How Many Hippos (*HOMHIP*): Algorithm for automatic counts of animals with infrared thermal imagery from UAV

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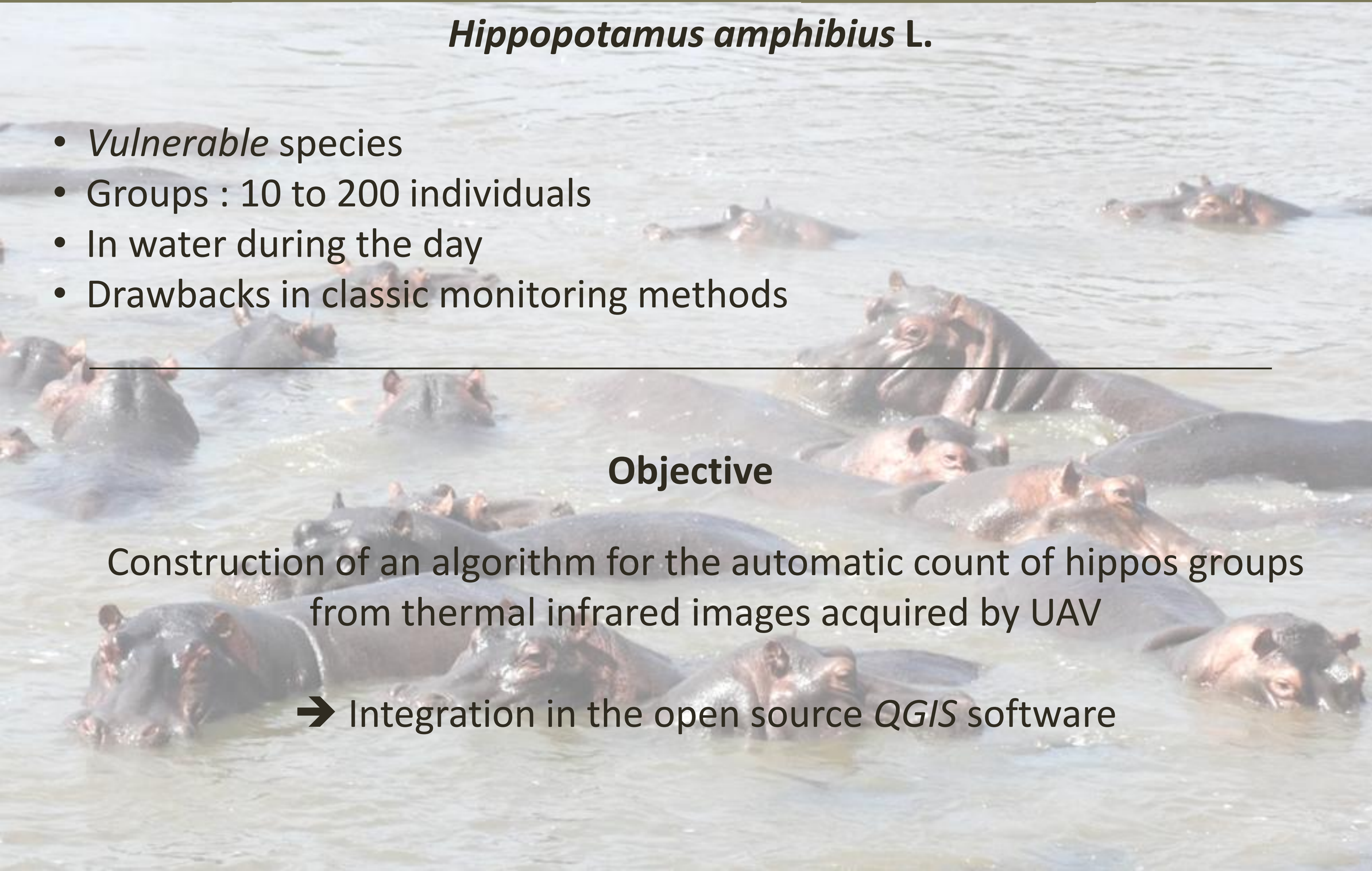
Communication presented at GeoUAV Worshop in the frame of the ISPRS Geospatial Week 2015

La Grande Motte, 2nd October 2015

Ir Simon Lhoest



Hippopotamus amphibius L.

- *Vulnerable* species
- Groups : 10 to 200 individuals
- In water during the day
- Drawbacks in classic monitoring methods

Objective

Construction of an algorithm for the automatic count of hippos groups from thermal infrared images acquired by UAV

➔ Integration in the open source *QGIS* software

Why doing monitoring ?

1. Quantify the impact of **poaching**
   - ➔ Natural growth = 6%/year
   - ➔ Reinforcement/moving of monitoring troops

2. Complete **demographic analyses**
   - ➔ More precise previsions of probable populations evolution

3. Evaluate the **impact of hippos** on their environment
   - ➔ Erosion?
   - ➔ Soils compaction?
   - ➔ Food disponibility?
   - ➔ Competition between herbivorous species?

