



Committee on Earth Observation Satellites

# Recovery Observatory (RO)

## Haiti Hurricane Matthew RO Status and Next Steps

Presentation to WGD #10  
Napoli September 5<sup>th</sup>, 2018

Agwilh Collet, Helene de Boissezon, CNES  
Jens Danzeglocke, DLR  
Deodato Tapete, Francesca Cigna, ASI  
Jean Philippe Malet, Anne Puissant EOST  
Andrew Eddy, RO Secretary  
with contributions of NASA, NOAA, Copernicus, WB Haiti





# Outline



## □ Haiti Recovery Observatory

- Mission : User Workshop #2
- CNES/EOST Terrain Motion products
- DLR – TerraSAR-X contribution
- ASI – Terrain motion products
- ASI/CIMA – activities for ROCopernicus EMS R&R N50 & N51
- Links with NASA, NOAA, ESA, WB
- Next Steps

## □ RO concept on other areas





# RO Haiti Status Overview



**Hurricane Matthew  
in Haiti  
Oct 4<sup>th</sup> 2016**

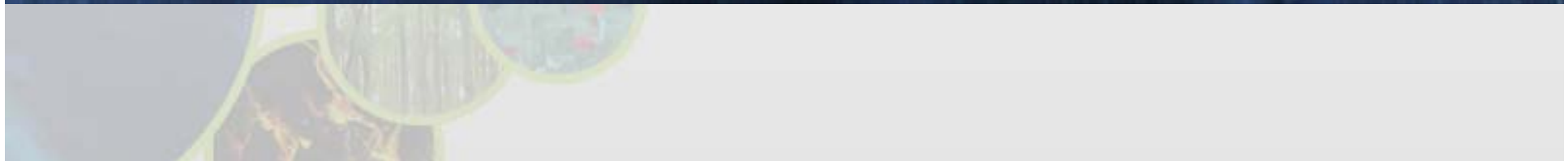
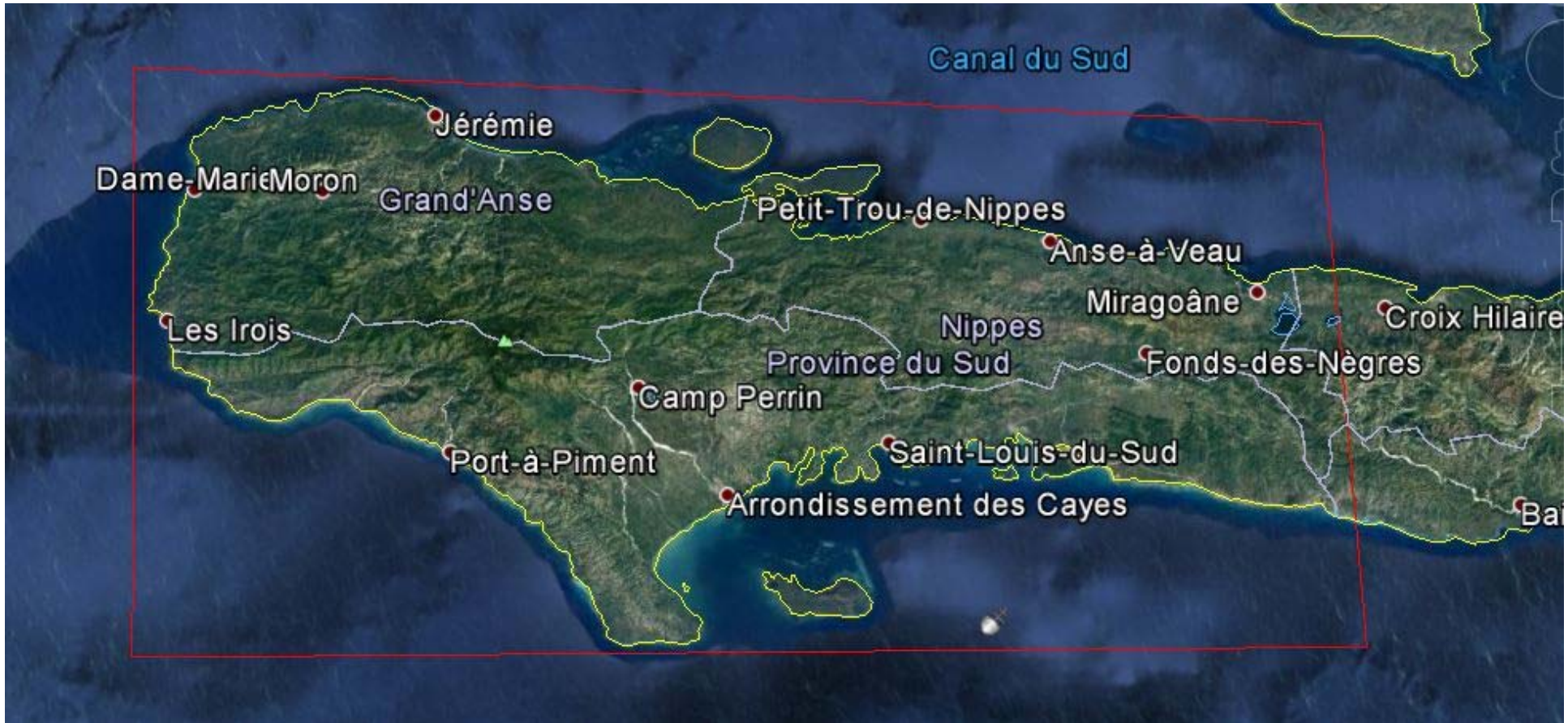
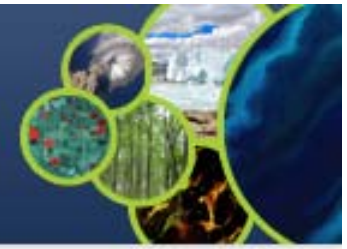
A Reminder of Haiti's diversity

- **Triggering of the RO by CEOS Chair - December 22, 2016**
- **Mission #1 to Haiti - end January 2017** Definition of activities in Haiti
- **Mission #2 to Haiti 29 May – 2 June 2017** 1st RO users workshop
- **Mission #3 to Haiti 5 Dec - 8 Dec 2017** technical review , link universities
- **Mission #4 to Haiti 8 – 11 Mai 2018 - 2<sup>nd</sup> User Workshop (PàP + Les Cayes)**





# Haiti RO covers three departments: Grand'Anse, Sud, and Nippes







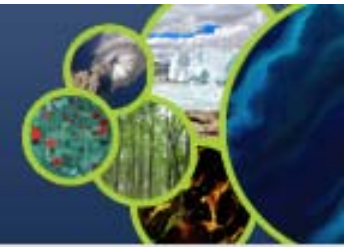
## Key elements since WGD mtg #9 -1



- Finalization of the **CNES / CNIGS MOU**, soon be signed
- Continued **engagement of space agencies** (ASI, CNES, DLR, ESA, NASA, NOAA)
- Activation of the **Copernicus Risk and Recovery Service** by the Delegation of the European Union to Haiti
- Drafting by Haitian partners of a **Capacity Development Plan**
- Writing the **Thematic Product Development Plan**
- A week of **mission in Haiti** with **two user workshops**: user feedback, new needs, cap building
- Holding the **CD # 3**
- Special session at **UR2018 Mexico**
- Coordination meetings with **UNOSAT, WG CapD**
- Proposal to **LPS2019**
- Working on a super site CEOS / GEO proposal in geophysical hazards / landslide



# RO Thematic Products



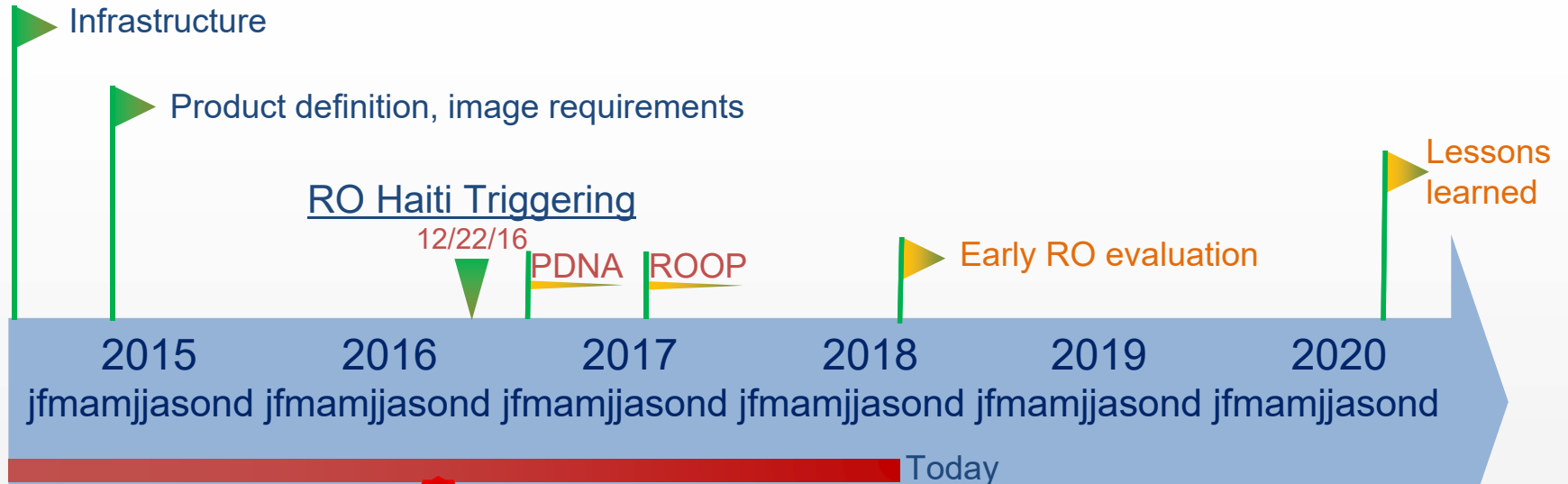
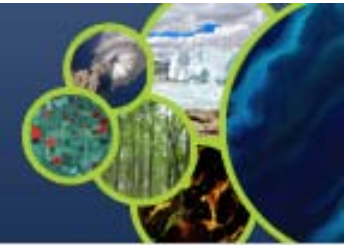
Produit	Utilisateur-clef	Elaboration	Données satellites
Buildings	CIAT/ Planning Ministry	SERTIT, Copernicus EMS	Pléiades, WV
Land Use	ALL	CNIGS/CNES	Orthophotos, Sentinel-2
Forest	ONEV /Environnement Ministry	Copernicus EMS	S2, Spot6/7, Optique THR
Agriculture	Agriculture Ministry	Copernicus EMS	Sentinel-2, SPOT
Macaya Park Monitoring	ANAP / ONEV / Env. Min.	Copernicus EMS SERTIT	Optic THR, radar THR
Suivi bassins versants	ONEV/ Agriculture Ministry	CIMA Foundation	MNT 1m/20cm and radar THR
Terrain Motion / Mining career	BME / Public Work Ministry	EOST, ASI	CSK, Pléiades, Spot6/7
Vector Borne Disease	Heath Minister/ OMS	NOAA	L8, Images NOAA + statistic needs
Air pollution	ONEV / Ministère Santé	NASA	S5P Tropomi Interest pronounced

**+ some new precise needs (more after on different thematics)**





# RO Timeline



Hurricane Matthew  
in Haïti  
10/04/16

Malawi, Nepal  
Demonstrators

Missions to Haiti  
(2 to 3 per year)

External Mission



Technical Review

5-8 Dec

1st  
31 Jan – 3 Feb

1st User Workshop  
29 May – 2 June

2nd User Workshop  
8 – 11 May

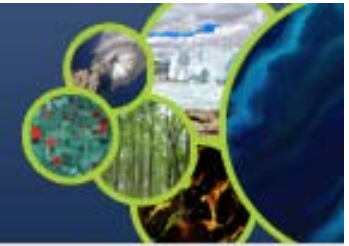


Generic RO discussion

WB + UNDP DC + NYC (date TBC) 7



## Mission : User Workshop #2



### First Workshop « local users » Les Cayes – 8 mai 2018

- About Thirty participants, including :
  - The Major of Jérémie
  - Les Cayes councils
  - American University of les Cayes
  - MARNDR (Agriculture ministry)
  - MDE/ONEV (Environment ministry)
  - PADF (Pan American Devlpt Found.)
  - ONU-Habitat
  - ONG Global
- First analysis of products
- Awareness of project objectives
- Clear involvement of local actors in support of the project
- Identification of training needs and capacity development



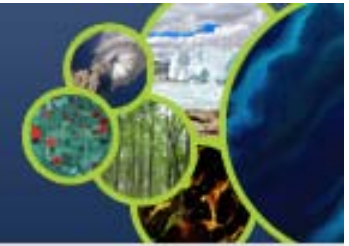
The Mayor of Jérémie during the workshop







## Mission : User Workshop #2



### Second Workshop at Port au Prince – 10-11 mai 2018

- About Thirty participants, including :
  - Minister of Planning : Fleurant AVIOL
  - CIAT, CNIGS, BME, ....
  - MDE/ONEV
  - UNDP, UNEP, UE, BID, ...
  - National Scientific Committee on Risks
  - .....
- Reaffirmation of project support:  
Min Planning, PNUD and CIAT directors
- 1ère analyse de produits
- Update on all topics
- Identification of training needs and capacity development
- Confirmation of priority areas
- Identification of new product tracks – vector diseases, coral reefs, air pollution
- 3rd Steering Committee held after the workshop



Introduction by the Minister of Planning



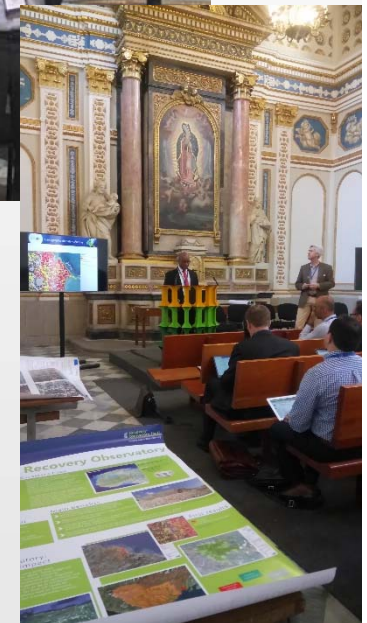
## Side Event UR2018 – May, 15



### Speakers :

- ❖ Haitian Civil Protection (Charte application announcement)
- ❖ World Bank
- ❖ UNDP
- ❖ European Commission (Copernicus Emergency)
- ❖ CNES
- ❖ CNIGS
- ❖ CIMA (ASI)

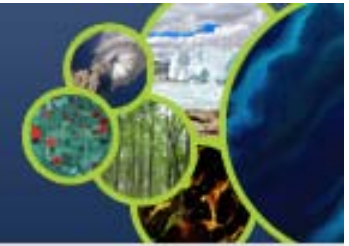
- **Forty listeners**
- **Strong audience interest (RO replicability issues)**
- **Reinforced links with WB, GFDRR teams working on Haiti**
- **RO contribution to two other side events (WGD, WB / Insurance)**
- **Working meeting with WB / GDRR: decision of White Paper CNES-WB-UN-EU, with WB review**







# CNES Production



- Internship CNES (April-September 2018)  
Adaptation of IOTA2 chain on Haiti for land use with S2

Context : No land use map since 98 ... 2014 in progress

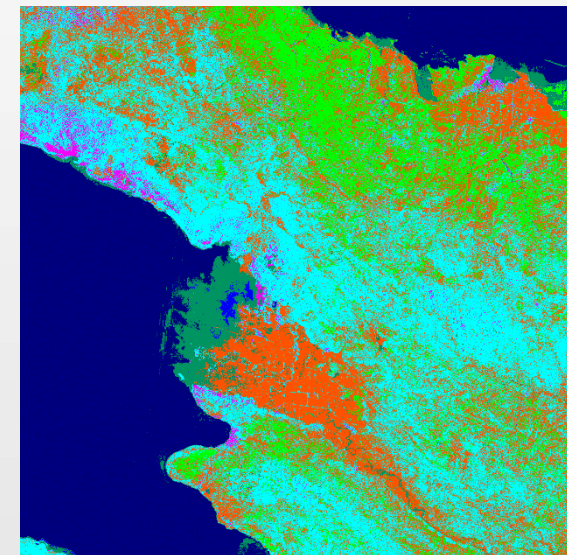
Data preparation procedure under development; will be exchanged with CNIGS. The goal is to go as far as possible with the limited data available.

