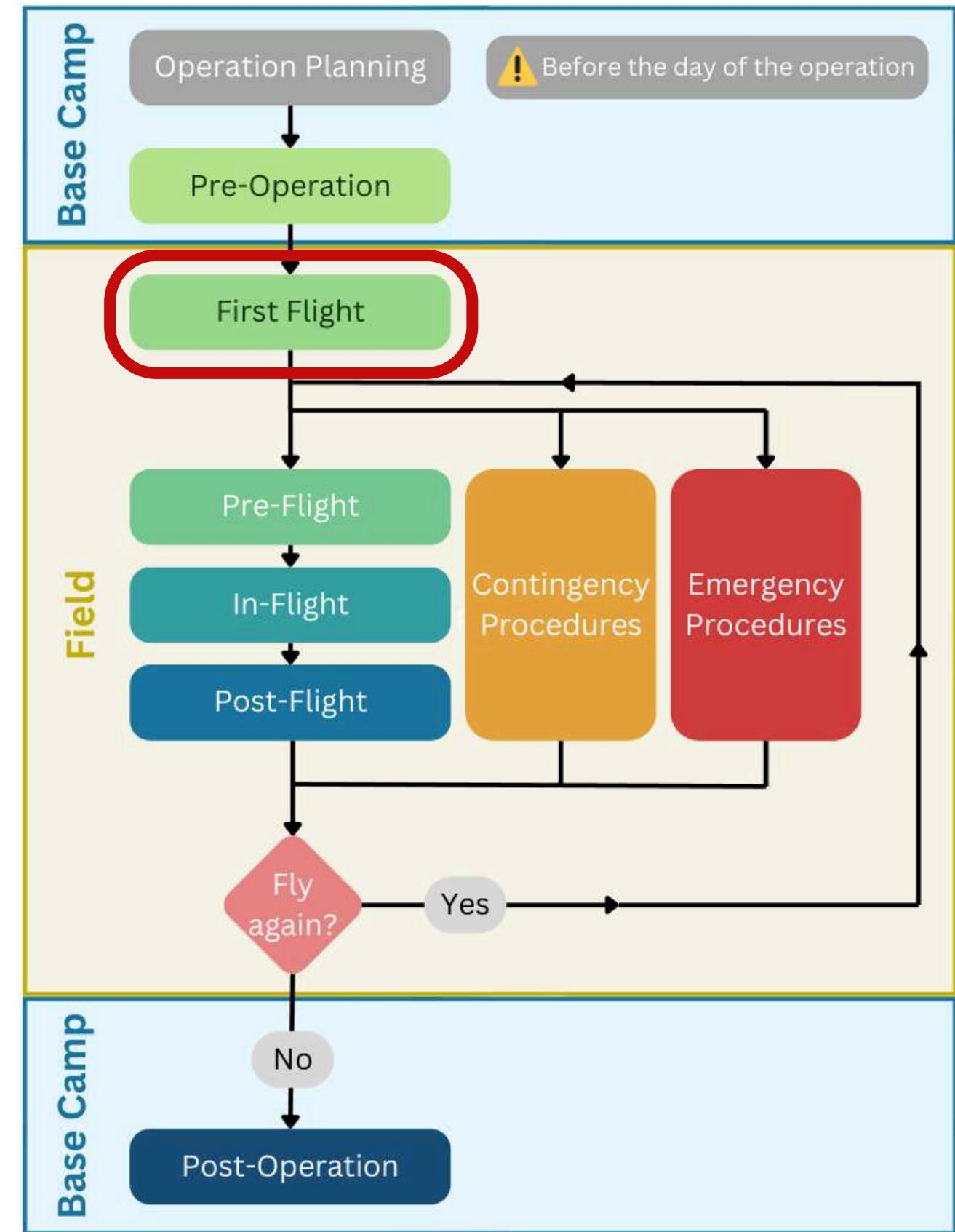
- **Inform 3rd parties**
  - ATC
  - Ol Pejeta radio room
- **Packing checklist**