Automatic procedures

- Detection + counting
- Mainly for birds colonies

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\+ Save time & efforts
\+ Easy to use
\+ Generally reliable results
\- More difficult than human interpretation

Criteria :

✓ Aggregation of individuals (but ~~too close together~~)
✓ High contrast (animal – background)
✓ Sufficient image quality

Falcon Unmanned© UAV

Camera *Tamarisk 640* (λ = 8-14 µm)

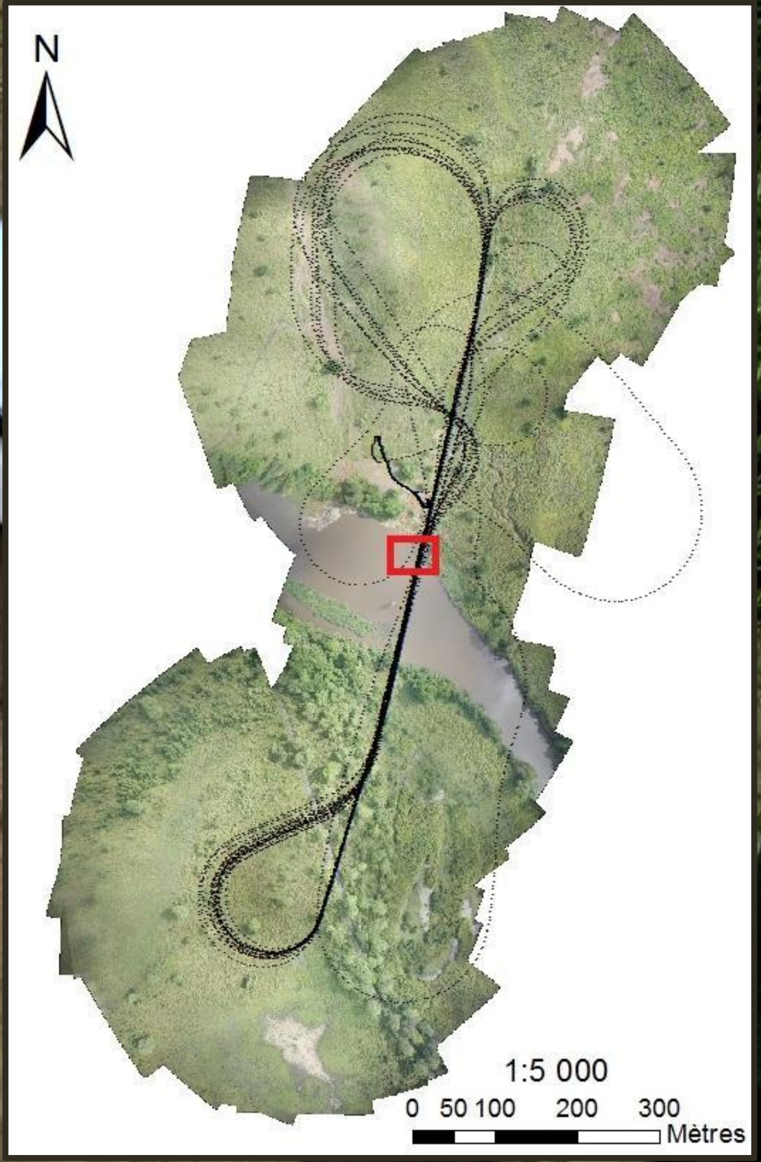
Garamba National Park (DRC)

Flight heights : 38 – 155 meters
(Pixel GSD = 3.8 – 15.5 cm)