- Internship CNES/IRD  
Update of the Territorial Diagnosis of the RO Area.  
By an Haitian academic at IRD (Montpellier)

- SERTIT activities on going (Feasibility tests ):

- Anthropogenic monitoring Macaya Park
- Tracking areas non-aedificandi Port Salut (non housing area)
- Monitoring protected areas UNEP

Culture  
Forêt  
Bâti  
Route  
Eau  
Mer  
Zone d'inondation



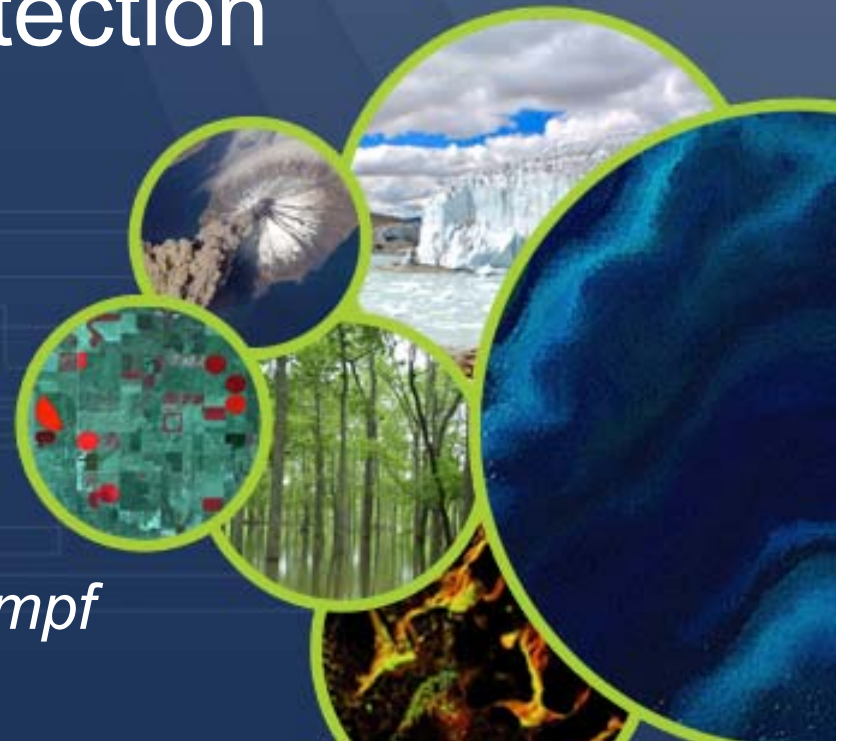


**Recovery  
bservatory Haiti**

# Automatic Landslide Detection and Mapping from VHRO images

*CNRS-EOST*

*E. Stell, J.-P. Malet, O. Marc, A. Stumpf*







# Post-hurricane landslide detection and mapping: Haiti



## Haiti – Les Anglais Cordillera

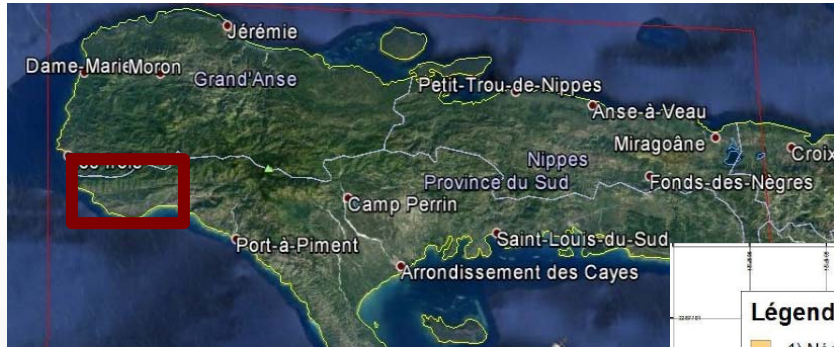
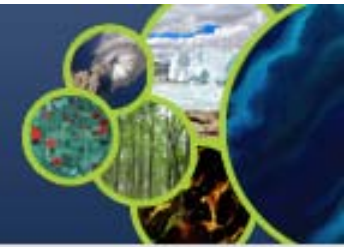


Also focus of Landslide Pilot





# Post-hurricane landslide detection and mapping: Haiti

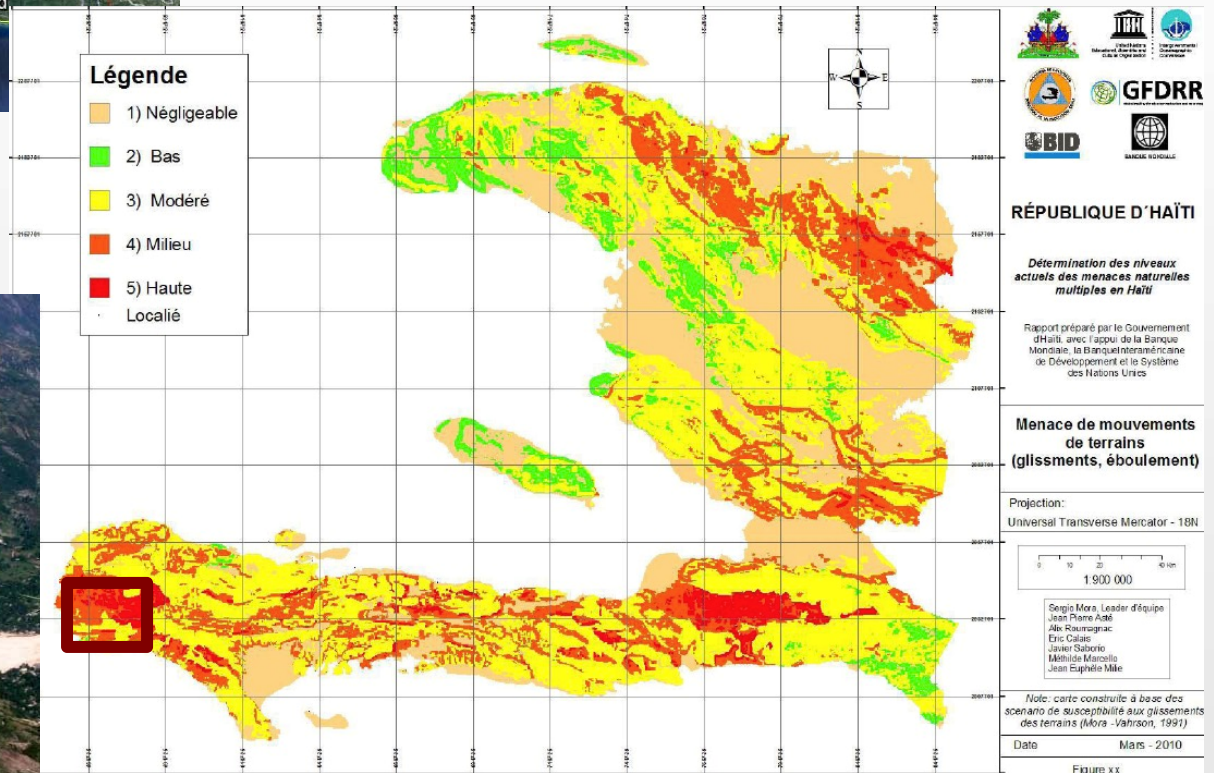


First landslide susceptibility map for the country

Topography = first driver of landsliding

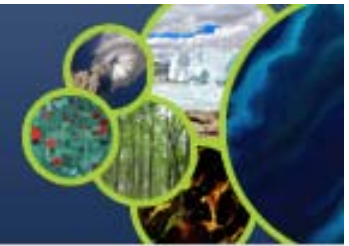
Map created without landslide information

Landscape after Matthews  
Major rain events





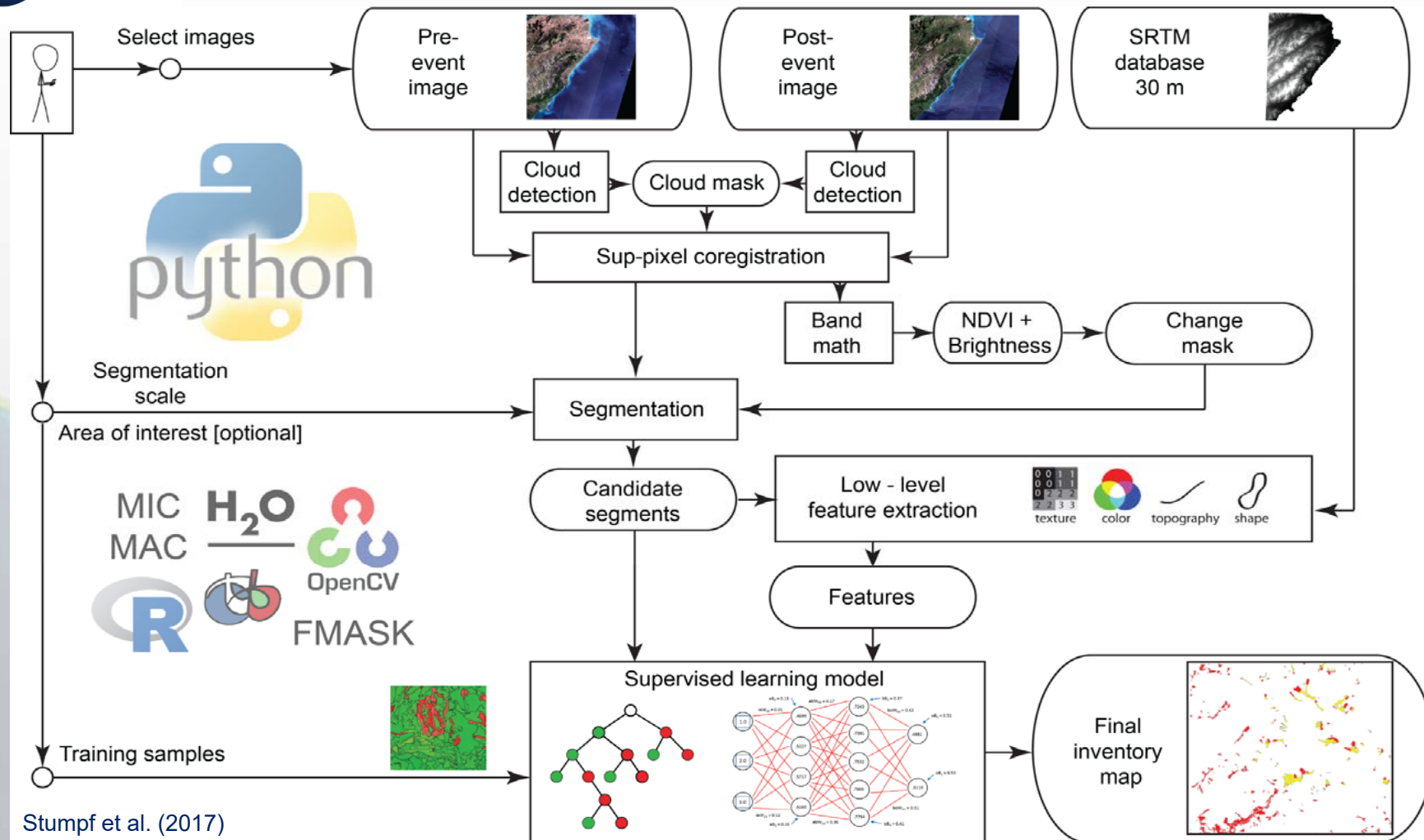
# Landslide mapping using medium-resolution Sentinel-2 Optical Data