# First Flight

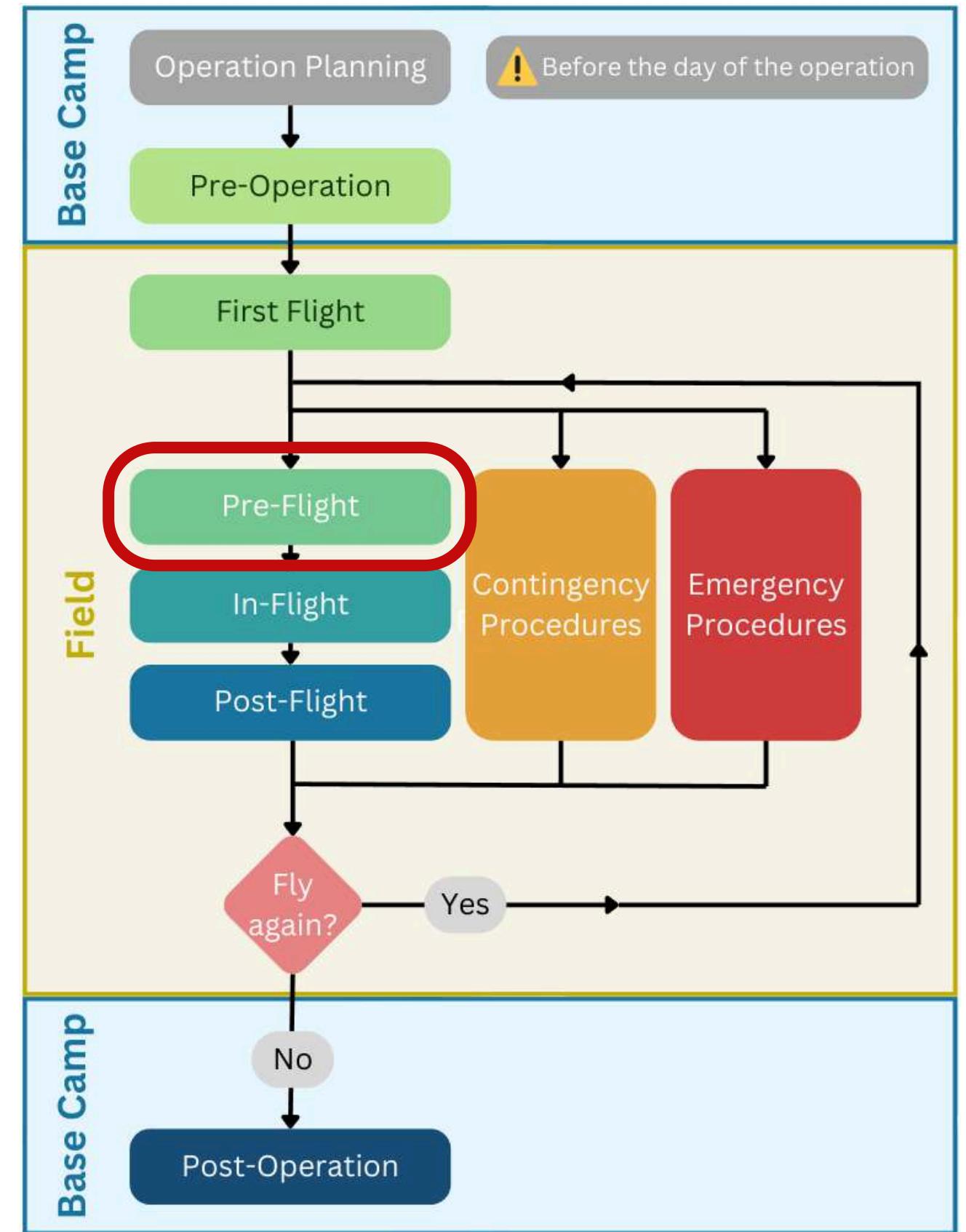
- **Operational Environment**
  - No-Fly zones
  - Topography (ground obstacles)
- **Safety briefing**
  - IMSAFE (Illness, Medication, Stress, Alcohol, Fatigue, Emotion)
  - Role allocation (pilot, assistant, ground obs., air obs.)
- **Check with 3rd parties**
  - ATC
  - Ol Pejeta radio room





# Pre-Flight

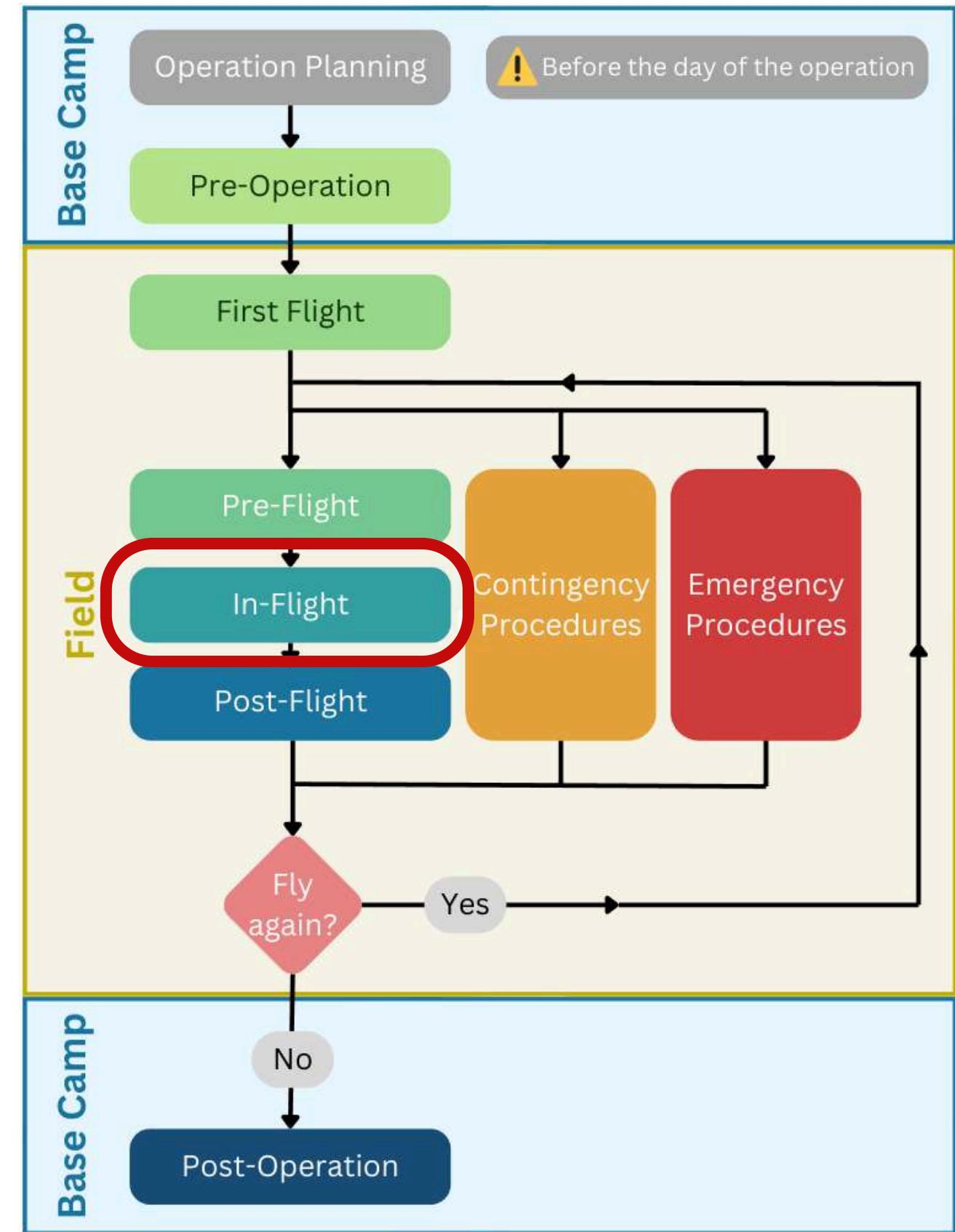
- **Equipment**
  - Inspect
  - Check failsafes
  - Check status (GPS fix, RSSI)
- **Check surroundings**
- **Advise ground team**





