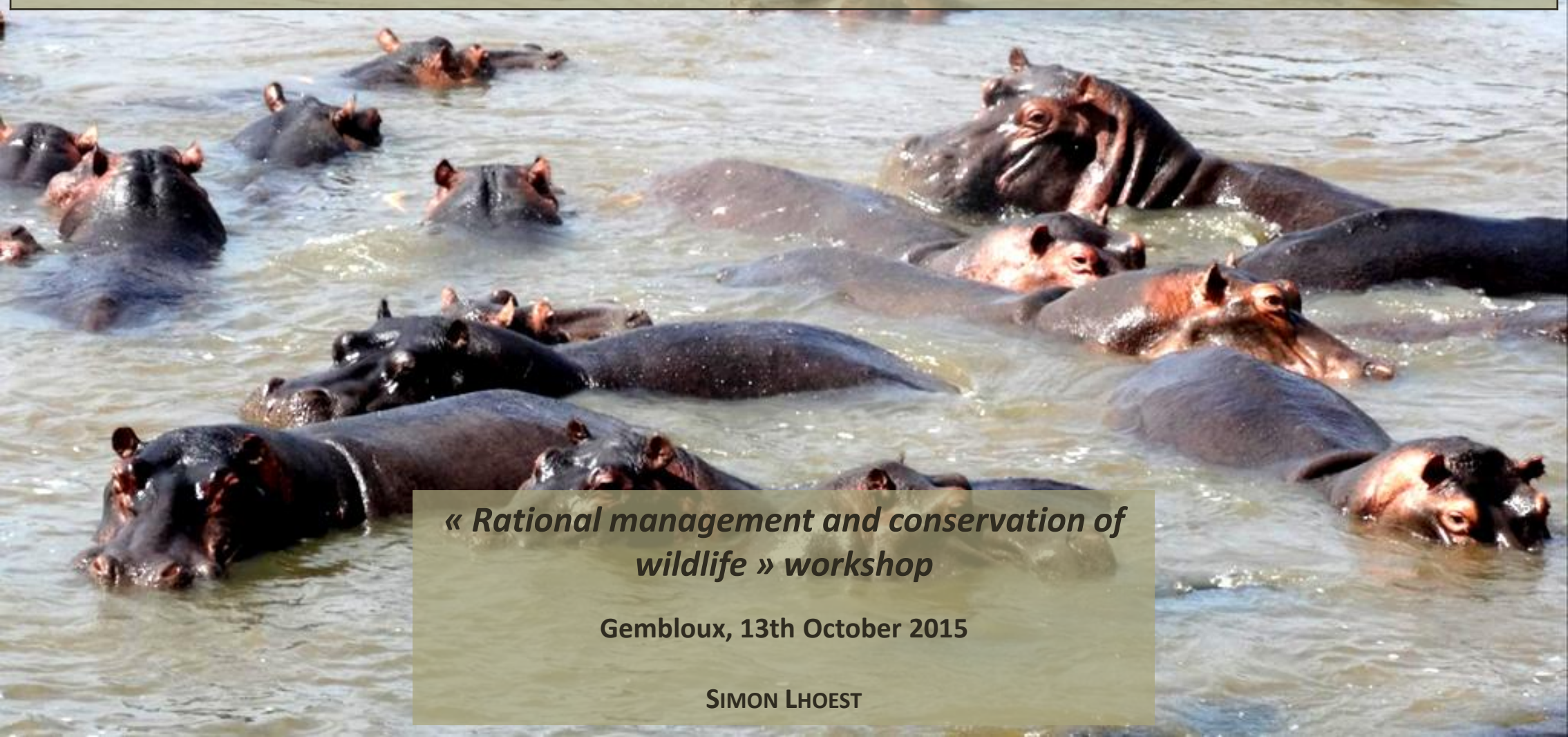


Contribution to the monitoring of the common hippopotamus (*Hippopotamus amphibius* L.) with the use of drone technology (Garamba National Park, DRC)



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*« Rational management and conservation of
wildlife » workshop*

Gembloux, 13th October 2015

SIMON LHOEST

Multiple anthropogenic pressures

➔ Decline of wildlife!



➔ Regular monitoring is essential!