## ALADIM: Automated Landslide Detection and Inventory Mapping

Image sources: S2 + VHRO ortho-images

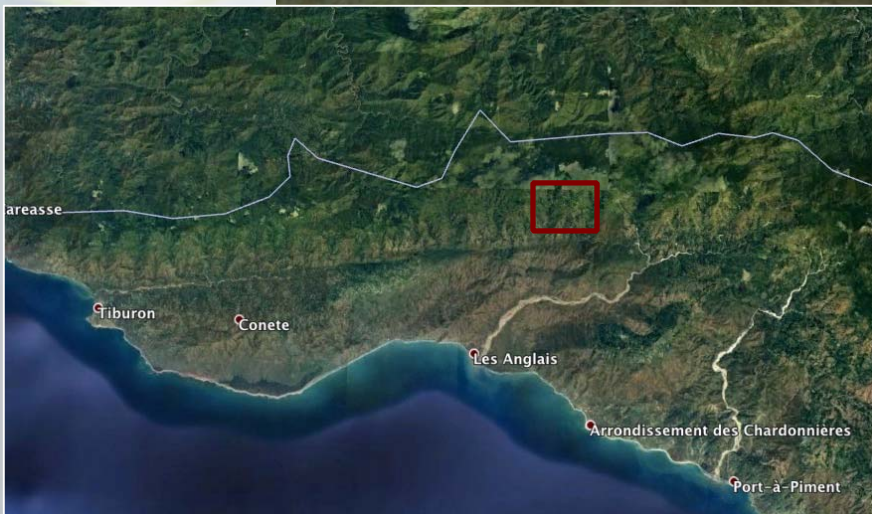
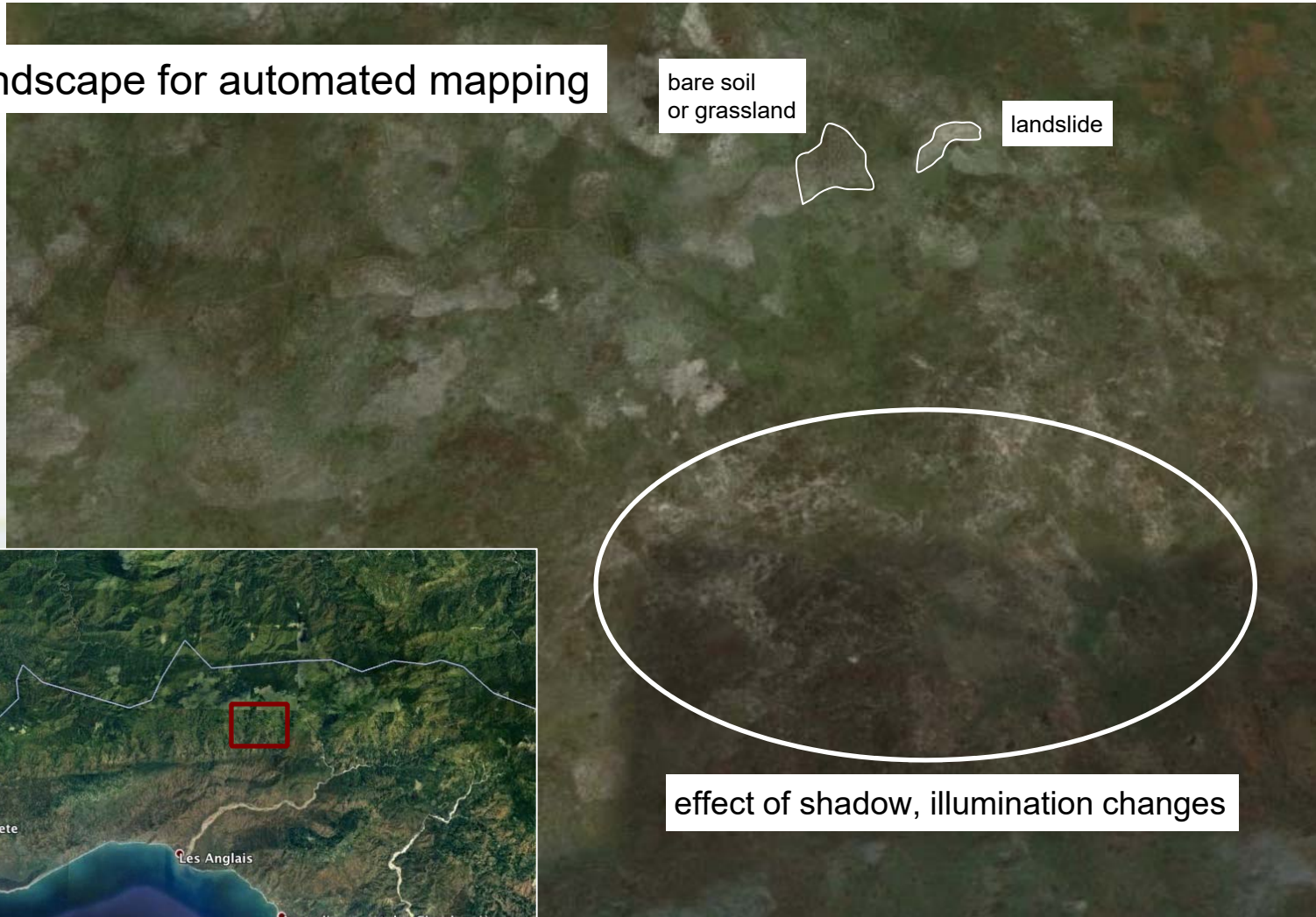
Supervised method - Selection of image features - Random Forest classifier  
HPC + cloud-based implementation (through dockerisation)







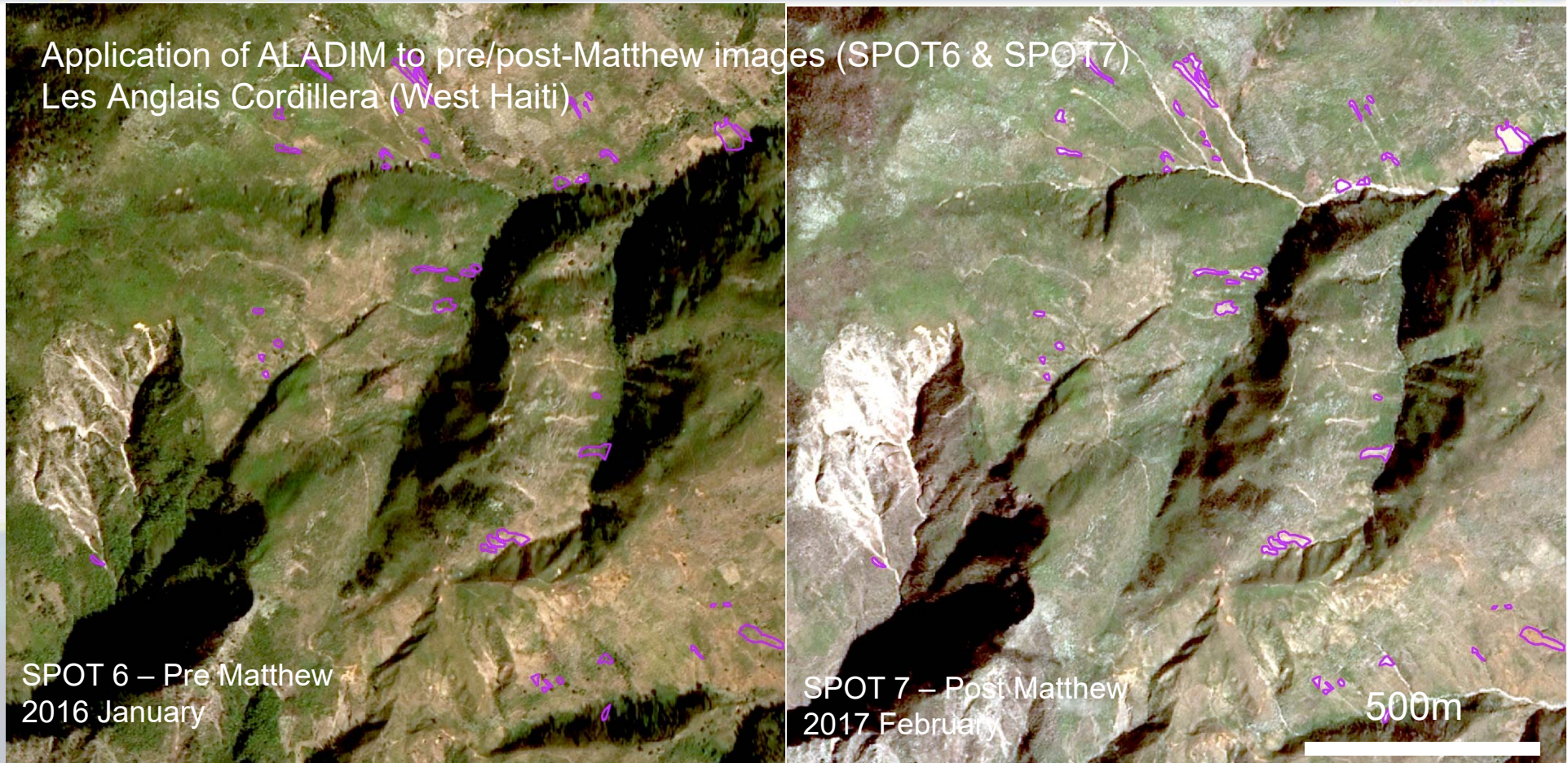
Complex landscape for automated mapping







Application of ALADIM to pre/post-Matthew images (SPOT6 & SPOT7)  
 Les Anglais Cordillera (West Haiti)



SPOT 6 – Pre Matthew  
 2016 January

SPOT 7 – Post Matthew  
 2017 February

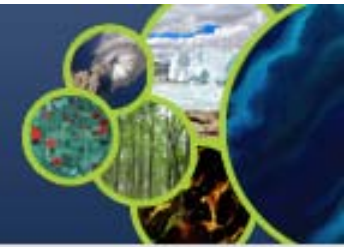
500m

Channel deposits are difficult to map (they may add ~30% of affected areas)  
 Shadows on West and North slopes may cause underestimation of the total landsliding  
 Many bare soils .... Difficult for automated mapping

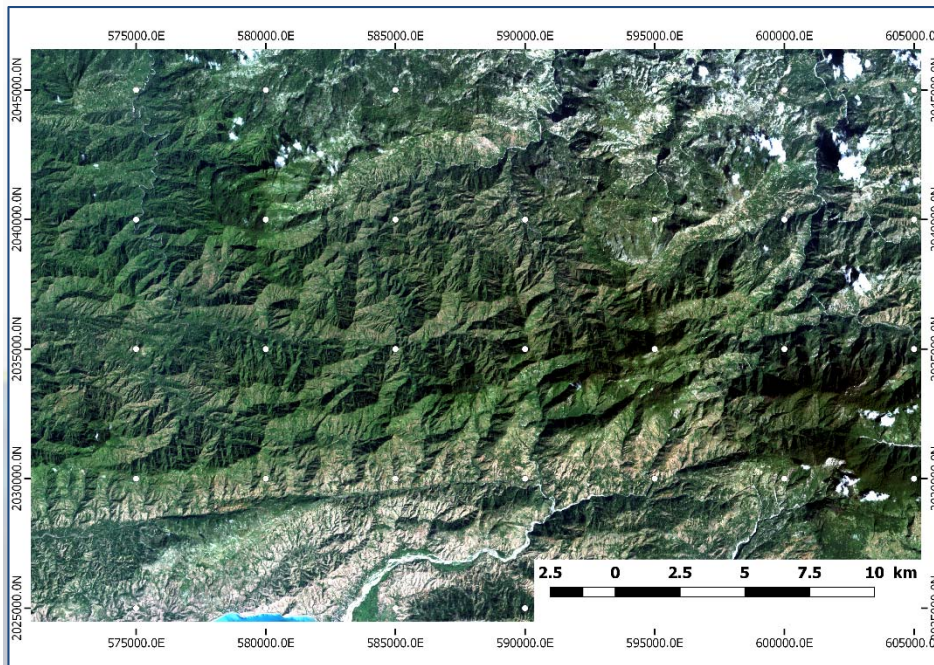




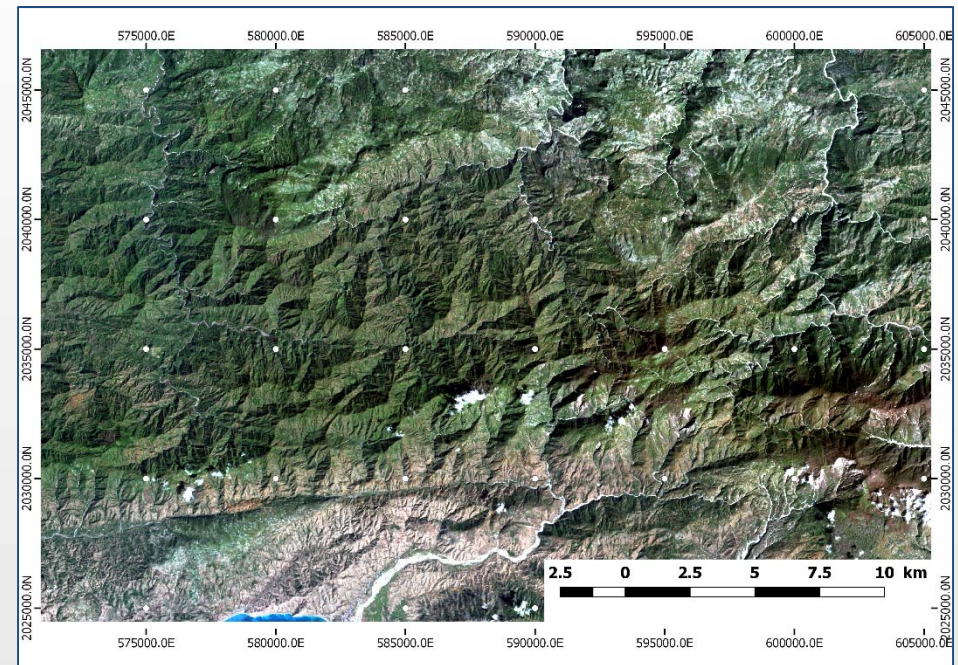
# Post-hurricane landslide detection and mapping: Haiti



Spot 6 pre-event 2016/04/14 (1.5m)



Spot 7 post-event 2017/04/04 (1.5m)







# Post-hurricane landslide detection and mapping: Haiti

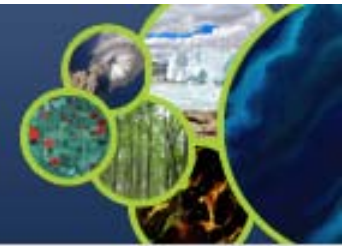


Experiments on different parameters were run in order to obtain the 'best' results