# In-Flight

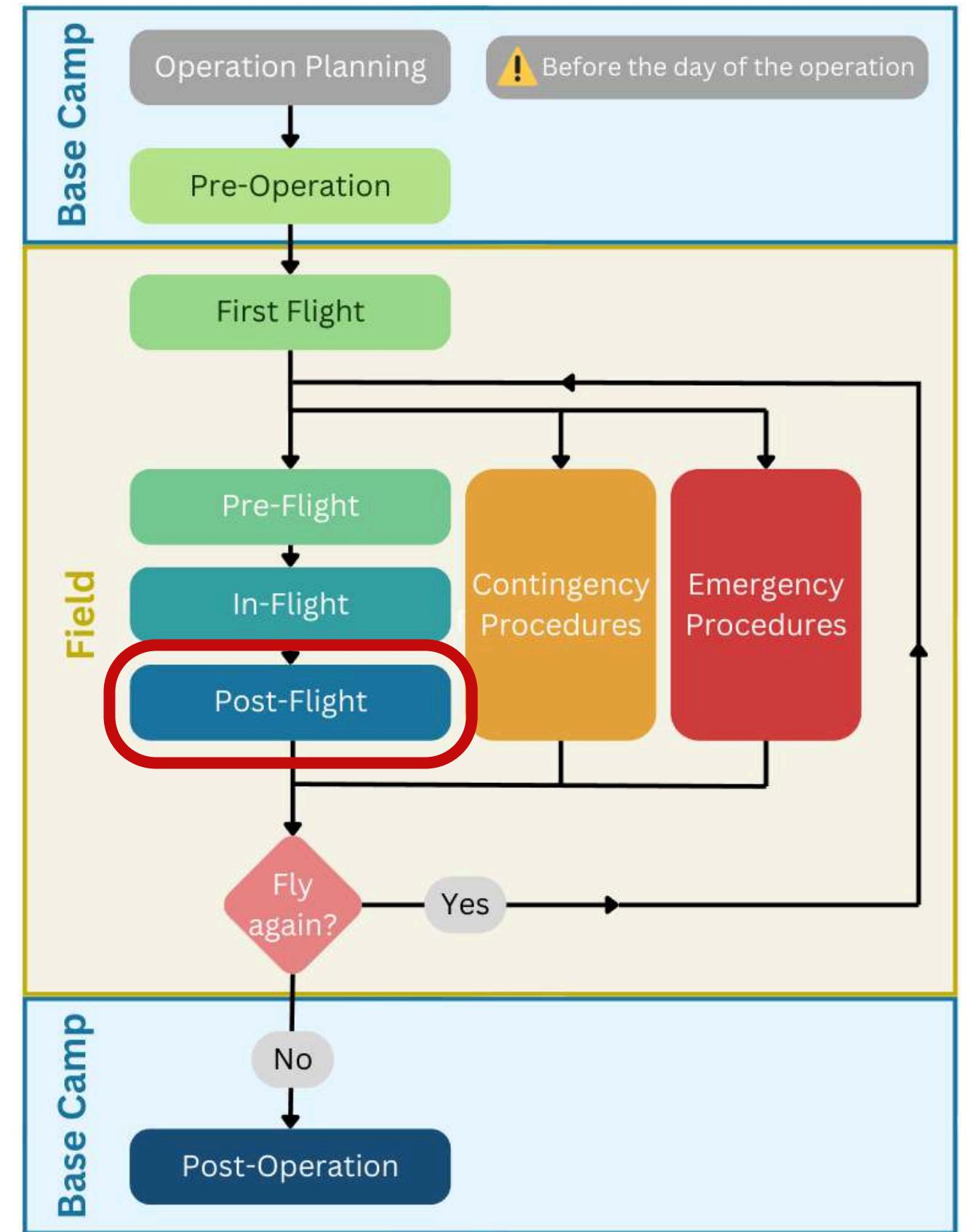
- **UAS performance**
- **UAS status**
  - Battery, GPS, RSSI, Altitude, Speed, Position
- **Check weather**
- **Check surroundings (airspace, ground)**