14 flights, 2 study sites

Manual extraction of images

Raster values = temperature

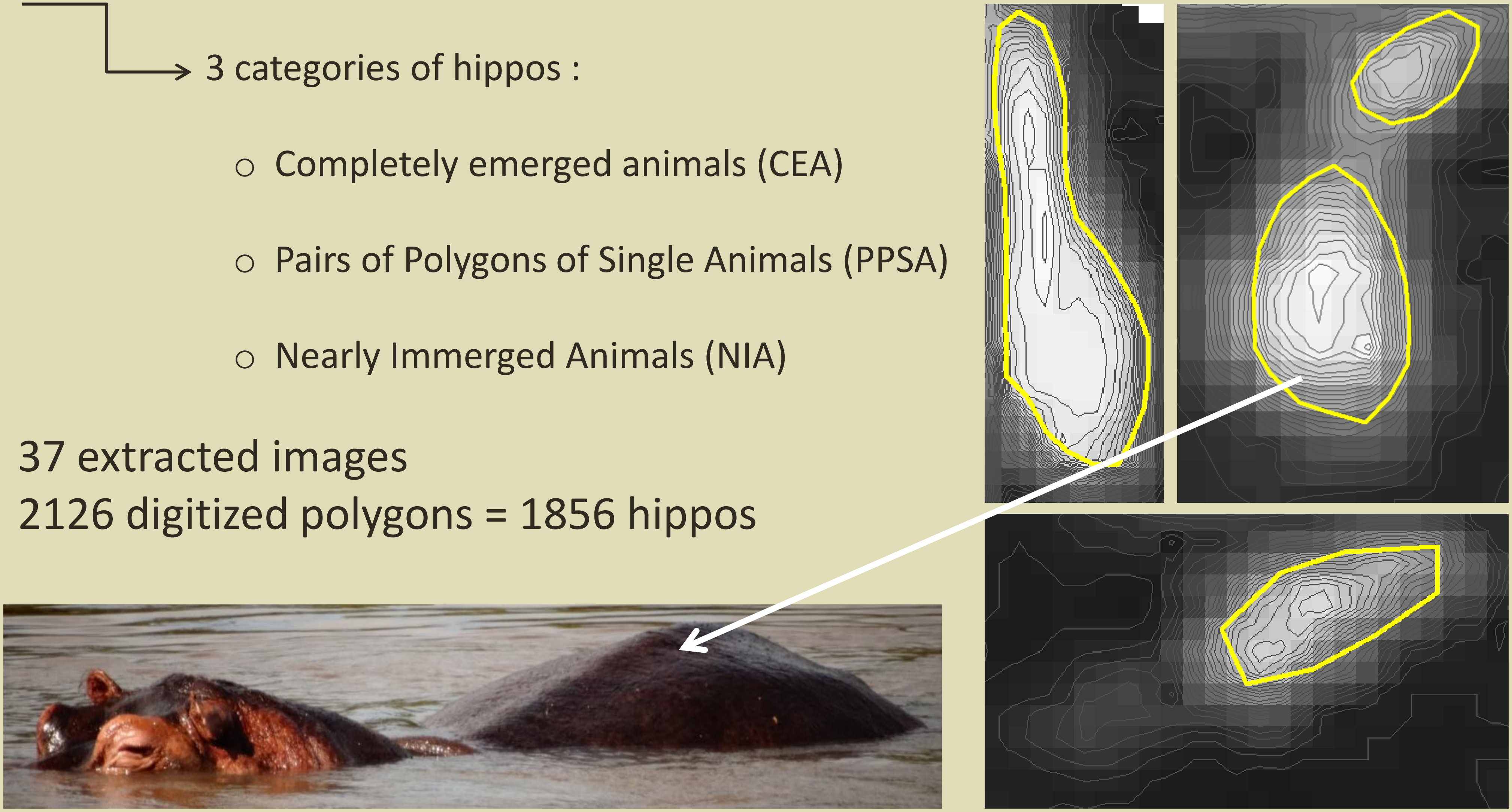


- Reference data = visual and manual digitization of hippos

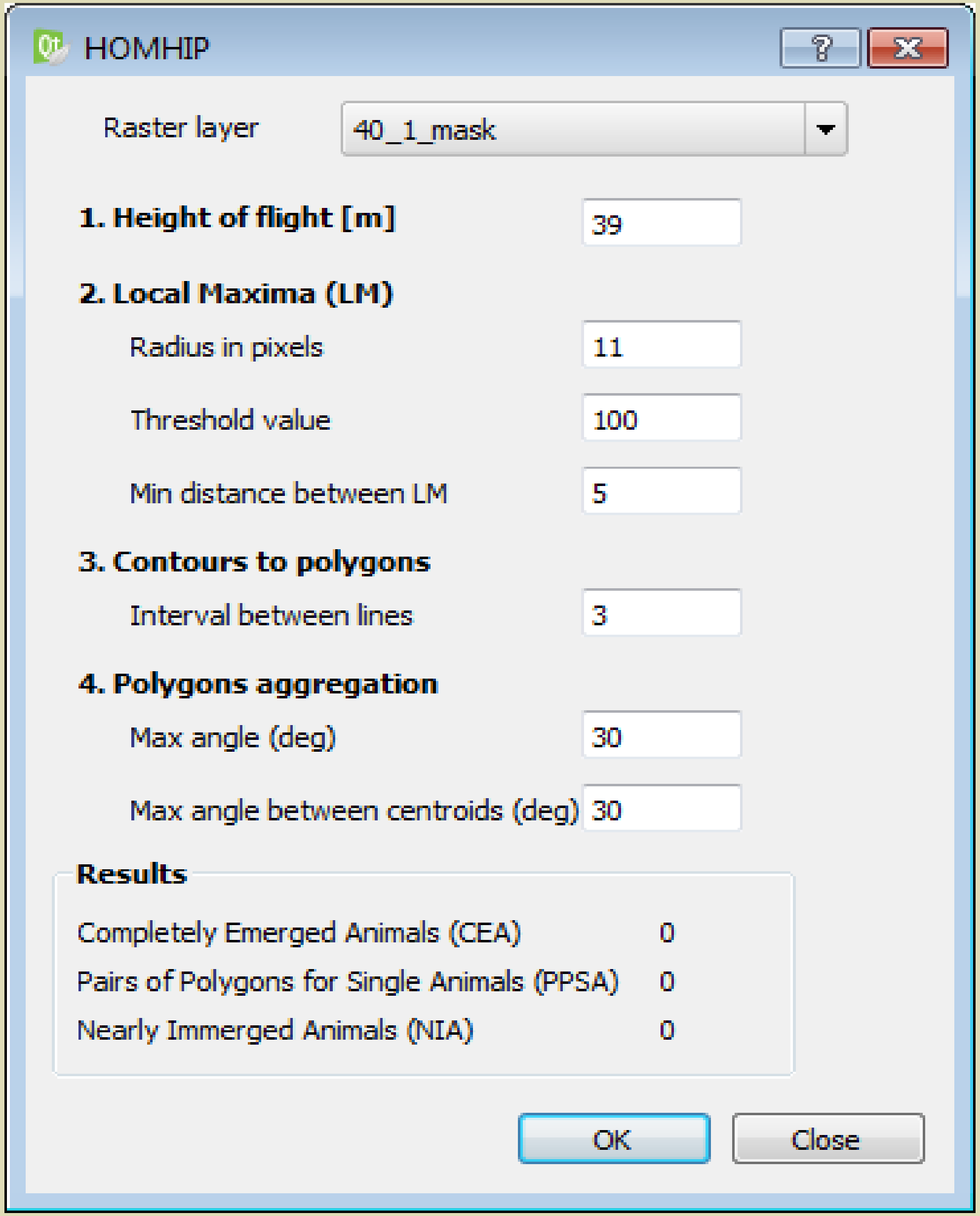
→ 3 categories of hippos :