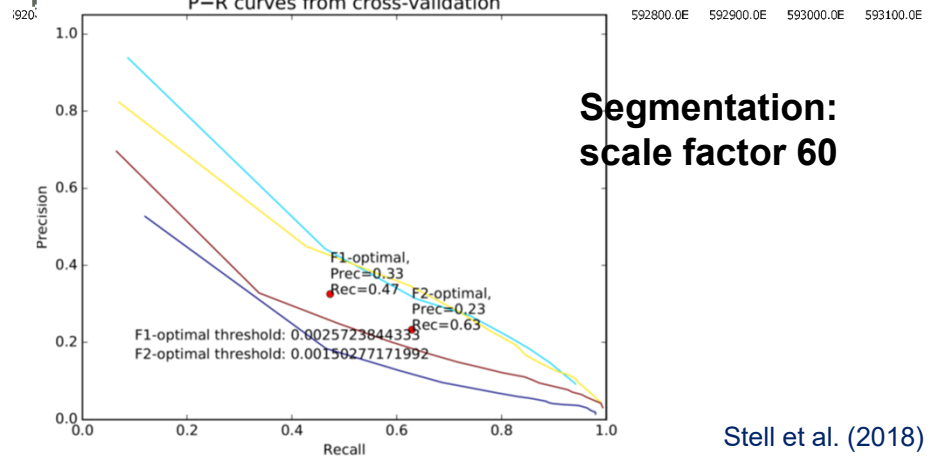
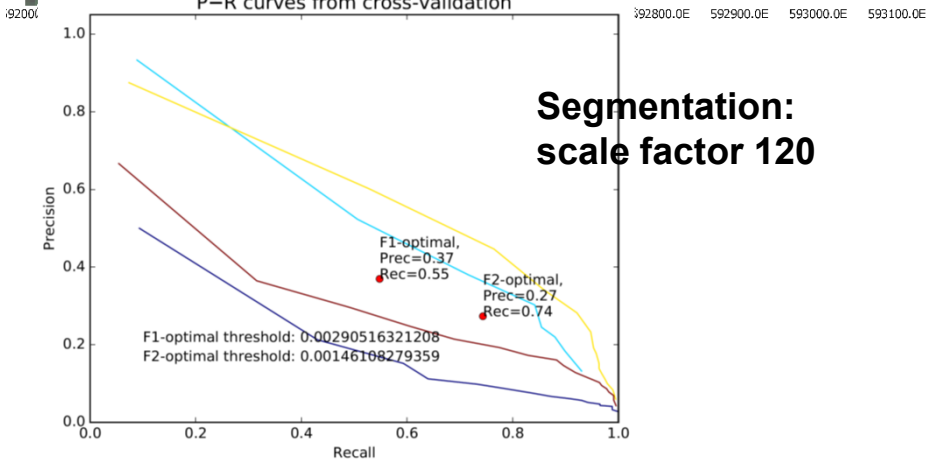
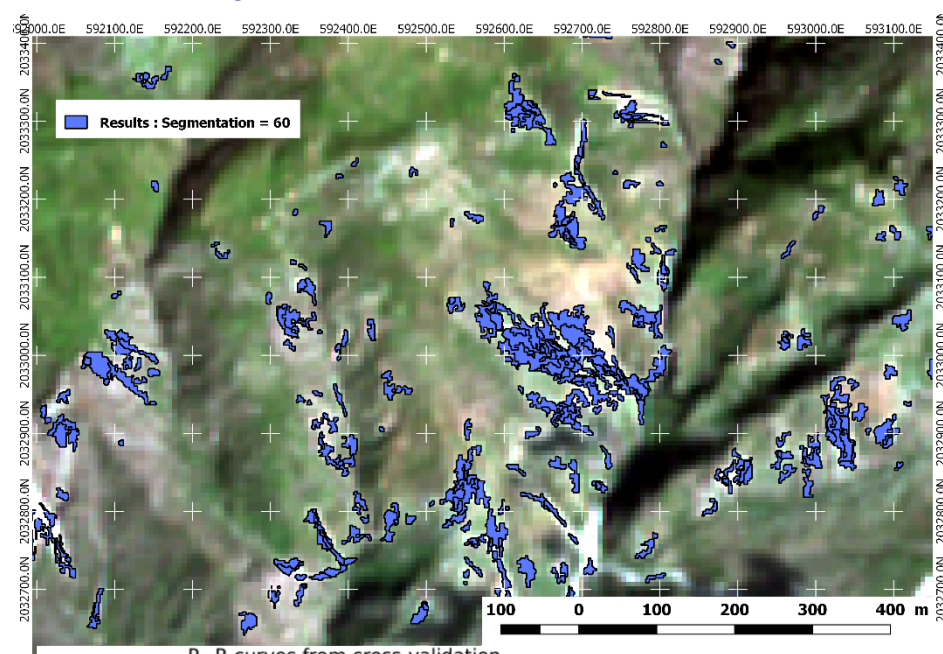
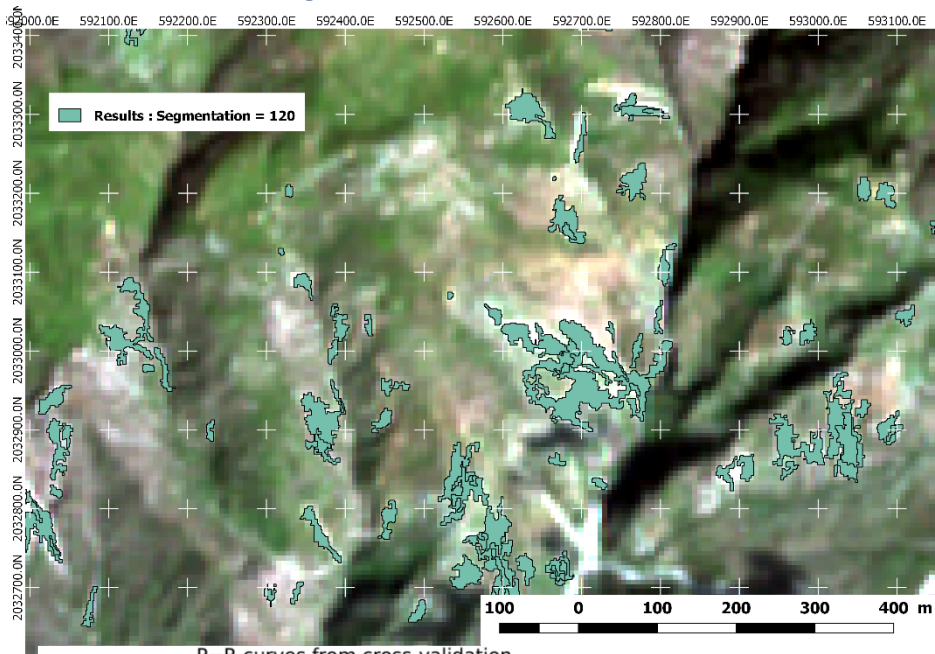
- **Segmentation** : The segmentation scale factor. Larger values will result in fewer larger segments and faster processing. Smaller values will result in more small segments which will increase the processing time but also typically the accuracy of the classification. The value depends a lot on the value range of the input imagery and the landscape characteristics. Settings tested : 20 / 60 / 120 / 200.
- **Training areas** : Area(s) mapped by the user, containing the training samples. Improve the diversity of the mapped landslides to improve landslide detection. Question: is it necessary to map a lot of landslides before running ALADIM ? Settings tested: 20 / 10 / 5 / 1 areas.
- **Positive Threshold** : A value between 0 and 1. If the fraction of positive area (i.e. landslide as mapped in the training samples) within a segment exceeds this value it is considered as a positive example. Different settings : 0.25 / 0.50 / 0.75.



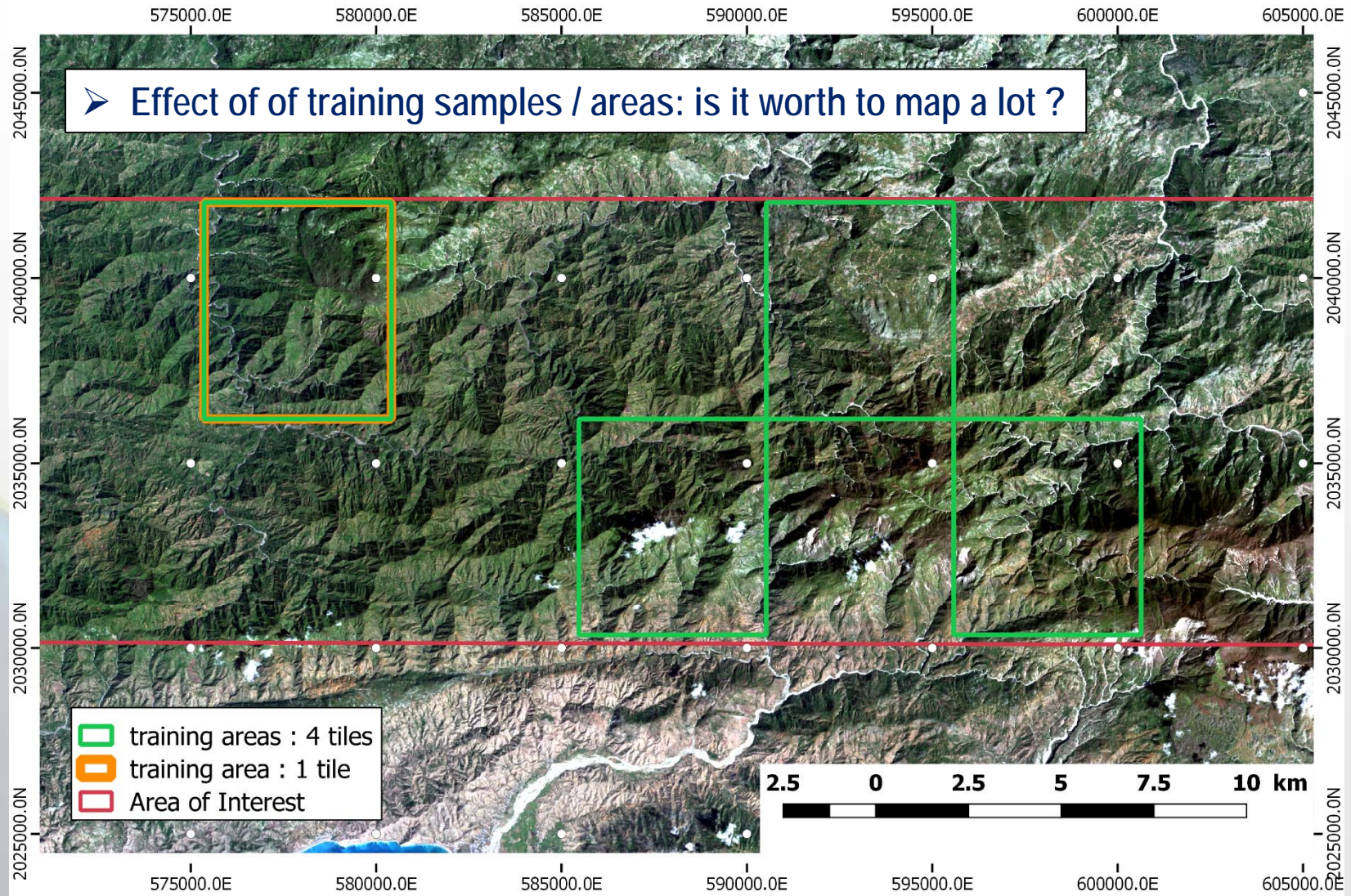
# Post-hurricane landslide detection and mapping: Haiti



Effect of segmentation: → better results for a coarse segmentation











# Post-hurricane landslide detection and mapping: Haiti

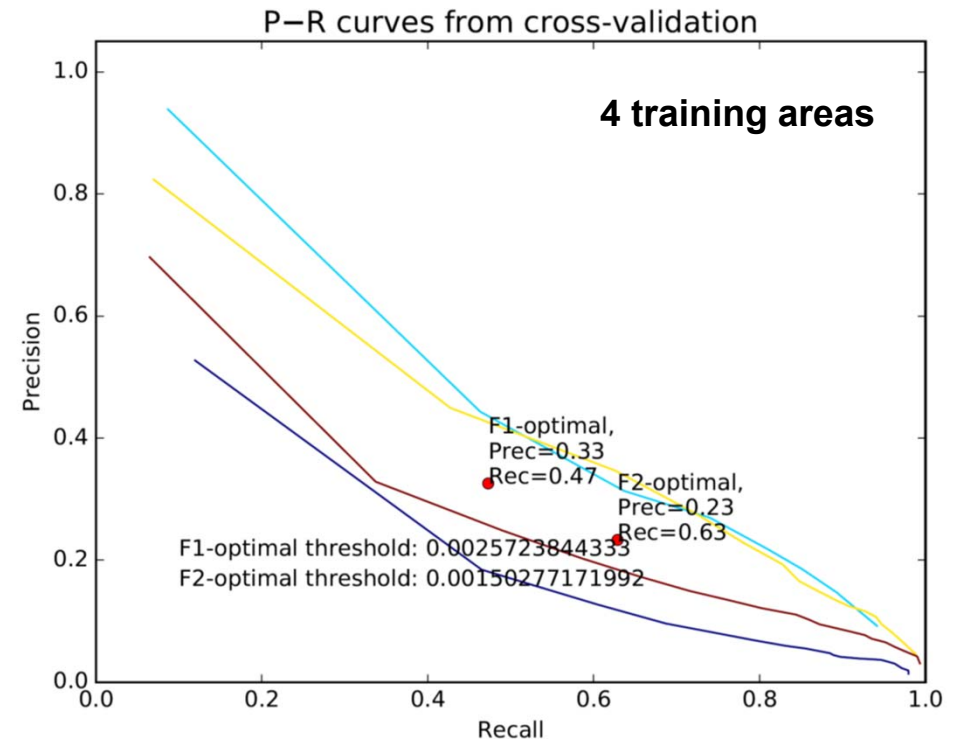
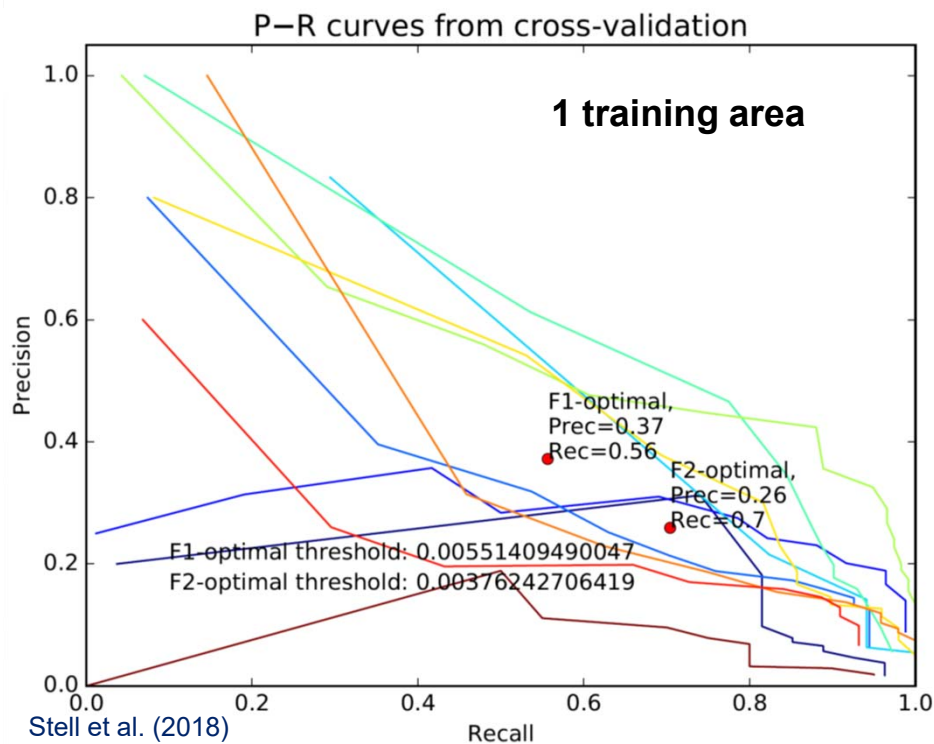