Pedestrian inventories	Aerial inventories	Drones
Low cost	Rapidity	Security
Logistics	Vast areas	Not easily accessible sectors
Imprecisions, operator effect	Not easily accessible sectors	Rapidity & logistics
Limited areas	High costs	Reliable and repeatable methods, animals disturbance
Potential risks	Logistics	Possible automation
	Dangers	Technical constraints
	Imprecisions, animals disturbance	Large datasets (time consuming!)

For large groups (schools, « reposoirs aquatiques ») :

1. Flight parameters optimization

→ Detection, visibility

2. Operator effect in countings?

3. Correction factor in countings

4. Demographic description of a group

5. Algorithm for the semi-automatic count of individuals

**RGB images
(real colors)**

**Infrared
thermal
imagery**

Garamba National Park

Two study sites

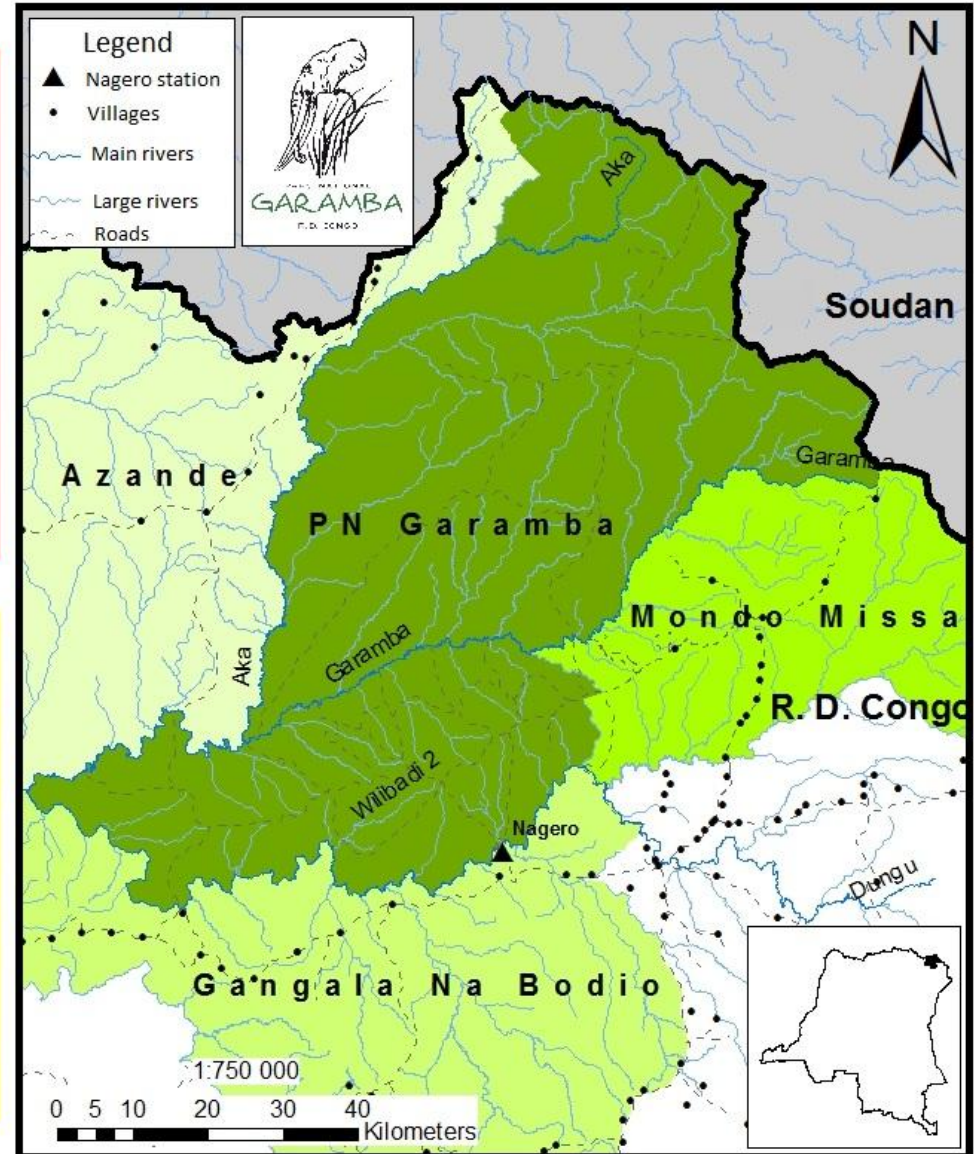
Two contrasted seasons :
dry & rainy

High poaching pressure!