# Post-Flight

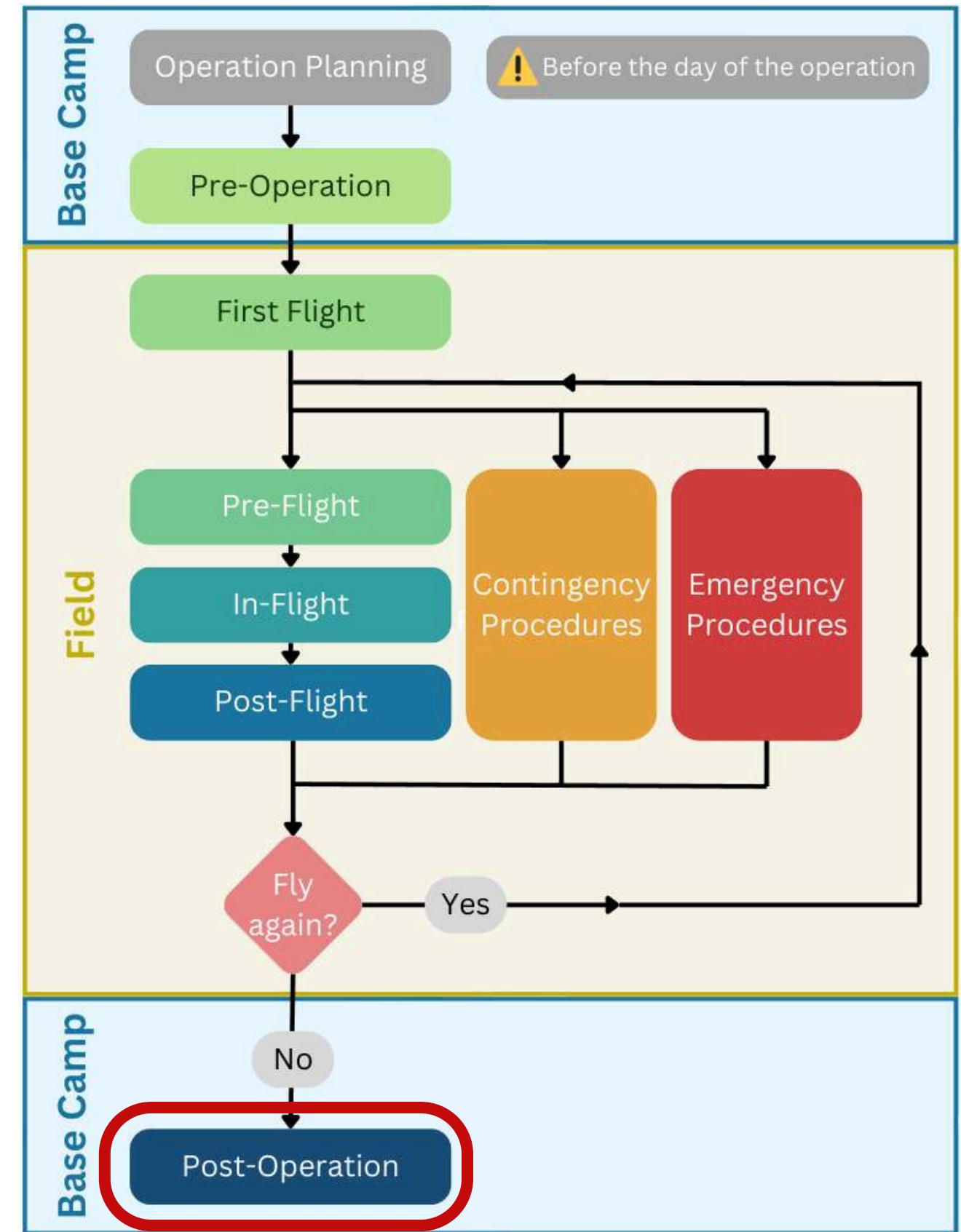
- Stop recording
- Remove batteries
- Visual UAS inspection