  - Completely emerged animals (CEA)
  - Pairs of Polygons of Single Animals (PPSA)
  - Nearly Immerged Animals (NIA)

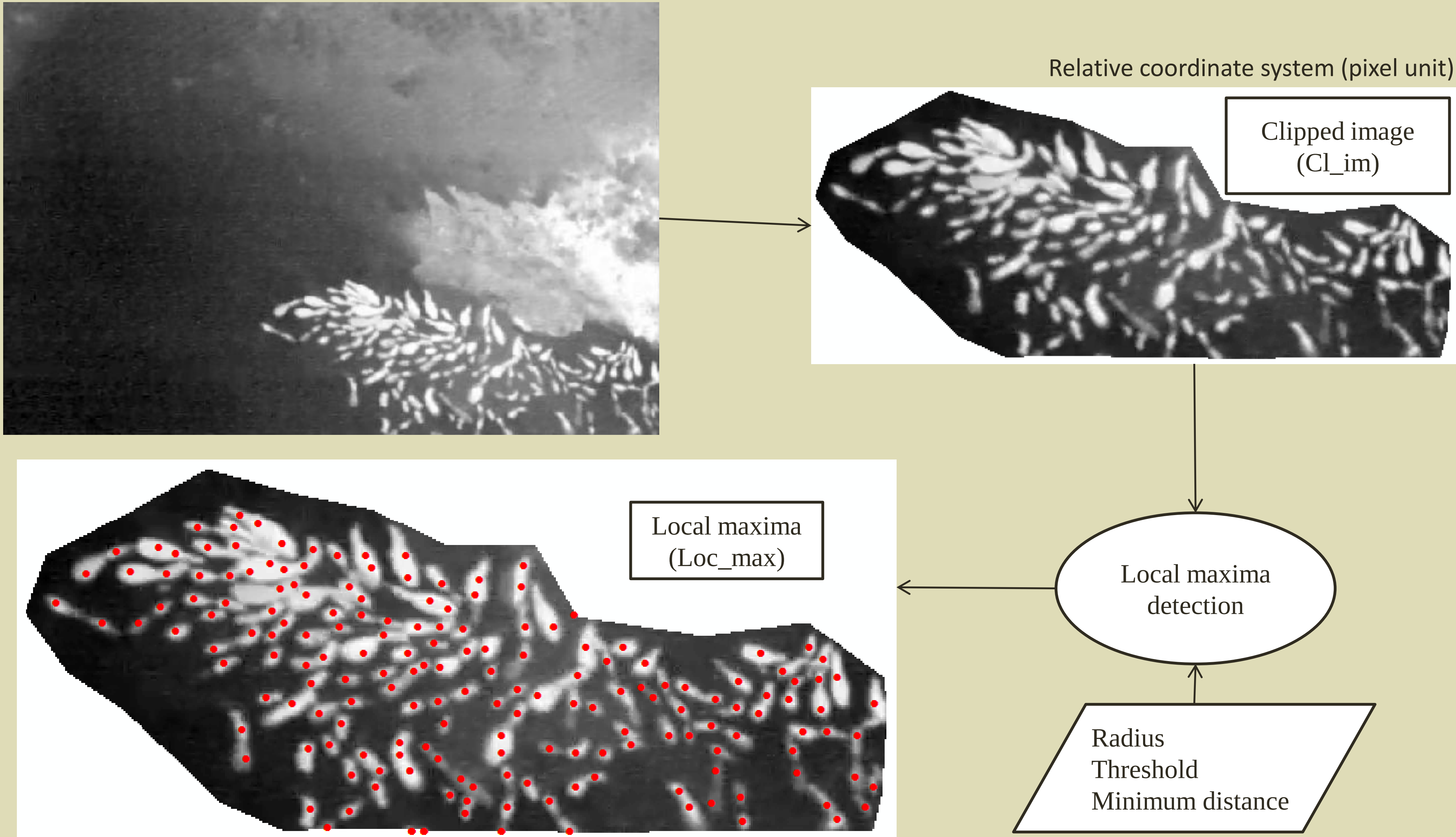
- 37 extracted images
- 2126 digitized polygons = 1856 hippos