## ➤ Effect of training samples / areas: is it worth to map a lot ?

Many landslides need to be mapped and integrated in the training sample because

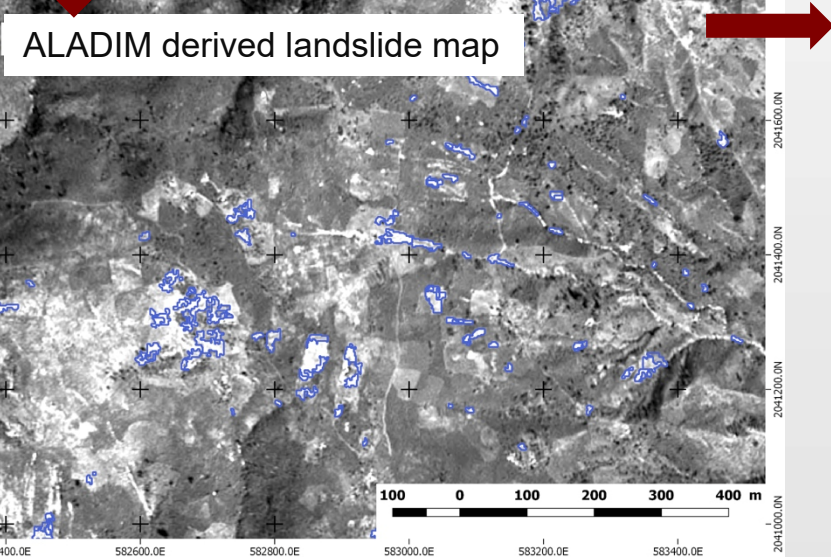
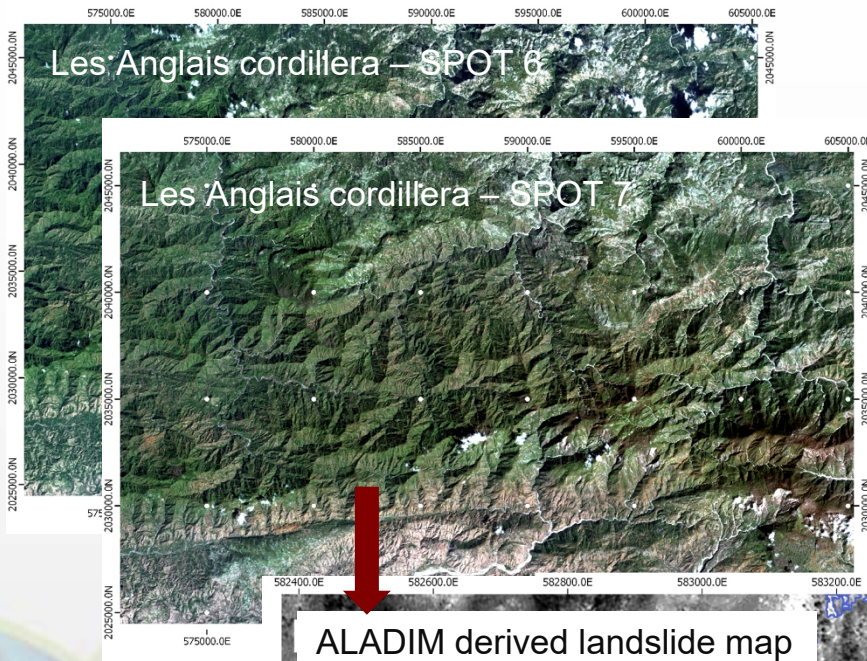
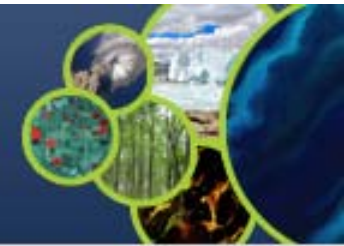
- of the complexity of the landscape (many anthropogenic activities, mining + agricultural fields)
- of the small size of the landslides (shallow and small)
- of the specificities of the images with a lot of shadows

→ better results with 4 training areas and better results if high resolution topography is integrated





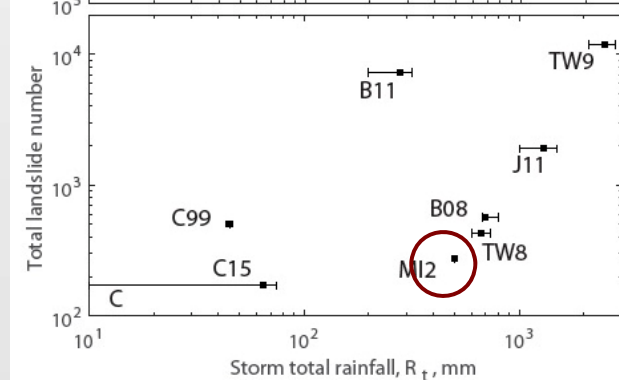
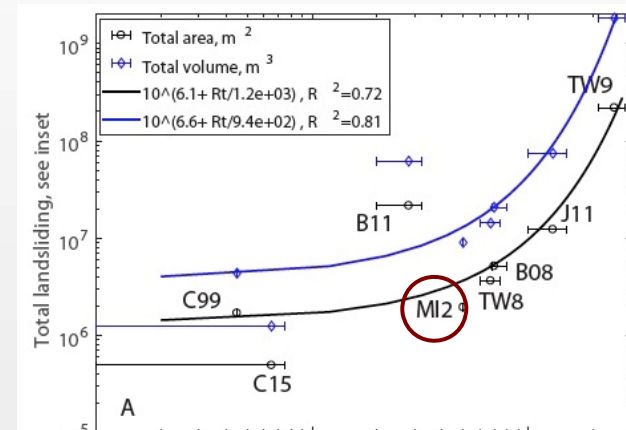
# Post-hurricane landslide detection and mapping: Haiti



Results of ALADIM-Caribbean:  
→ Haiti – post-Matthews landslides



Landslide statistics and relation to triggers for several recent Hurricanes/Cyclons





1. Develop Active Learning (AL) strategies for optimizing the creation of the training sample  
→ projet IM-CLASS (post-doc appli) funded by CNES (*A. Deprez*)

2. Mask non-possible landslide areas before the classification  
→ geological and topographic filtering  
→ landcover filtering

3. Generalize the approach to the complete RO area  
→ projet IDEX (post-doc) funded by Univ. Strasbourg (*S. Nakostian*)

4. Possibly test on new images after new landsliding events → EO-based landslide observatory over Haiti (links with GeoHazard Lab, with Landslide Pilot, etc)



# Potentialities of Pléiades imagery to detect mineral extraction sites (quarrying, mining) in tropical environments

Anne Puissant

with the contribution of L. Schwaab

LIVE UMR 7362 CNRS / UNISTRA

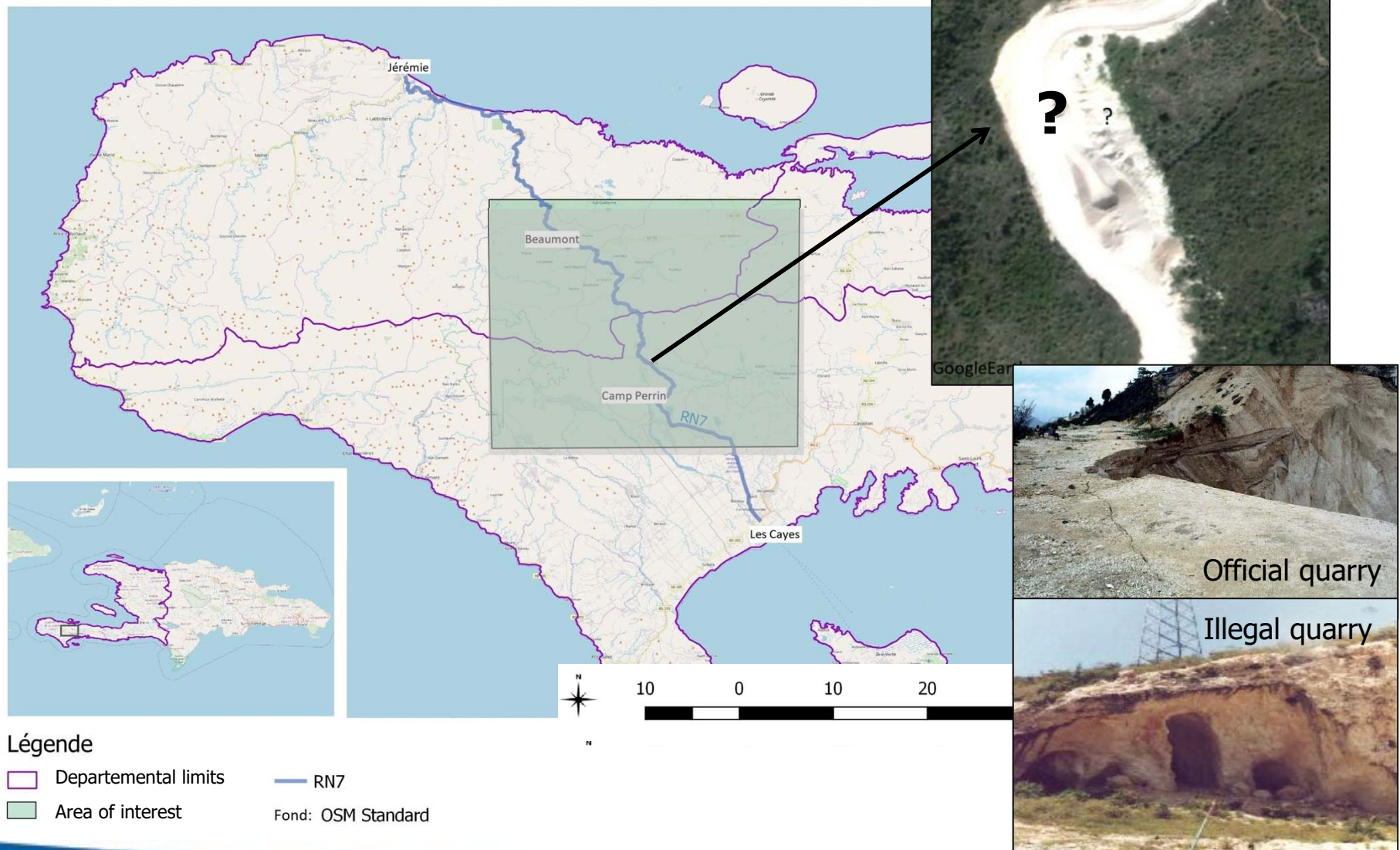
[anne.puissant@unistra.fr](mailto:anne.puissant@unistra.fr)



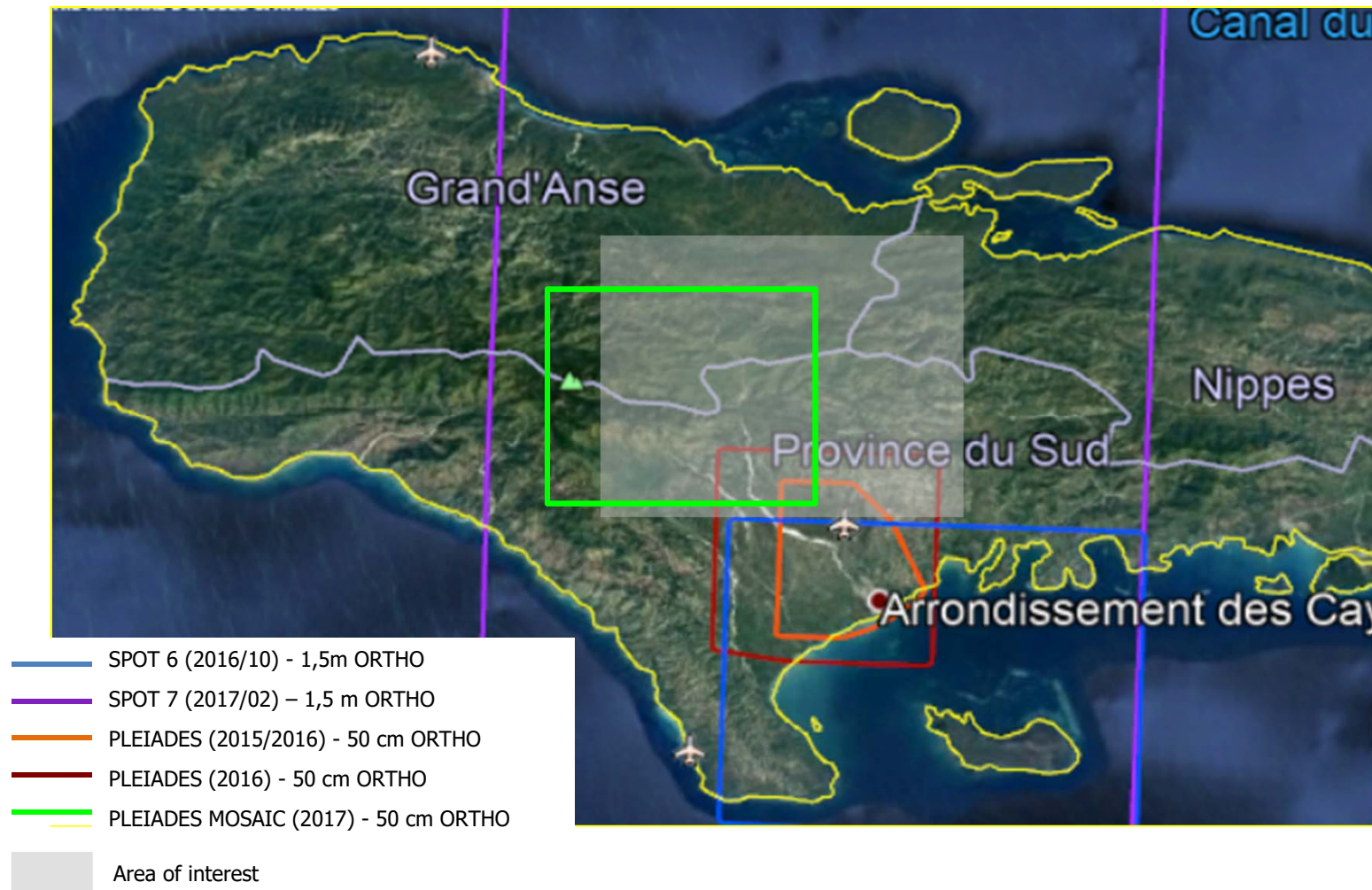
Committee on Earth Observation Satellites