# Post-Operation

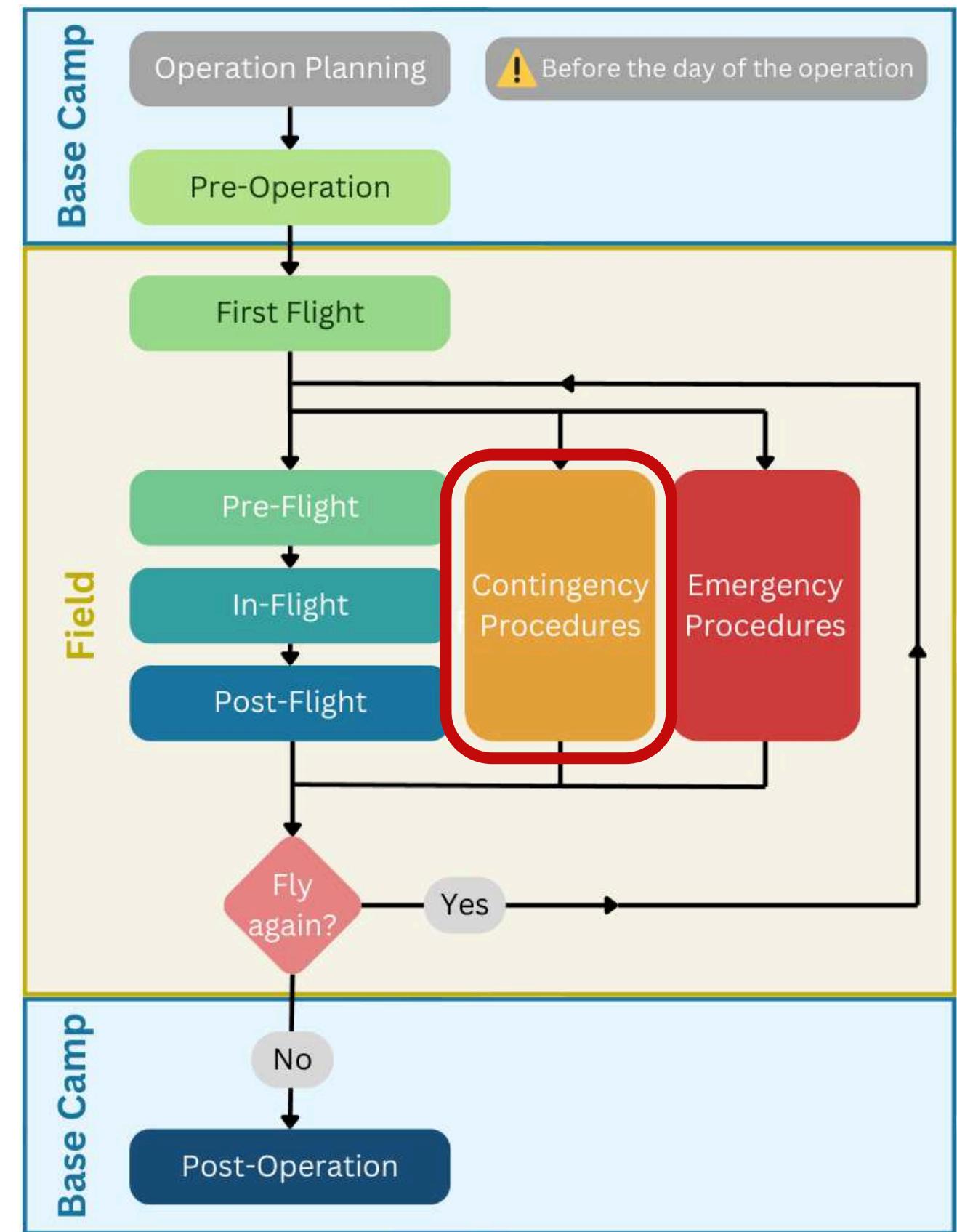
- **Inform 3rd parties**
  - ATC
  - Ol Pejeta
- **Backup Data**
- **Recharge batteries**
- **Fill flight logs**





# Contingency Procedures

<b>C01 - Low battery/high drain</b>	<b>C02 - High-wind carries UAS</b>
<ul style="list-style-type: none"> <li>Sufficient battery to RTH?           <ul style="list-style-type: none"> <li><b>YES:</b> RTH</li> <li><b>NO:</b> Slow landing</li> </ul> </li> <li>Drone close to home?           <ul style="list-style-type: none"> <li><b>YES:</b> Manual landing</li> <li><b>NO:</b> RTH</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Exited the flight geometry?           <ul style="list-style-type: none"> <li><b>YES:</b> Follow Emergency E03</li> <li><b>NO:</b> Slow landing</li> </ul> </li> <li>Able to RTH?           <ul style="list-style-type: none"> <li><b>YES:</b> RTH</li> <li><b>NO:</b> Slow landing</li> </ul> </li> </ul>
<b>C03 - Aircraft approaching</b>	<b>C04 - Wildlife approaching</b>
<ul style="list-style-type: none"> <li>Lower drone to a safe altitude (below 30m AGL)</li> </ul>	<ul style="list-style-type: none"> <li>RTH</li> <li>Get in the car</li> <li>Control drone, move away</li> </ul>
<b>C05 - UAV warnings or errors</b>	<b>C06 - C2 link warnings or errors</b>
<ul style="list-style-type: none"> <li>Able to RTH?           <ul style="list-style-type: none"> <li><b>YES:</b> RTH</li> <li><b>NO:</b> Slow landing</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Orient antenna towards UAS</li> <li>RTH</li> <li>Consider driving towards UAS</li> </ul>
<b>C07 - Poor Weather (Rain, Wind, Visibility)</b>	<b>C08 - Crew feeling unwell</b>
<ul style="list-style-type: none"> <li>RTH</li> </ul>	<ul style="list-style-type: none"> <li>RTH</li> </ul>
<b>C09 - 3rd party approaching</b>	<b>C10 - Flight geography breached</b>
<ul style="list-style-type: none"> <li>Assistant communicates, and avoids distracting the RPIC.</li> </ul>	<ul style="list-style-type: none"> <li>UAV under control?           <ul style="list-style-type: none"> <li><b>YES:</b> RTH</li> <li><b>NO:</b> Follow Emergency E04</li> </ul> </li> </ul>