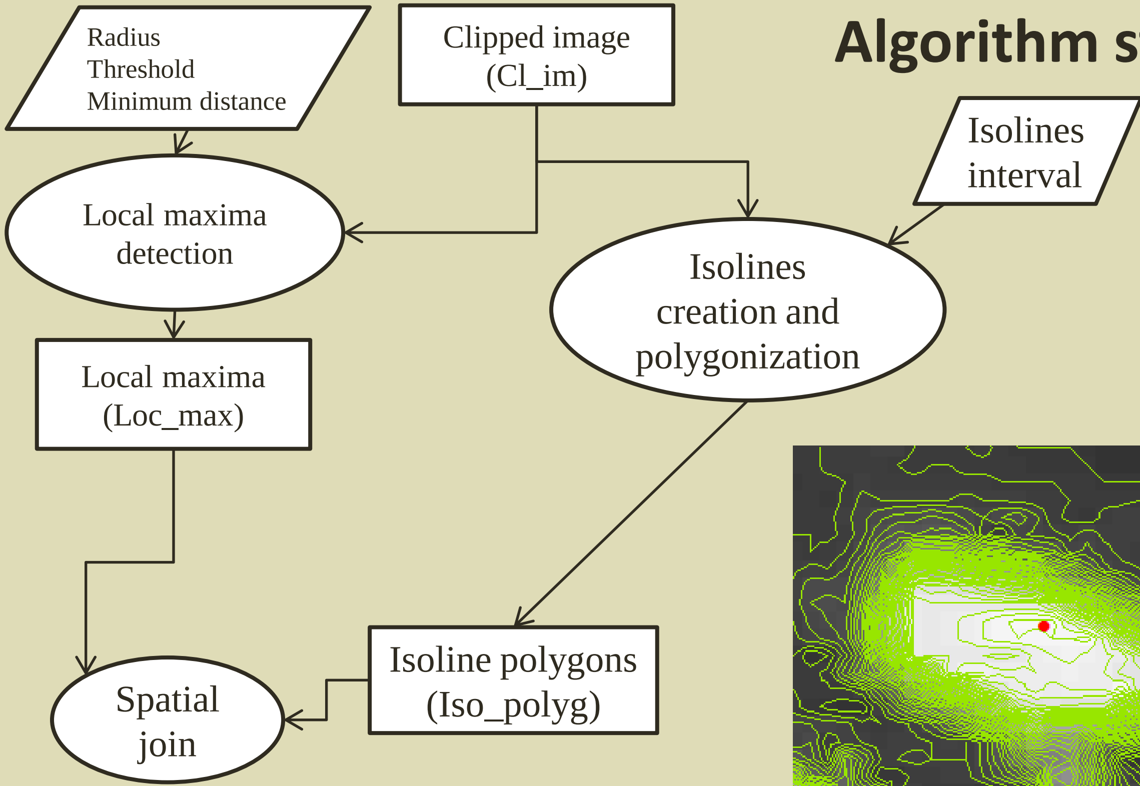
- *Python* script for all the geoprocessing
- *QGIS* application
- Graphical User Interface