# ROI: area with intense & non-regulated mineral extraction sites

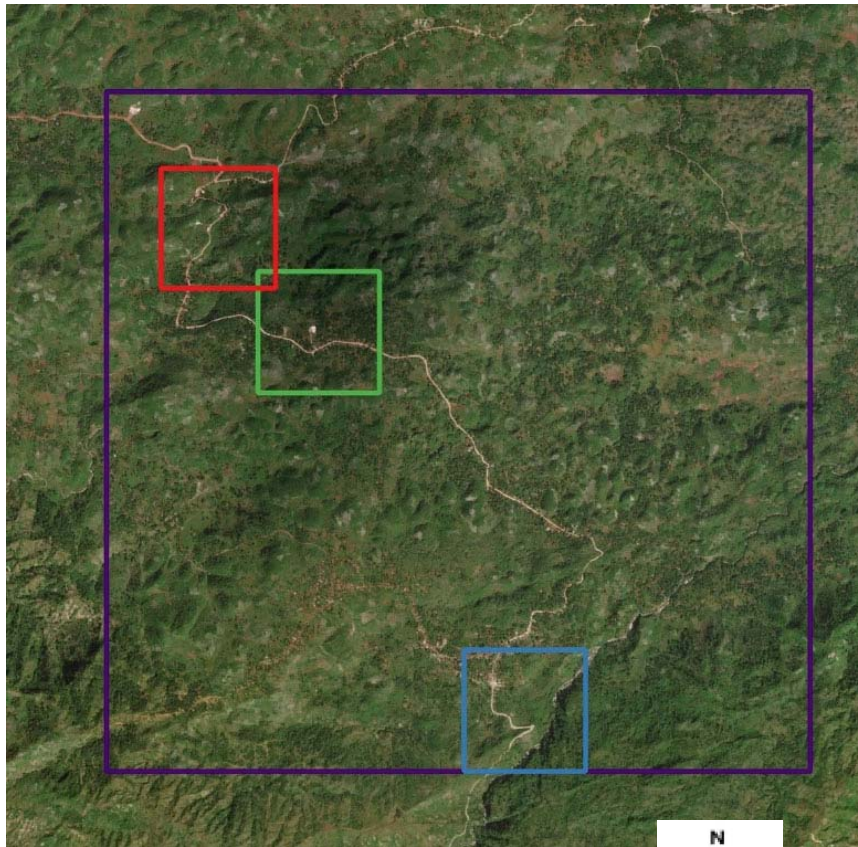


# Image dataset (SPOT / PLEIADES)

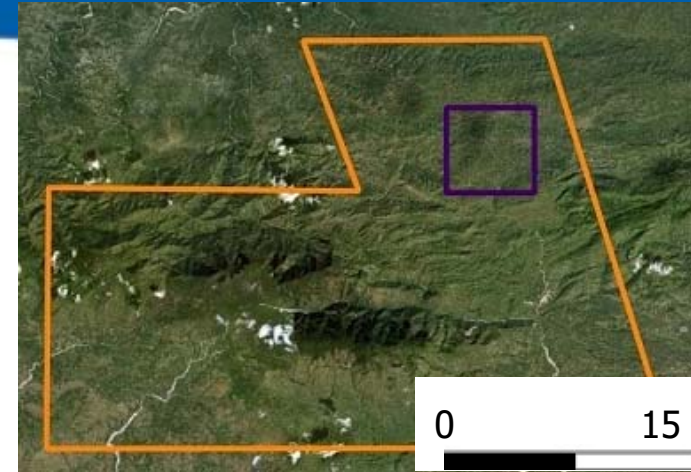
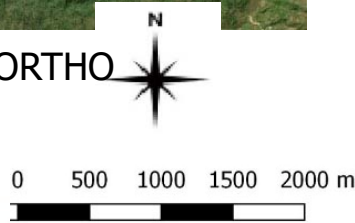




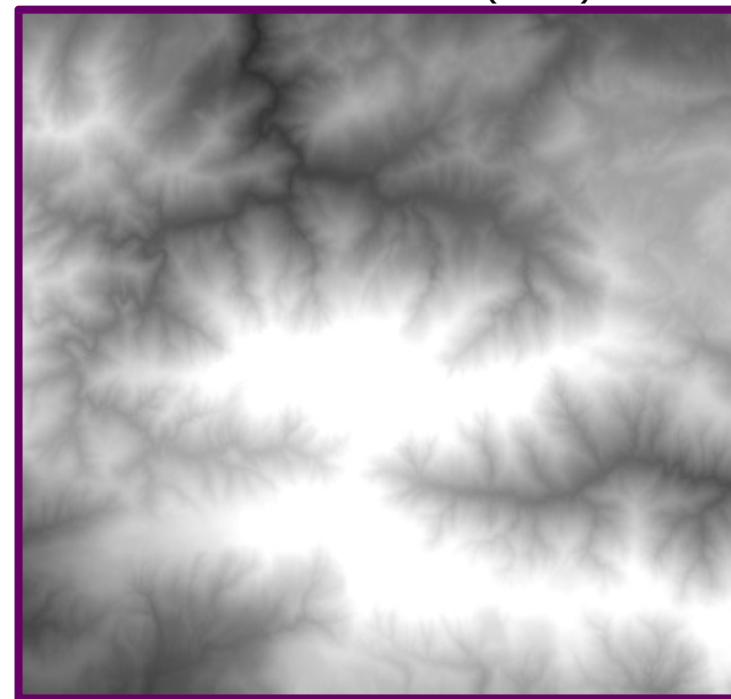
# Test areas



PLEIADES (2017) - 50 cm P+MS ORTHO

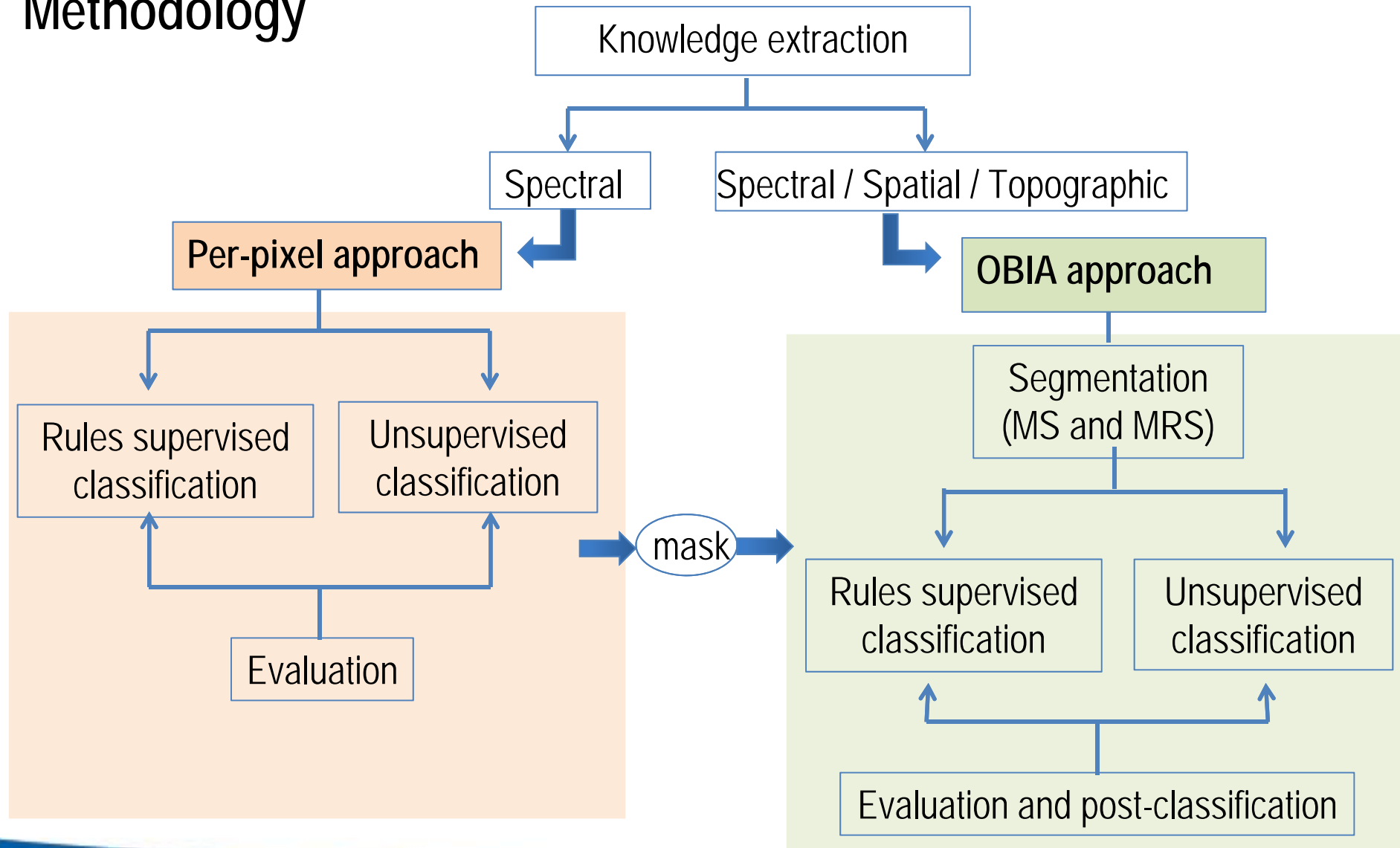


MOSAIC PLEIADES (2017) - 50 cm ORTHO



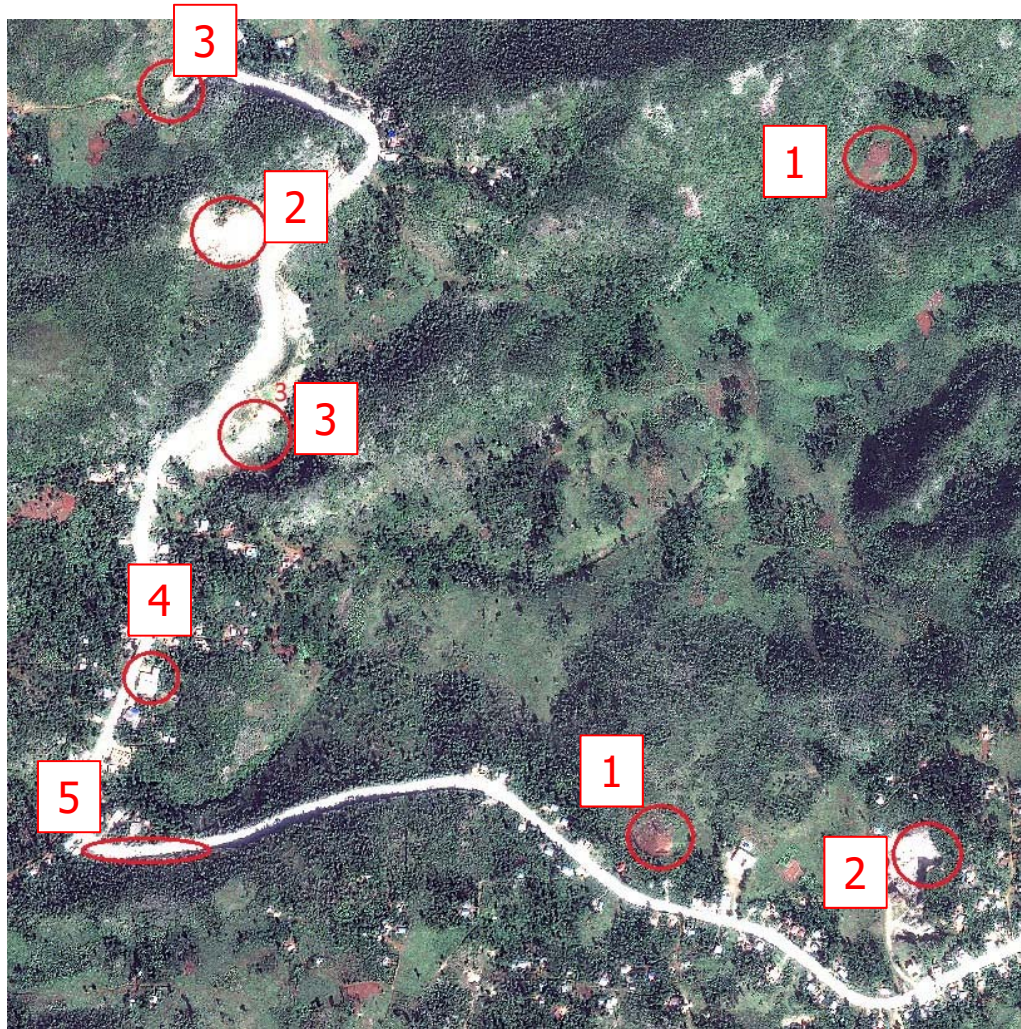
LiDAR DSM (2014 - 1,5m)

# Methodology

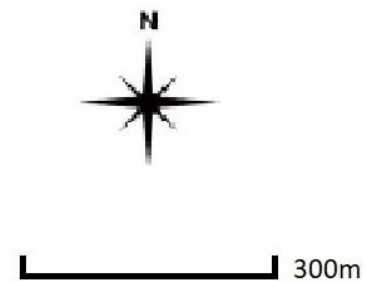




# Definition of landcover classes

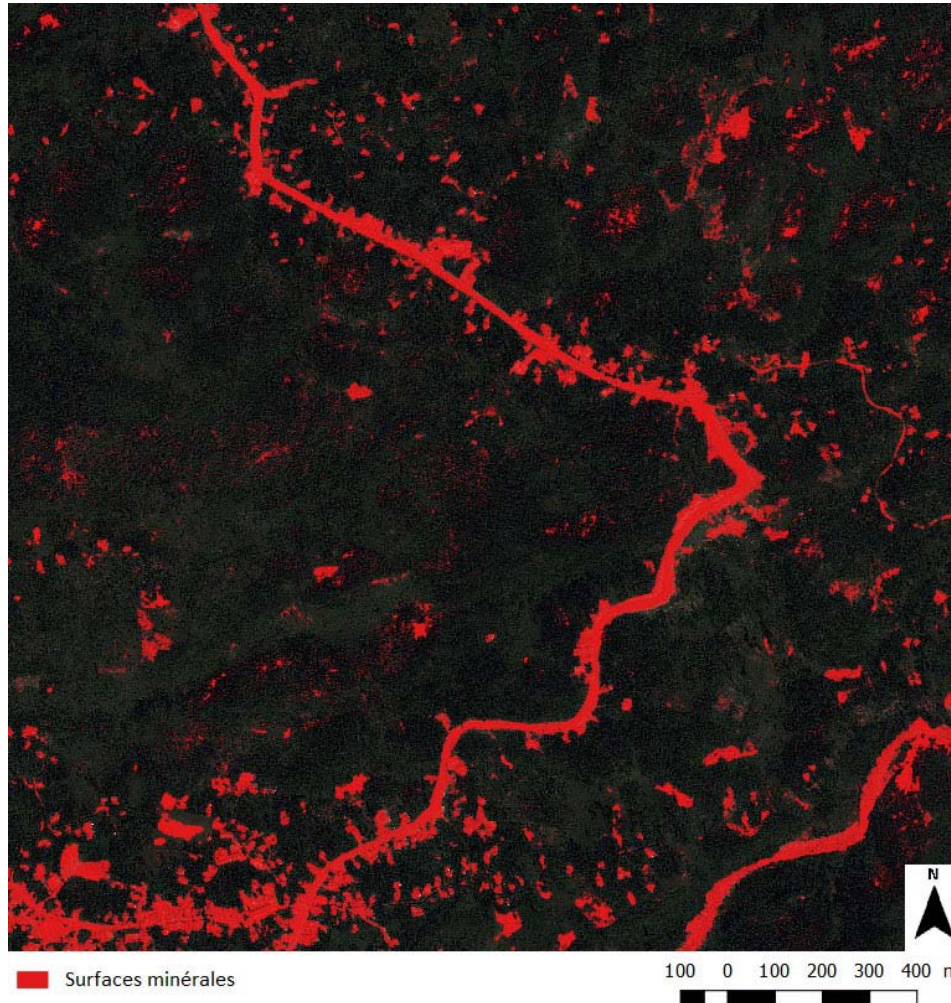


1. Bared soils (red soils, e.g laterite)
2. Mineral extraction surfaces
3. Other mineral surfaces  
(possible mineral extraction surfaces)
4. Houses
5. Roads