# Emergency Procedures

## E01 - Aircraft dangerously close

- AP shouts "Kill Kill Kill"
- Activate kill switch

## E02 - Threatening Wildlife

- Get in the car ASAP!
- Manually RTH

## E03 - Operational Vol. Breached

- Activate kill switch
- Communicate with ATC (+254-XXX XXX XXX):
  - Location, bearing, time
  - Remaining flight time, drone size / type, speed

## E04 - Loss of control/ fly-away

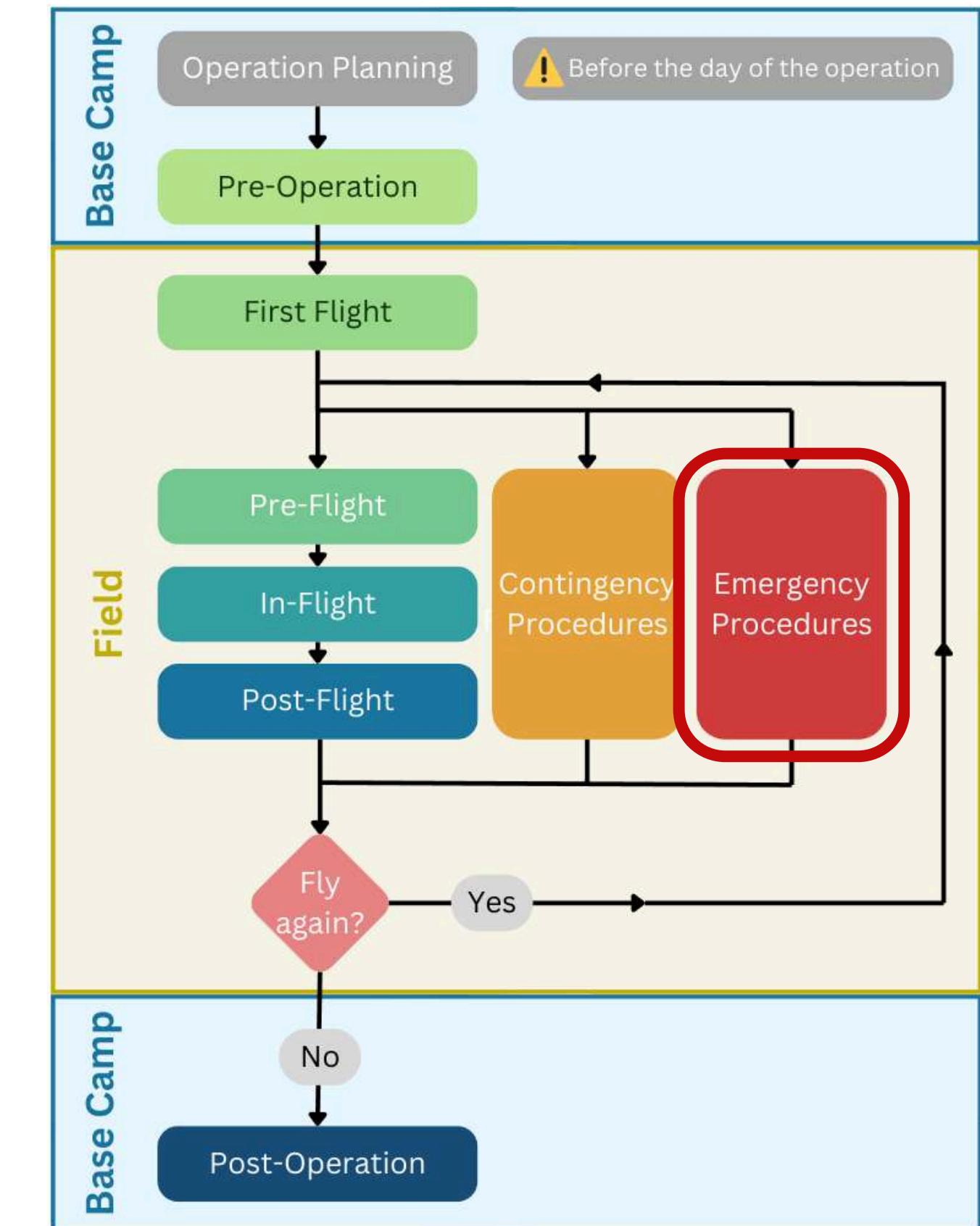
- Try switching flight modes
- Try to regain control, or activate kill switch
- Communicate with ATC (+254-XXX XXX XXX):
  - Location, bearing, time
  - Remaining flight time, drone size / type, speed