Wilibadi 2 site



Dungu site



Falcon Unmanned© UAV

Autonomy

45 to 75 minutes

Remote control

Maximum 10 kilometers

Take-off

By hand / catapult

- 10 flights

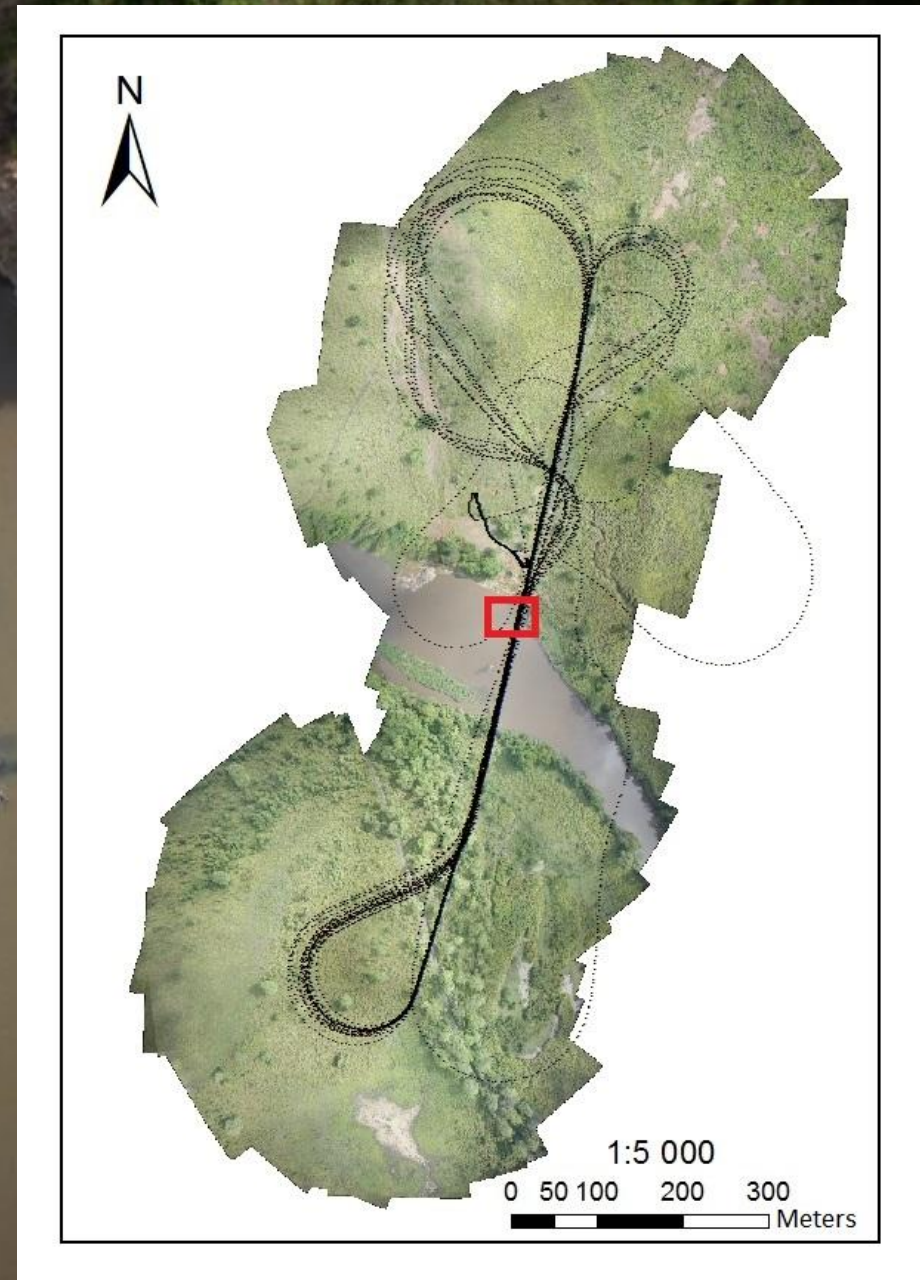
- Dungu site

- 252 selected photos

- 6 flight heights:
40, 60, 80, 100, 120, 140 meters

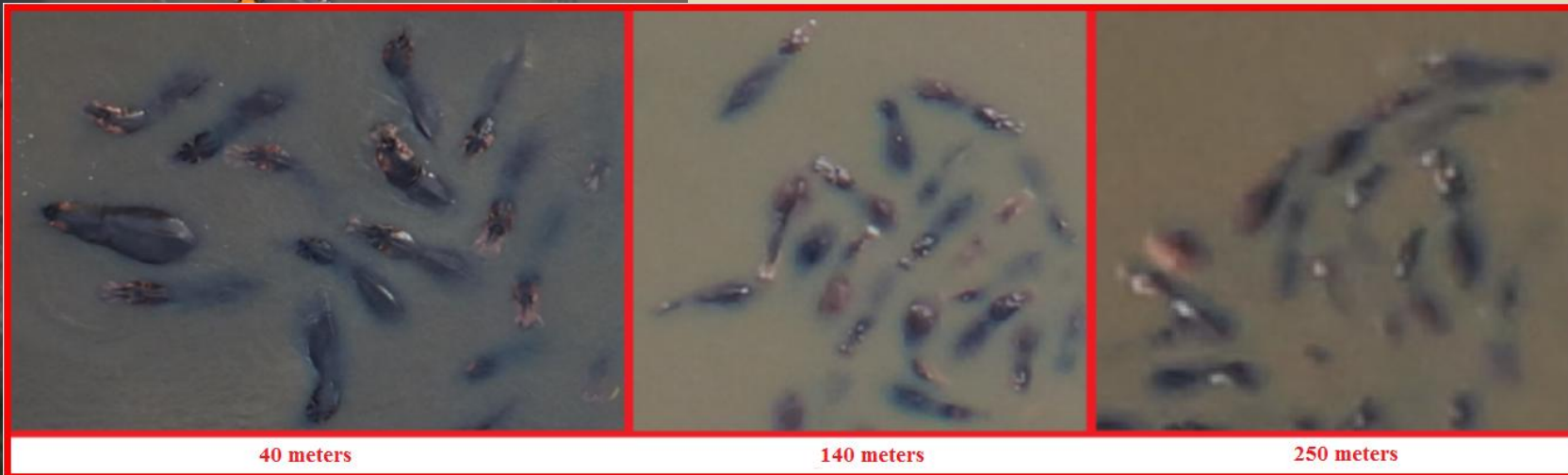
- Other quantified parameters:

- Sun reflection → For each image
- Cloud cover → For each flight
- Wind speed → For each flight





- Manual countings: *WiMUAS* software
- **8** operators
 - **3** experienced
 - **5** inexperienced
- Random order of images
- Defined counting zone
- Observations **certain** / **uncertain**
- 252 photos x 8 operators
= 2016 experimental units