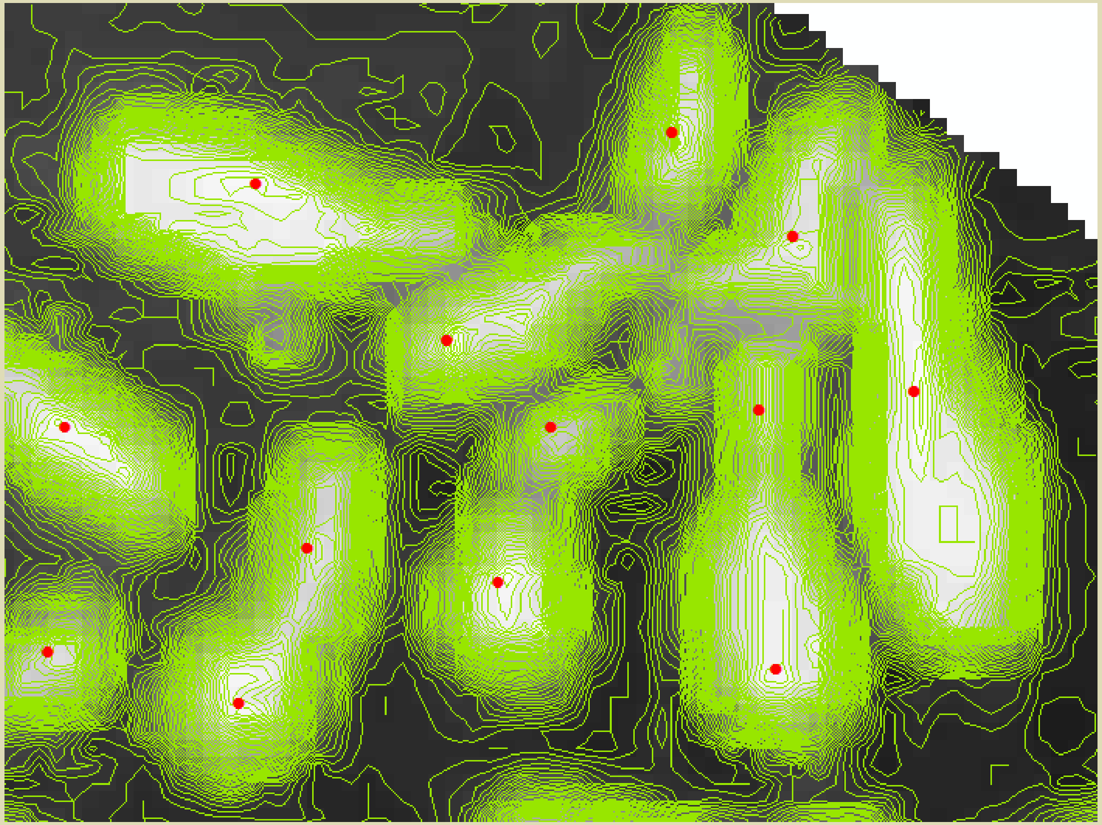


Algorithm steps



Algorithm steps





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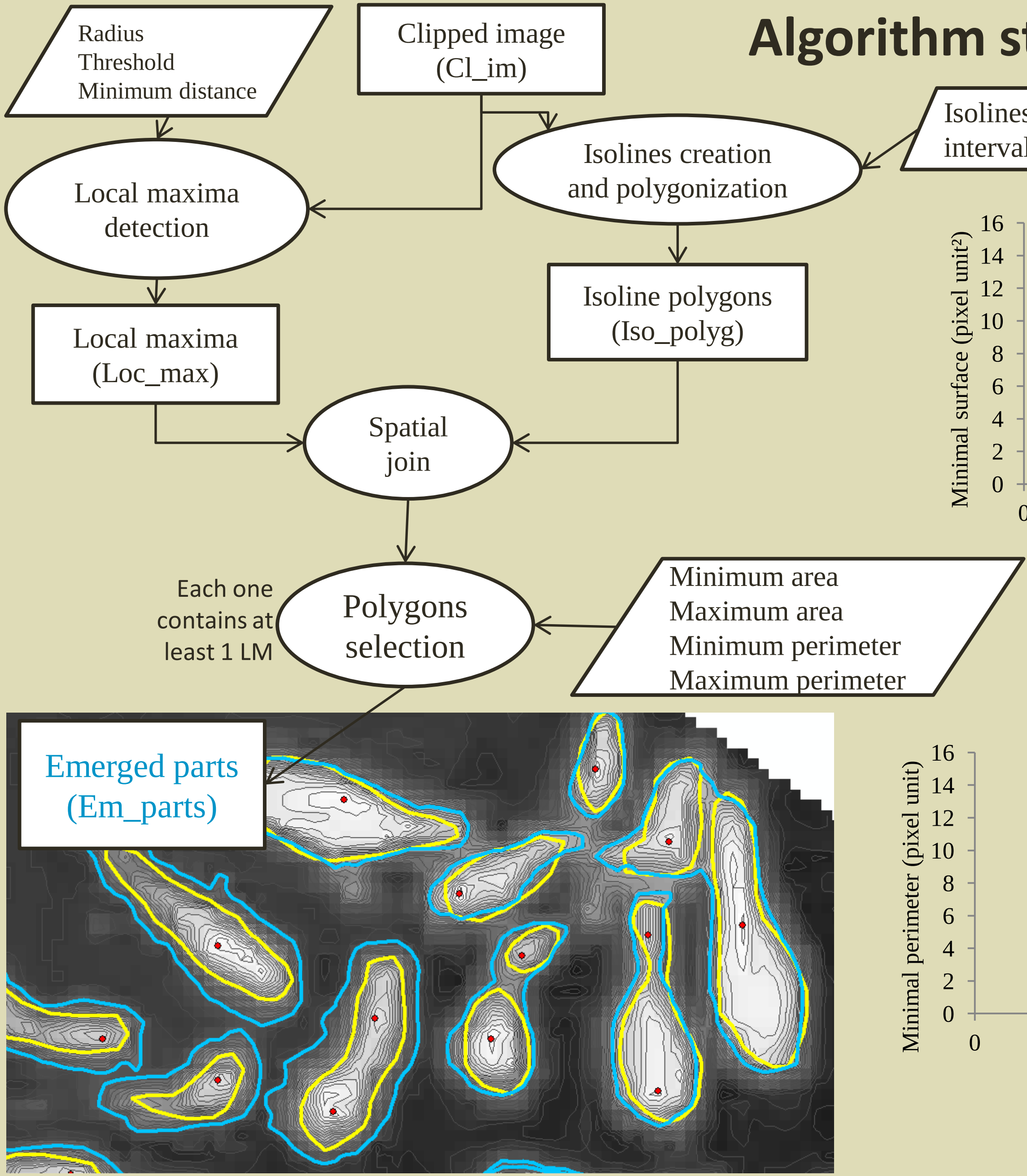
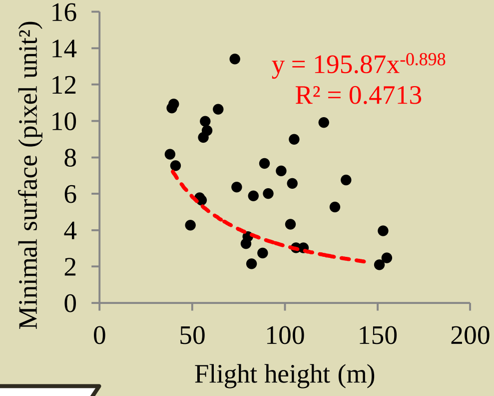
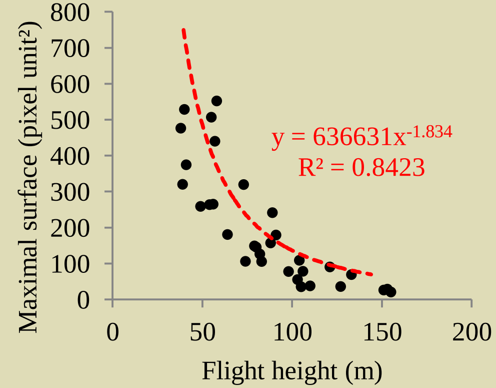
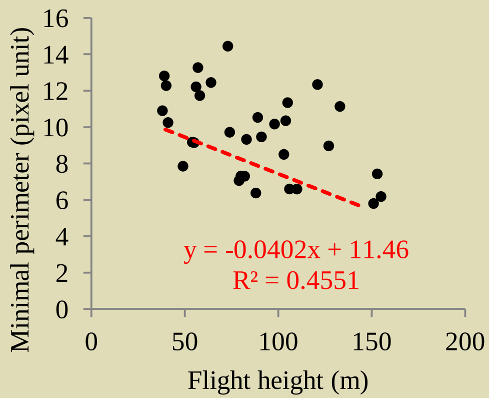
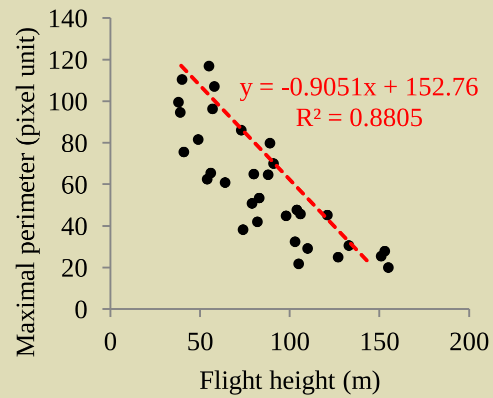