## E05 - Bush fire

- Call radio room: +254-XXX XXX XXX

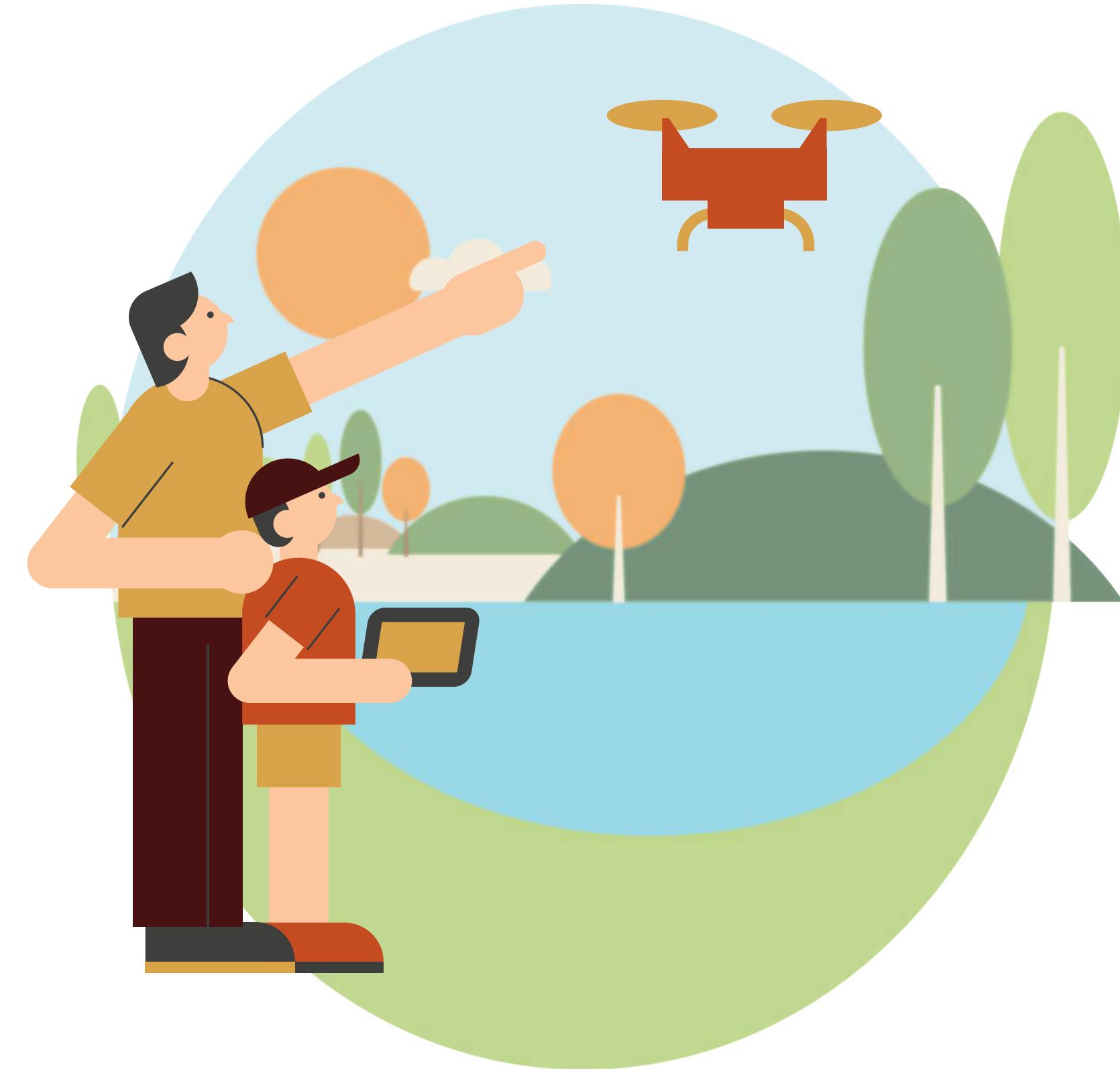
## E06 - Crew unfit for flight

- RTH
- Provide first aid
- Call radio room: +254-XXX XXX XXX





**That's it!**  
Now you are  
**officially** ready  
to fly safely!





# Stay safe, and feel free to reach out!

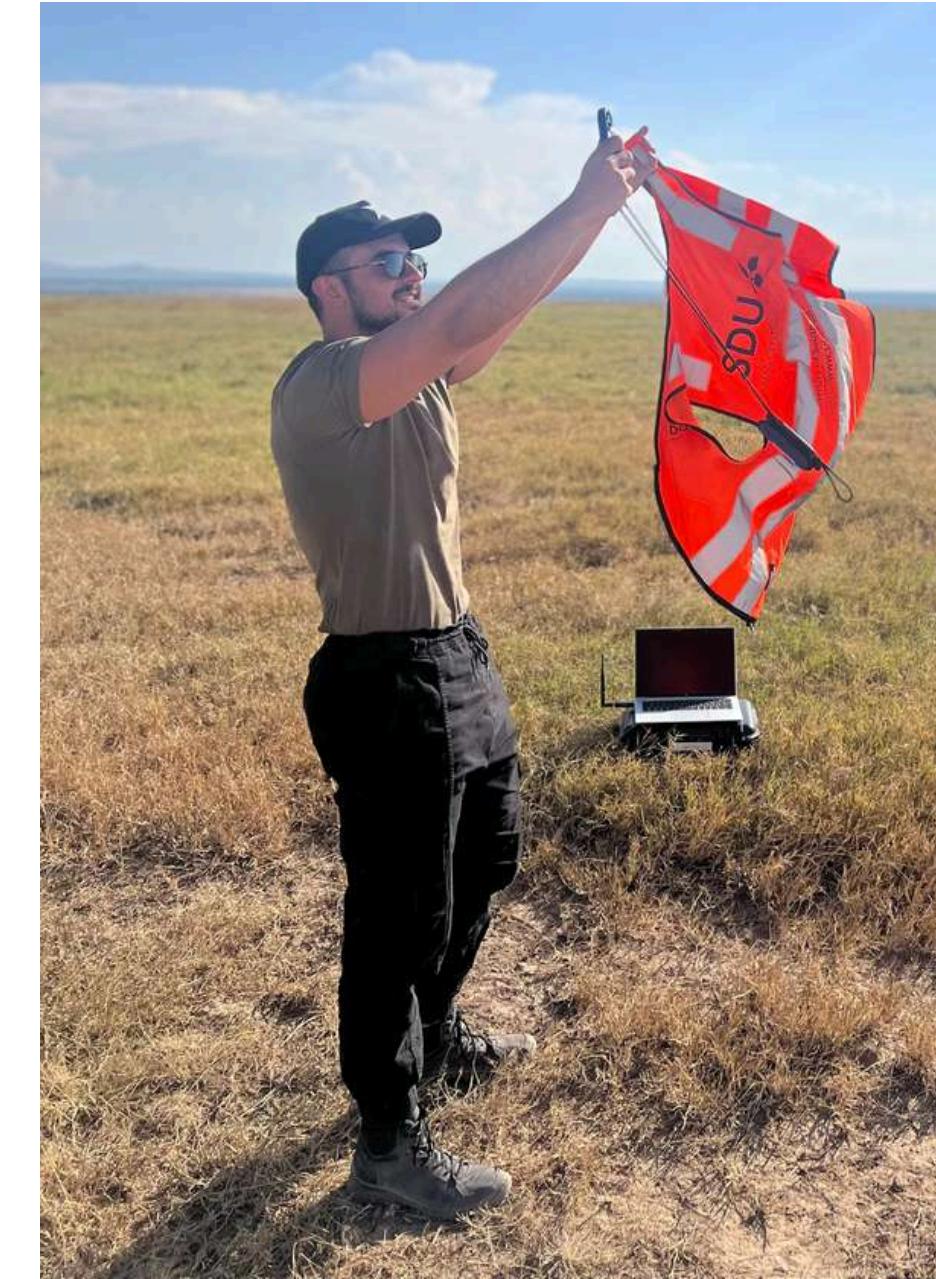