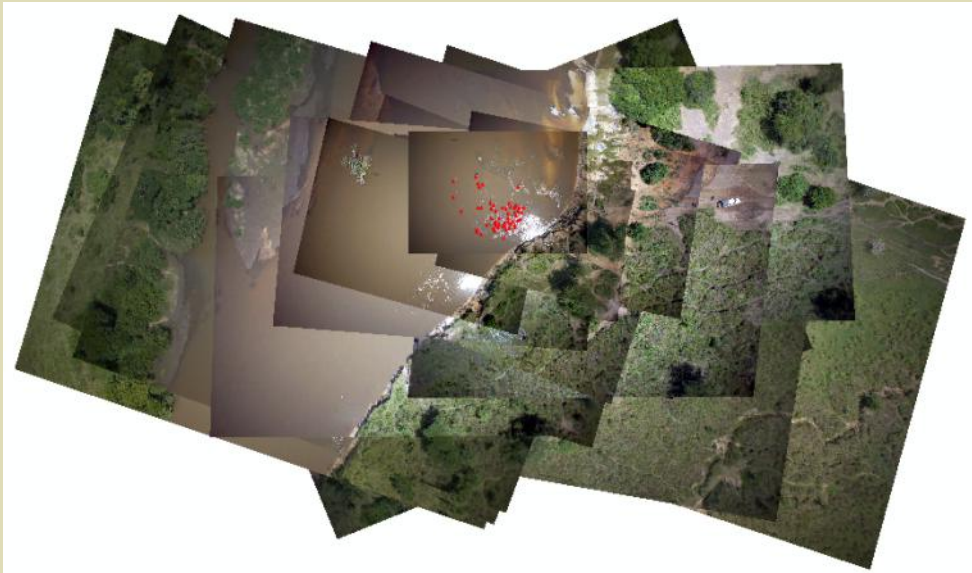
40 meters

140 meters

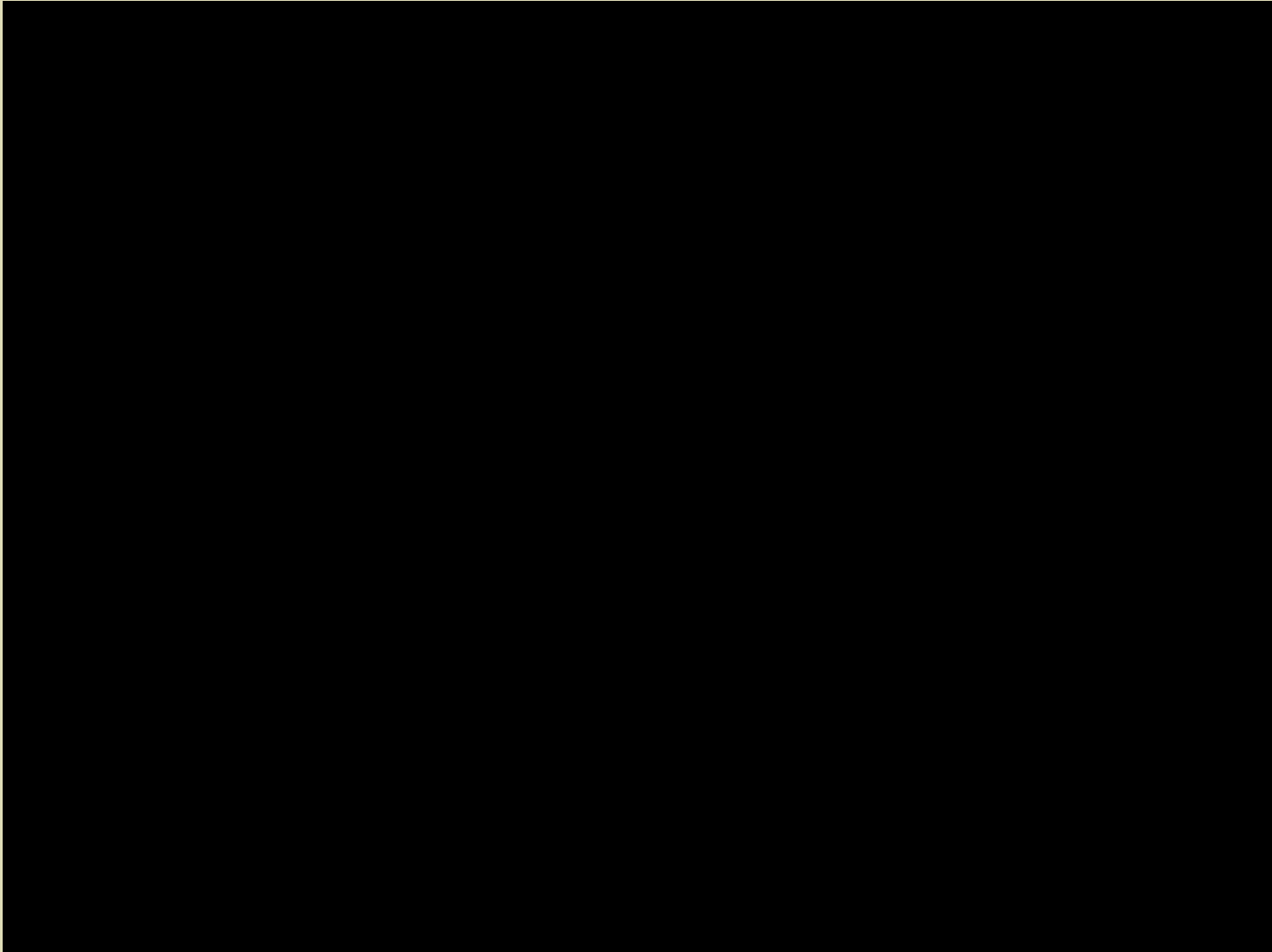
250 meters

Estimation of the total number of hippos present during a flight

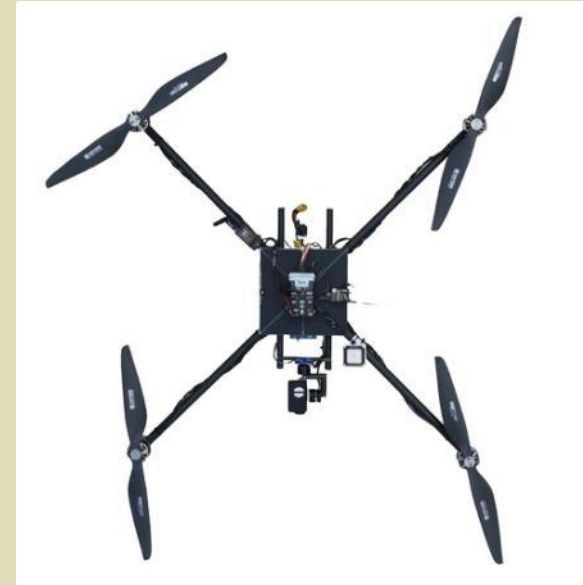
- Georeferencing of 15 successive images
- Points layer: positions of animals
- Addition + moving of points between images
- Estimated number of hippos = final number of points