# Per-pixel approach for vegetation masking

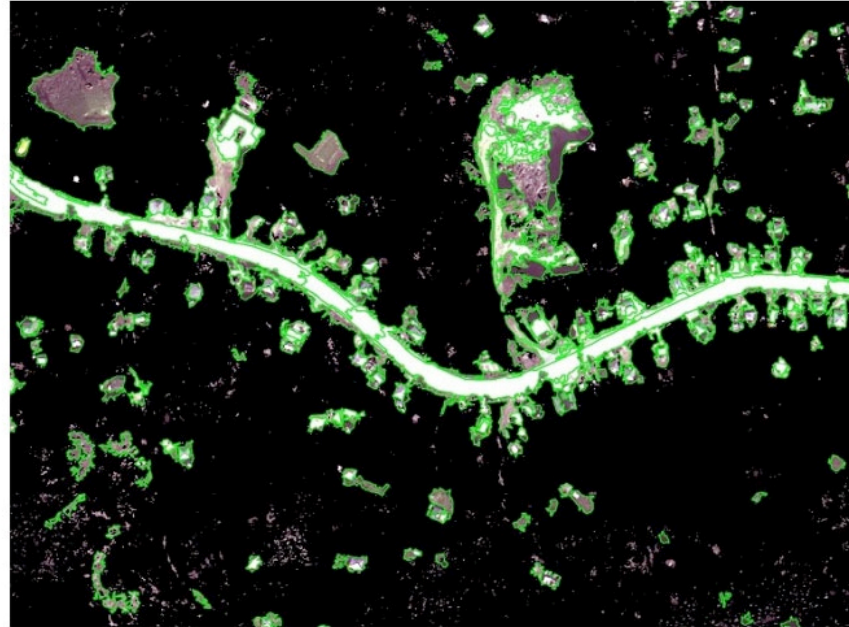


Best result with a k-means  
in 10 classes on the NDVI  
index

-  mineral surfaces
-  mask (vegetation / shadow)

# OBIA approach for the detection of mineral extraction areas

- Meanshift segmentation (OTB)

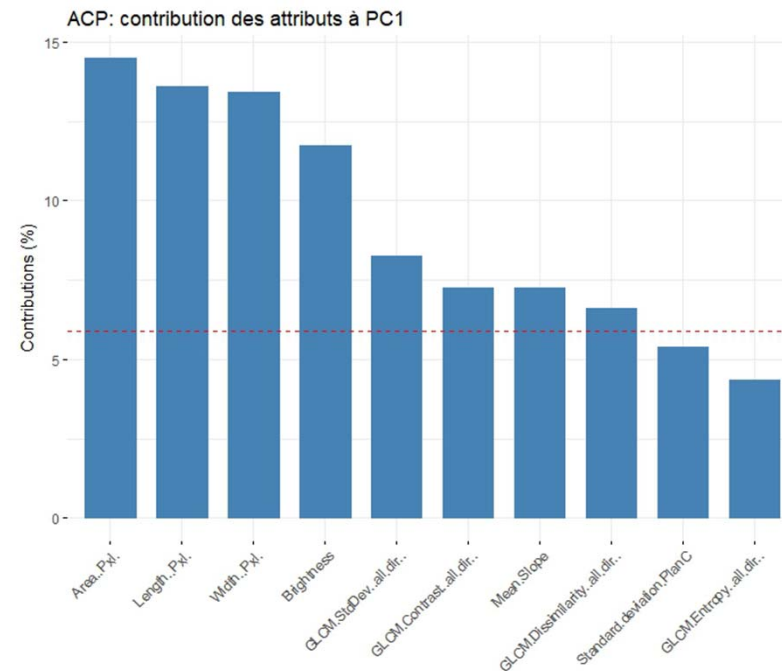
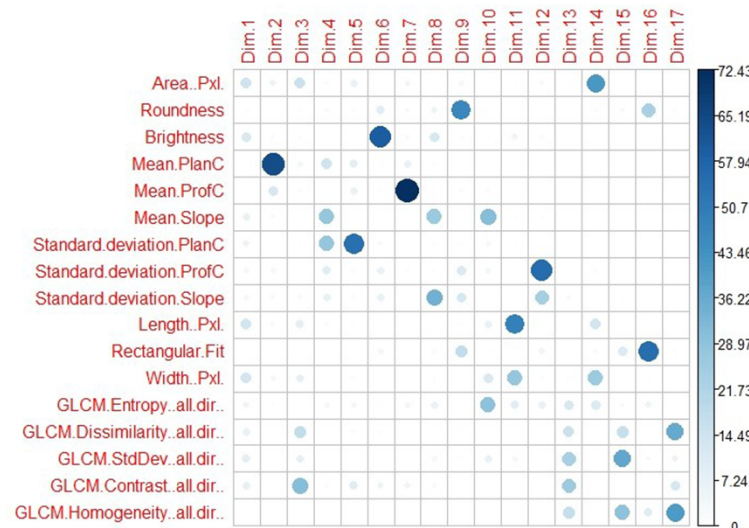




# OBIA approach for the detection of mineral extraction areas

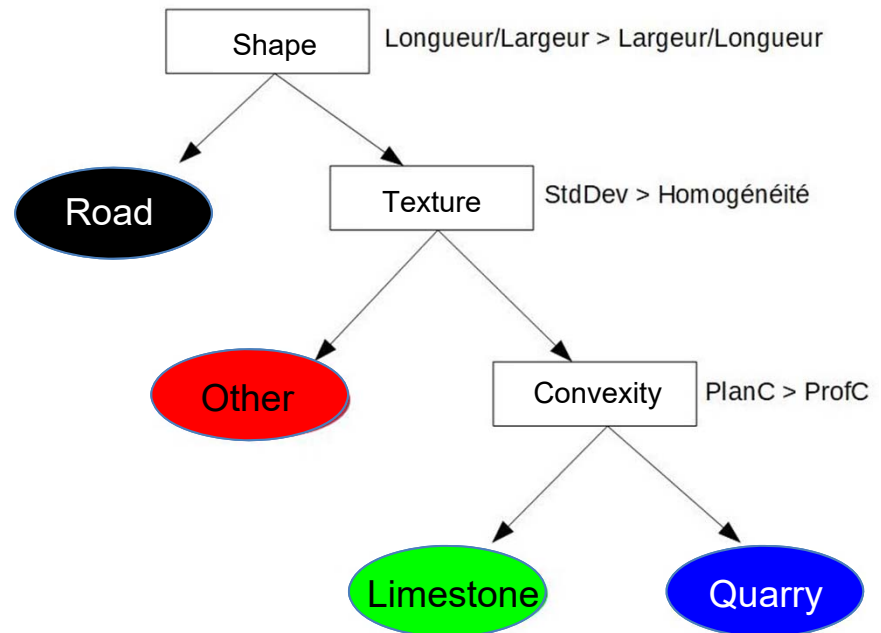
- Meanshift segmentation (OTB)
- Knowledge extraction : PCA based on spectral, spatial and textural images index

=> To identify best attributes / features



# OBIA approach for the detection of mineral extraction areas

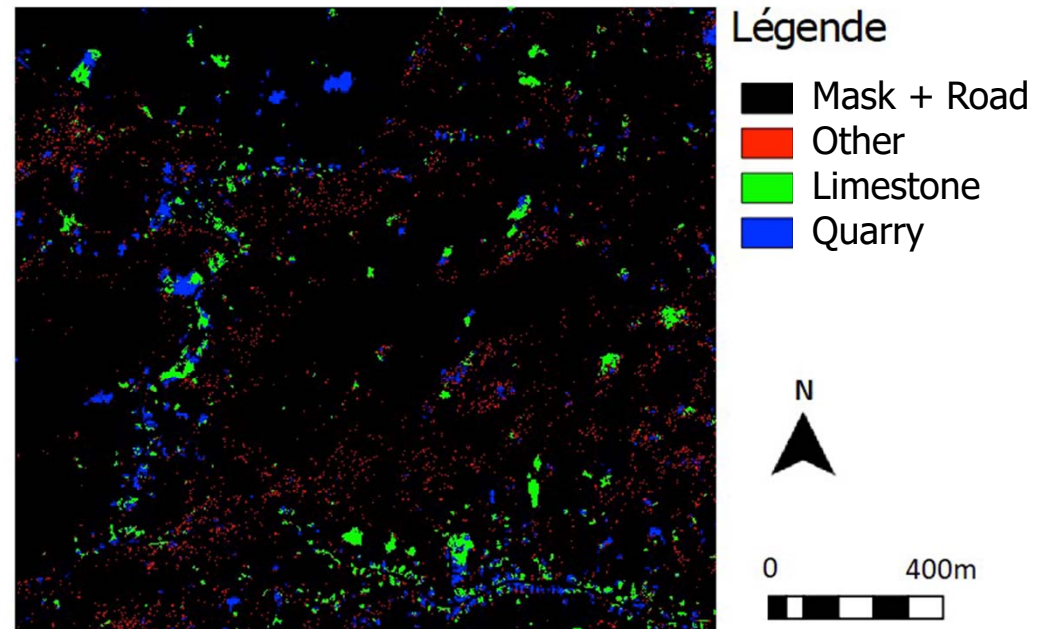
- Meanshift segmentation (OTB)
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- Rules based supervised classification -> decision trees





# OBIA approach for the detection of mineral extraction areas

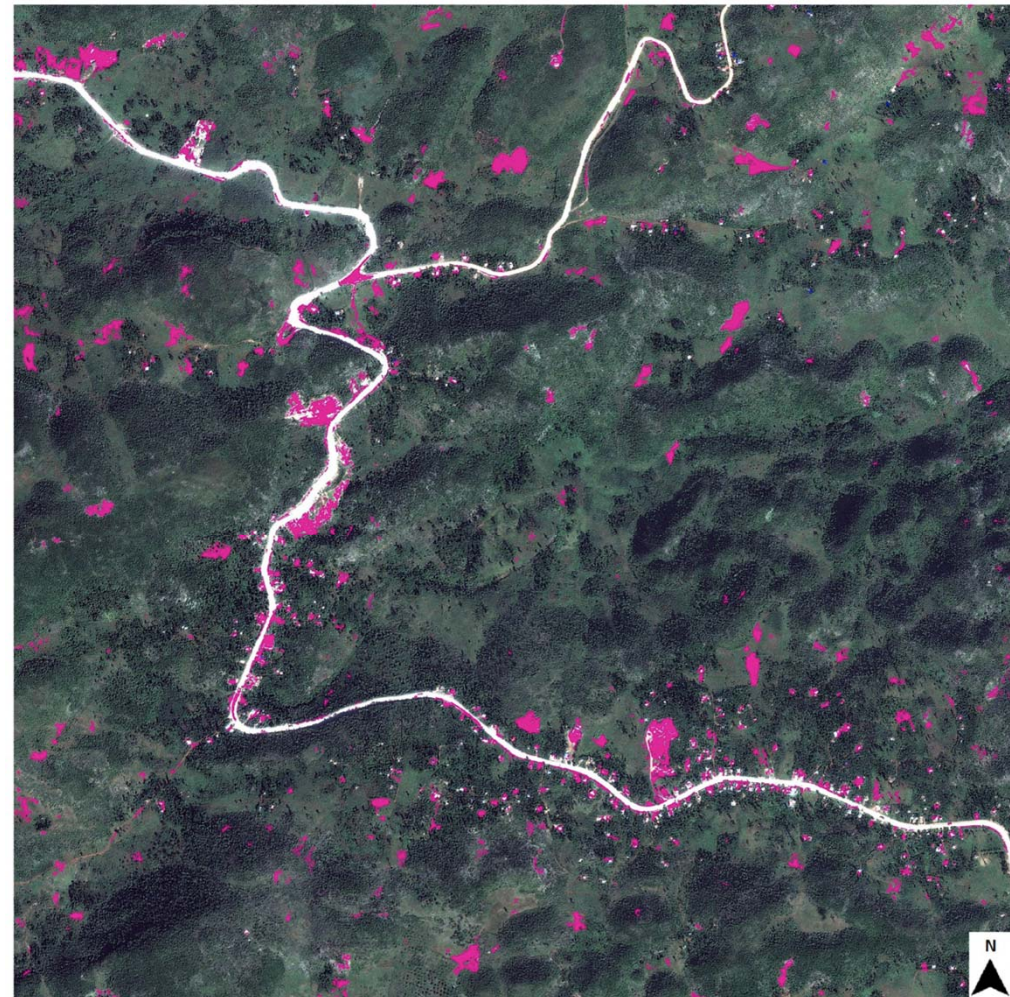
- Meanshift segmentation (OTB)
- Knowledge extraction : PCA based on spectral, spatial and texture images index
- Rules based supervised classification -> decision trees
- Results and evaluation



Producer Accuracy	79,37 %
User Accuracy	38,15 %

# OBIA approach for the detection of mineral extraction areas

- Meanshift segmentation (OTB)
- Knowledge extraction : PCA based on spectral, spatial and texture images index
- Rules based supervised classification -> decision trees
- Results and evaluation
- Post-classification (majority filter)



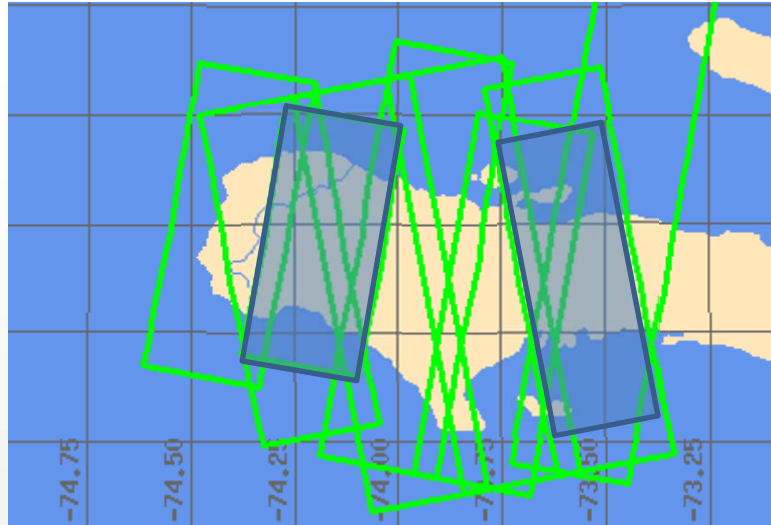
Potential quarries





## Conclusions and perspectives

- First tests on several ROIs with interesting results
- Application of the methodology on large Pléiade imagery
- ... but need of ground truth or validation data to assess the results and to apply to other ROIs
- Enhance the methodology by integrating pre-defined landcover classes (e.g. for instance OSO methodology tuned for Haiti)



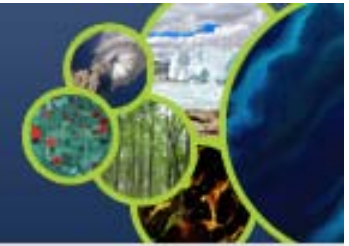
TSX acquisitions are running more smoothly now, and we have concluded the 6th coverage.

- There are open questions still about who will actually work with the data.
  - motivate academia in Germany : master thesis about TSX-based change detection in the given area of Haiti...
  - ASI work using ESA's Geohazards Exploitation Platform (GEP)
  - EOST ?