**Guy Maalouf**  
WildDrone PhD Candidate  
Safe UAS BVLOS Operations  
[guym@mmpi.sdu.dk](mailto:guym@mmpi.sdu.dk)



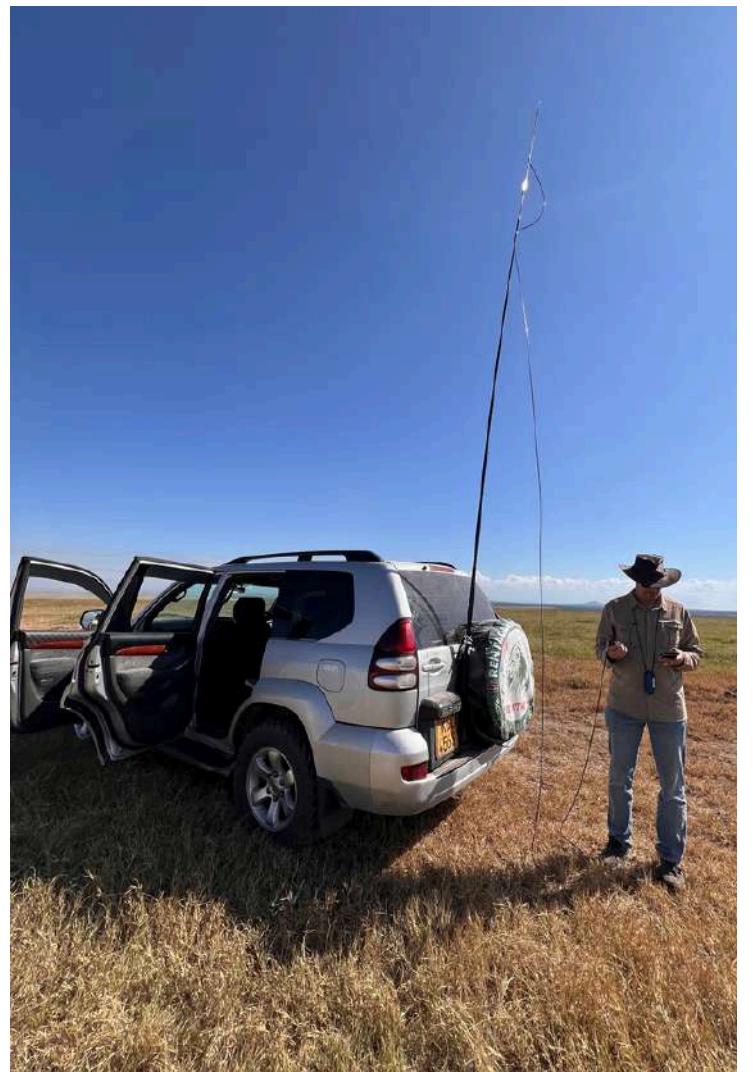


# Pictures from the field - Checklists





# Pictures from the field - Airspace safety





# Pictures from the field - Wildlife