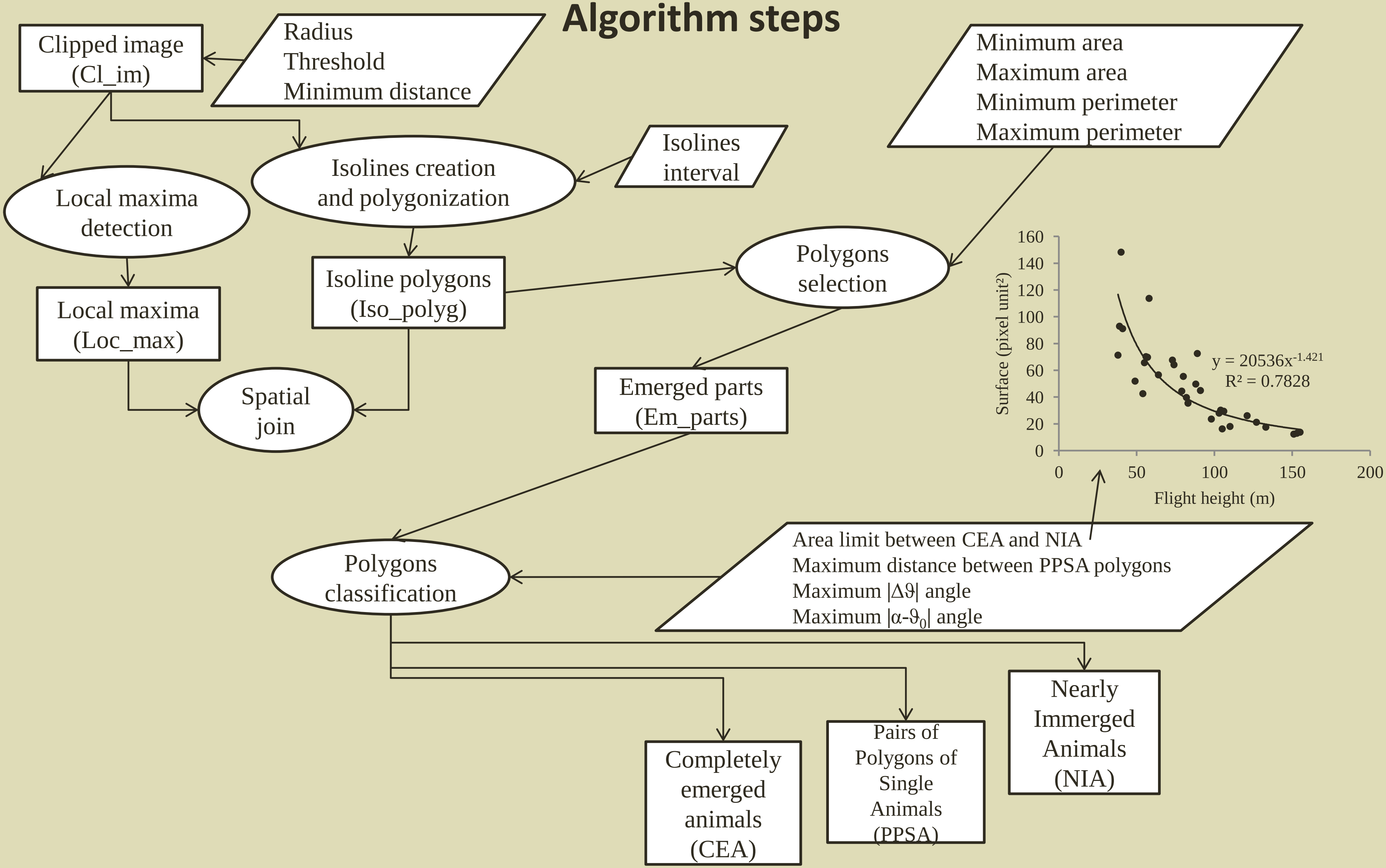








Algorithm steps



Algorithm steps

Criteria for *Pairs of Polygons corresponding to a Single Animal* :