Estimation of the total number of hippos present during a flight: Alternatives?



Multicopter UAV?



Source : www.airbotservices.com

Flight parameters optimization

- Calculation of the **detection rate**
 - Calculation of the **certainty rate**
- } For each of the 2016 EU

- 2 mixed binary logistic regression models

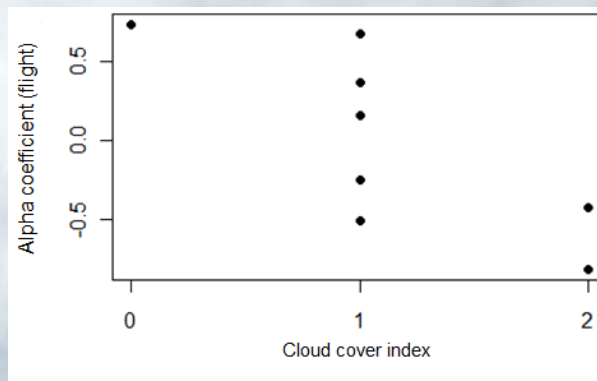
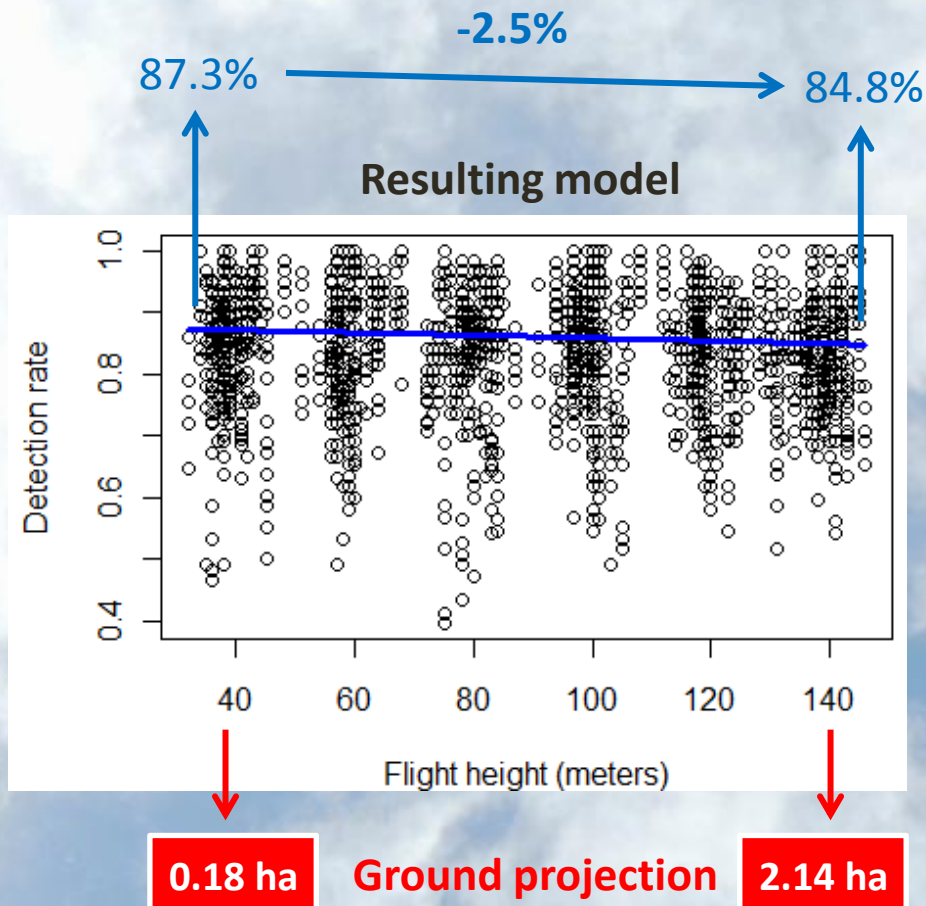
Factors:

- Fixed: Flight height
- Random: Flight, photo, operator

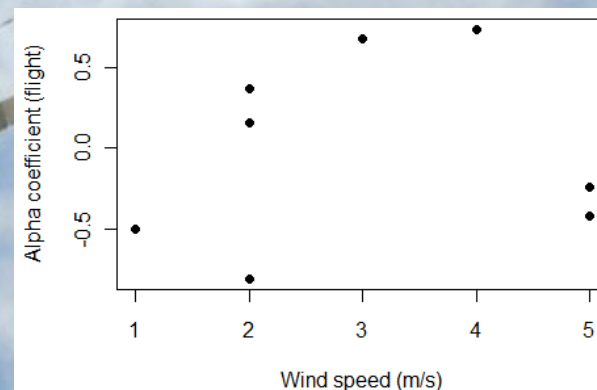
Result: $\ln\left(\frac{Rate}{1 - Rate}\right) = a + b * Height + \alpha_{flight} + \beta_{image} + \gamma_{operator}$

Models	a	b	Standard-deviation α	Standard-deviation β	Standard-deviation γ
Detection rate	1.991	-0.002	0.556	0.335	0.335
Certainty rate	2.304	-0.003	0.313	0.268	0.722

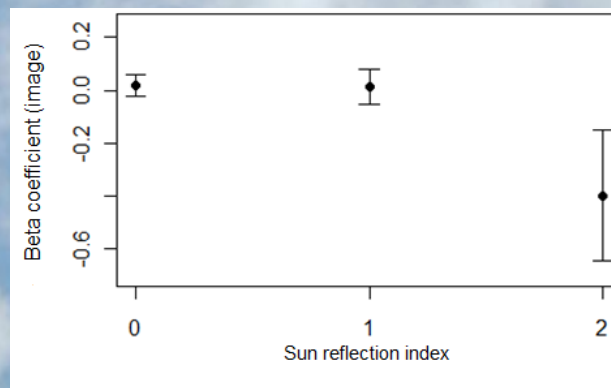
Graphical results (detection rate)



➔ Impact of the cloud cover?