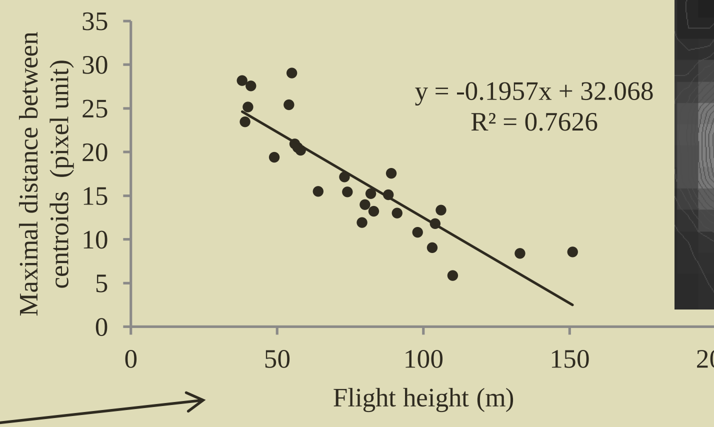
1. Polygons size

Area < CEA polygons

2. Proximity

Maximal distance between polygons

= fct (flight height)



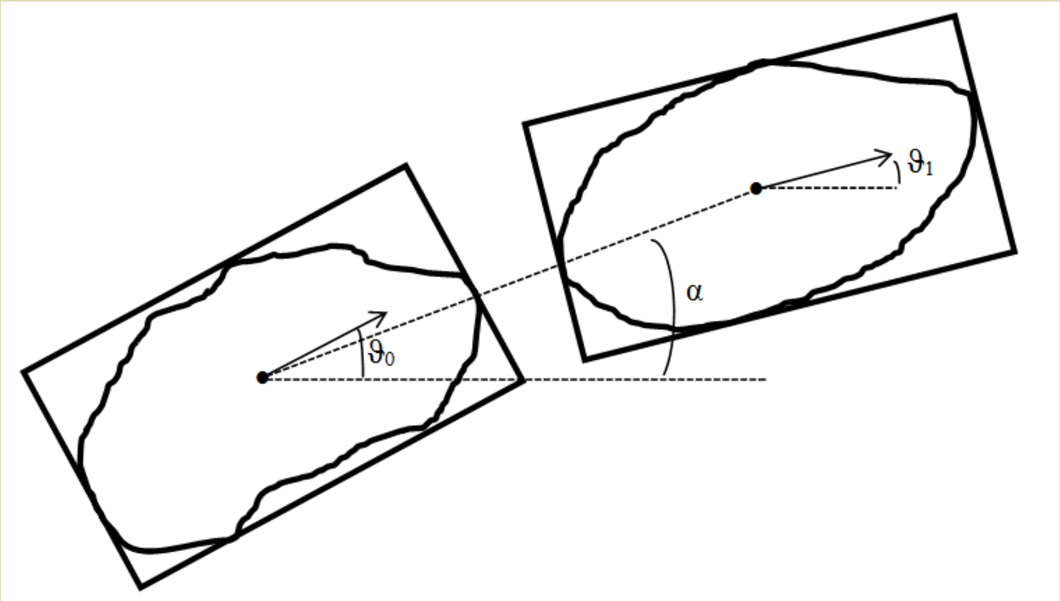
3. Alignment

- Minimum Bounding Boxes

  ➔ orientation characteristics

- 2 angles computed : **|$\Delta\vartheta$|** & **|α-ϑ_0|**

  ➔ maxima values



✓ 30% of images (rainy season)

Mean total error	**+3.9%**
Mean NIA error	+28.5%
Mean PPSA error	-55.4%
Mean CEA error	+20.2%

Minimal total error	-4.9%
Maximal total error	+12.9%

	NIA (Nearly Immerged Animals)	**PPSA** (Pairs of Polygons corresponding to Single Animals)	**CEA** (Completely Emerged Animals)	**Total**
Automatic – manual correlation	0.47 ($p = 0.149$)	0.14 ($p = 0.674$)	0.42 ($p = 0.197$)	<u>0.98</u> ($p < 0.001$)

Image processing

- ➔ Influence of input parameters!
- ➔ Difficult to deal with hippos very close together
- ➔ Hippos categories tend to compensate in counts, but … necessary improvement!
- ➔ Automation of the masking process & selection of images?

Practical recommendations of flight

- ➔ Rainy season (April to November)
- ➔ Not in the end of the afternoon
- ➔ Avoid fog

Exploitation of results

- ➔ Some hippos (under water) are not detected
- ➔ Necessity of a correction factor:

  1.25, according to Delvingt (1978) & Lhoest (2015)

Sensors and UAV improvement

- ➔ Combination of several sensors?
- ➔ Use of high resolution infrared photos?
- ➔ Multicopter platform?

+ Such algorithms are really important to deal with the huge amount of UAV data:

- Great perspectives
- Save time
- Easy to use (open source software)
- Standardized & reproducible procedure ➔ avoid operator effect in counts!
- Adaptable parameters

- Improvement still necessary:

- Automation of pre-process
- Determination of optimal input parameters values

Thanks for your sustained attention!

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