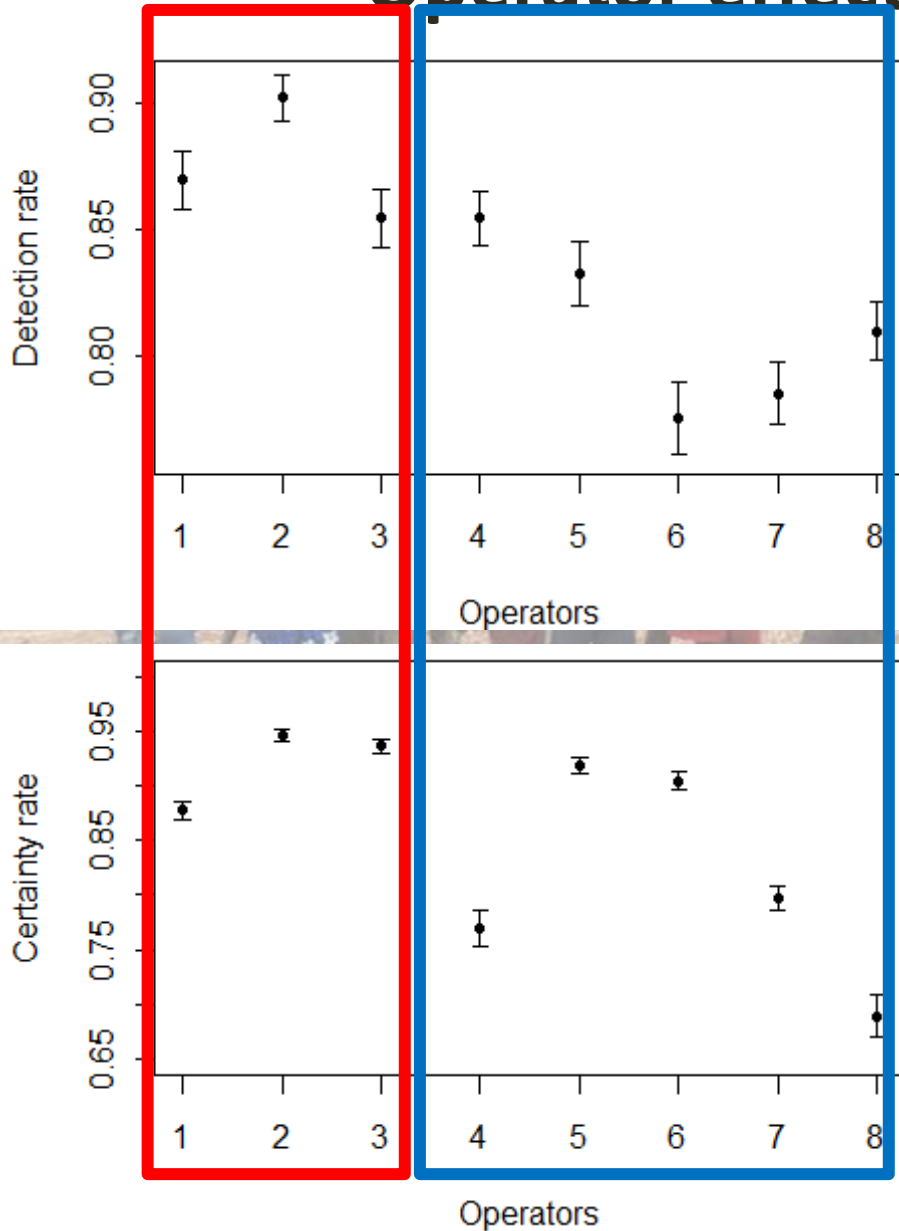


➔ Impact of the wind speed?



➔ Impact of the sun reflection!

Operator effect in countings?



Experienced
Inexperienced

Clear operator effect!

Correction factor of counts

- Correction factor = inverse of the detection rate
- **CF 1** = Correction of **detection**, compared to the estimated number of animals during the current flight
- **CF 2** = Correction of **population** estimation, compared to the maximal estimated number of animals between all flights
- **Global CF = Mean** of CF 1 and 2

Correction factors types	All operators	Experienced operators	Inexperienced operators
1 (during the flight)	1.218 [1.211; 1.226]	1.156 [1.146; 1.166]	1.256 [1.245; 1.266]
2 (maximum between flights)	1.286 [1.276; 1.295]	1.220 [1.207; 1.232]	1.325 [1.312; 1.338]
Global (mean)	1.252 [1.243; 1.260]	1.188 [1.177; 1.199]	1.290 [1.279; 1.302]

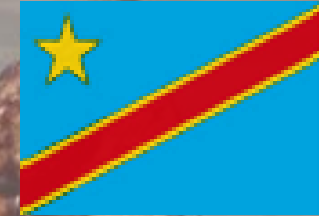
Practical recommendations

- ✓ Flight height: 140 meters
- ✓ Between 6:30 and 8:45 am (3-4°N, 29-30°E)
- ✓ Dry season
- ✓ Limited cloud cover
- ✓ Avoid strong winds & fog
- ✓ Same experienced operators for the counts

Perspectives

- Promising tool for wildlife inventories
- Use of a *multicopter* platform?
- Technical improvements (autonomy, sensors)
- Combination of RGB images & thermal infrared?
- Development of large scale survey protocols

Thanks for your sustained attention!



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