# ASI – Terrain motion products



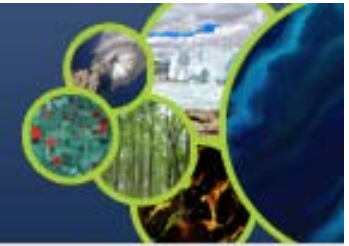
## Scientific goals

- Develop experimental scientific products tailored to obtain useful information on ground stability and motions for target areas of the RO
- Test VHR SAR for hotspot mapping via:
  - bespoke COSMO-SkyMed SpotLight campaign in different recovery contexts
  - InSAR processing within ESA Geohazards Exploitation Platform (GEP)

## Target areas (stakeholders' priorities)

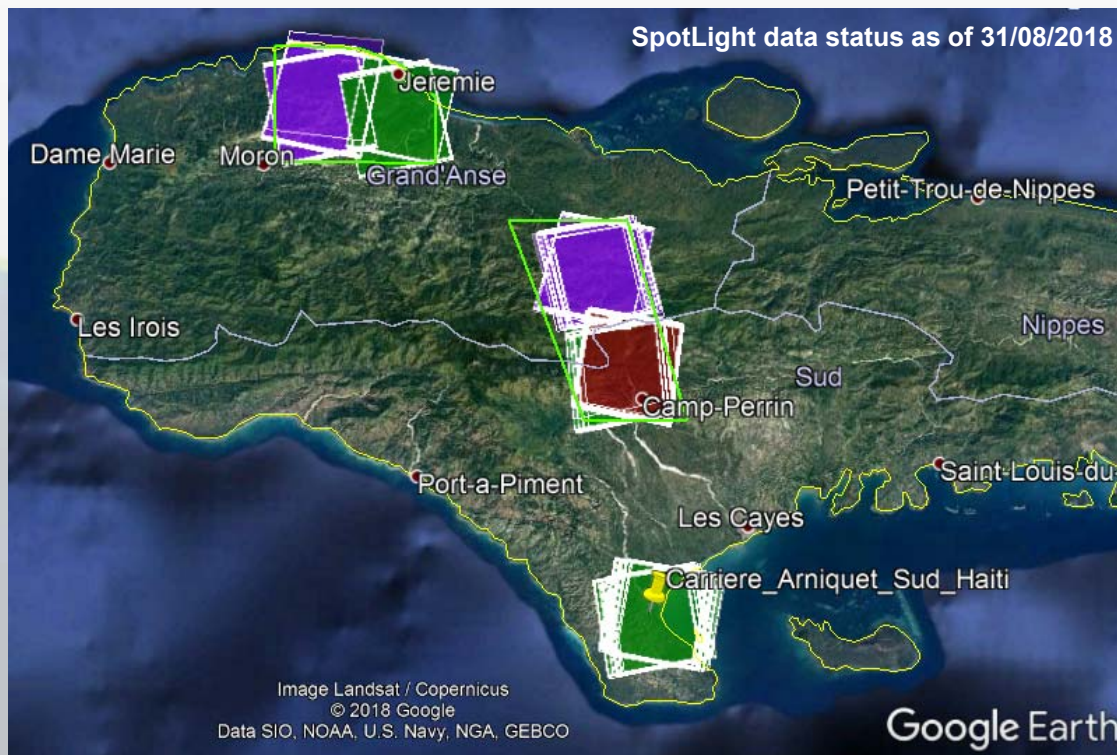
- Jeremie (urban + rural)
- Camp-Perrin (rural + road network)
- Carriere Arniquet (rural + mining)





## Satellite data → newly acquired ASI's COSMO-SkyMed X-band data

- 3-year long tailored monitoring campaign [[started on 1<sup>st</sup> Dec 2017](#)]
- SpotLight images at very high spatial resolution (1 m)
- Ascending and descending mode acquisition geometries, 16 days revisit time



**More than 160 COSMO-SkyMed**  
SpotLight scenes already acquired  
for the target areas

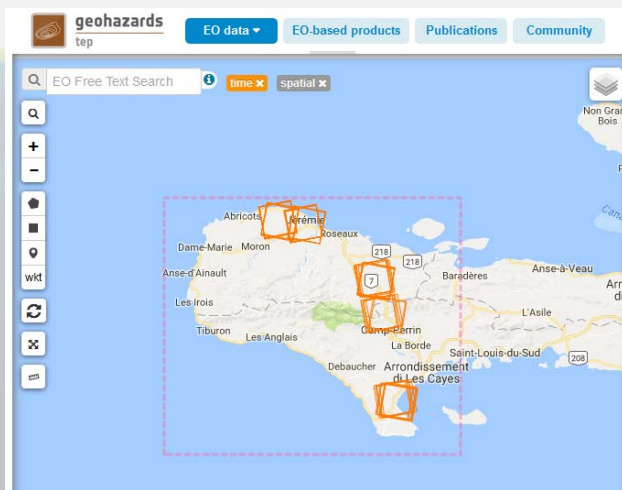
~16 scenes per site, per geometry

(as of 31/08/2018)

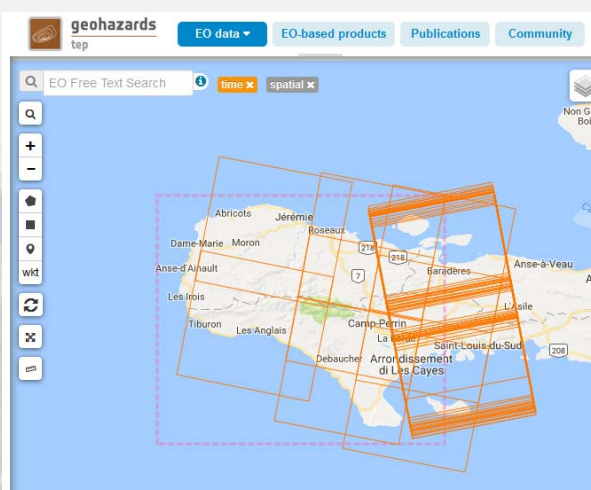


## Exploitation of ESA's Geohazards Exploitation Platform (GEP)

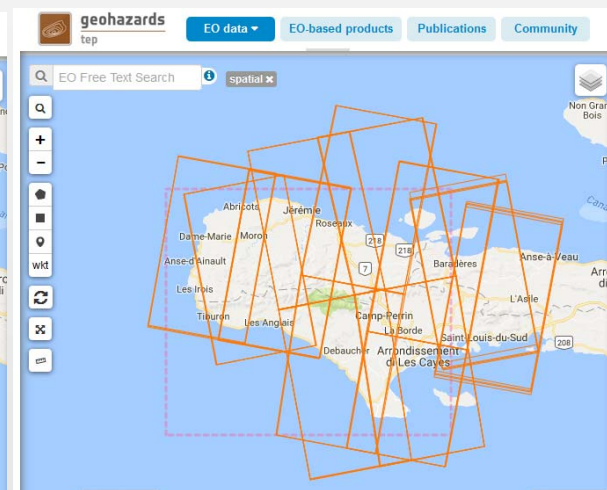
- Feb 2018: RO-Haiti GEP project approved
  - Mar/Apr 2018: work with ESA and Terradue to setup GEP account & tools
- Task 1: Ingestion of new SAR data into GEP [*Feb 2018 - present*]
- **COSMO-SkyMed**: regularly uploaded by ASI and ESA onto ESA's ftp since Feb. 2018
  - **TerraSAR-X**: link with DLR server established by DLR and ESA in Feb. - Mar. 2018



**COSMO-SkyMed SpotLight**



**COSMO-SkyMed StripMap**



**TerraSAR-X StripMap**

➤ Task 2: Start testing GEP hosted processing services [*Jun 2018 - present*]

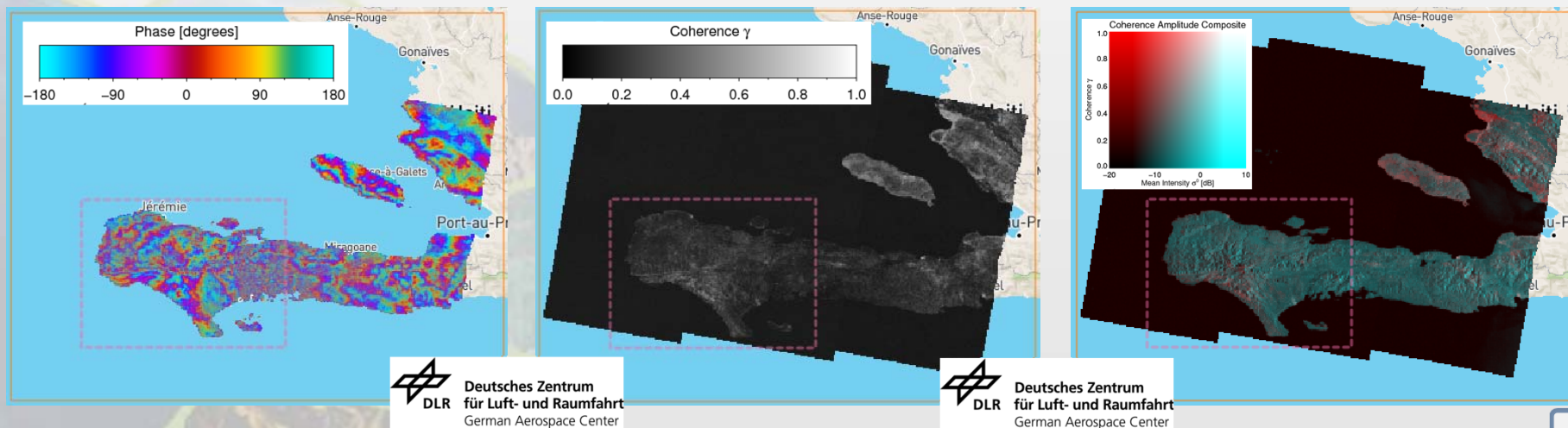
- **Sentinel-1 Medium Resolution InSAR Browse:** service allowing detection of deformation and surface change, systematically running for selected areas (>20% CEOS seismic active areas, 22 active volcanoes in EU, Latin America, SE Asia) and on-request for major events

**Currently available products in Haiti (only since Feb 2017)**

- Differential interferograms
- Coherence maps
- Amplitude change composites
- Coherence-amplitude composites

*Example of products for Sentinel-1 pair*

**14/04/2017-26/04/2017**







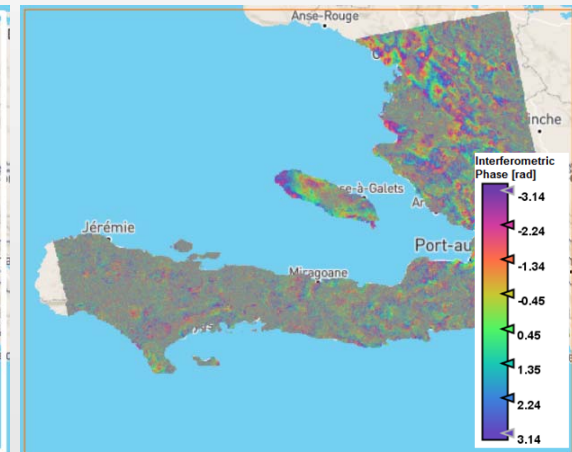
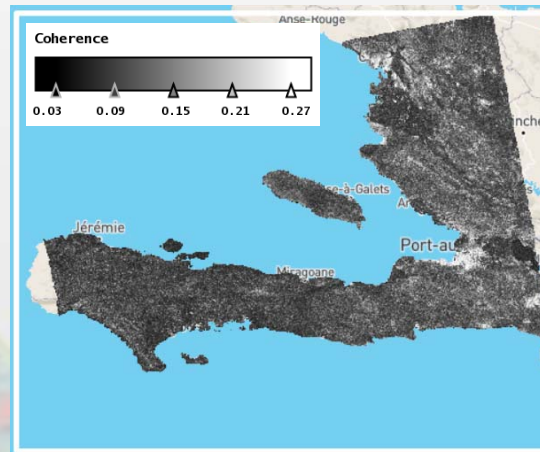
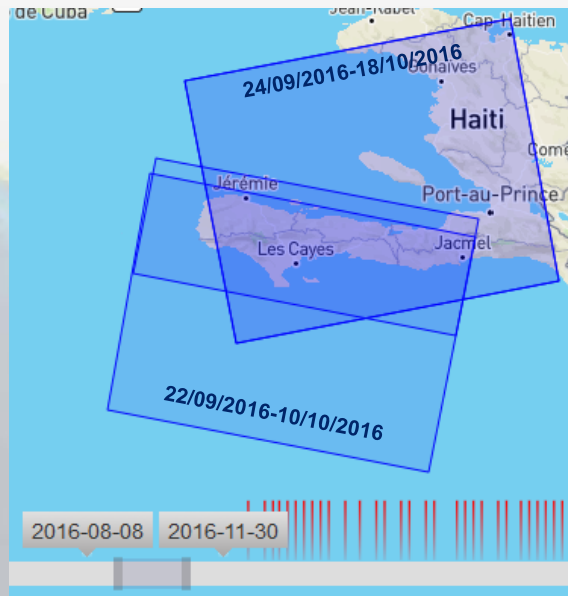
- Task 2: Start testing GEP hosted processing services [*Jul 2018 - present*]
  - **SNAP InSAR:** interferometric processor for Sentinel-1 TOPSAR IW SLC data performed through SNAP (Sentinel Application Platform) - Sentinel-1 Toolbox (S1TBX)

Data pairs (pre- vs. post-Hurricane Matthew)



### Processing outputs

- Differential interferograms
- Coherence maps
- Displacement maps



*Example of outputs for Sentinel-1 pair*

**24/09/2016-18/10/2016**  
(processed in only ~4 hours)

➤ Task 2: Start testing GEP hosted processing services

- **NEXT STEPS:** as per the project plan, processing services with COSMO-SkyMed and TerraSAR-X will be tested

- **SNAP archetype** for COSMO-SkyMed and TerraSAR-X data: to create coherence maps and interferograms

- >>> Processing services to be released

- **Advanced InSAR:** to process multi-temporal data stacks and extract point targets and their deformation histories

- >>> FASTVEL & P-SBAS processing services already developed to process Sentinel-1 IW data

- >>> SNAP+StaMPS combined processing service to process Sentinel-1 and COSMO-SkyMed time series

- >>> P-SBAS processing service to process COSMO-SkyMed data

- Will feed into ESA GeoHazards Lab discussion later today during the technical meeting

➤ Dissemination & capacity building

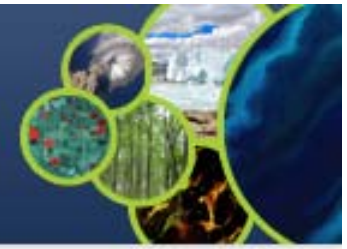
- Presentation of GEP trials at *ESA  $\Phi$ -week EO Open Science event* (Nov 2018)

- Future training of Haitian partners to use GEP with Sentinel-1 data, and X-band imagery by COSMO-SkyMed and TerraSAR-X





# ASI / CIMA





# Copernicus EMSN50&51



- EMSN050 “Cities”

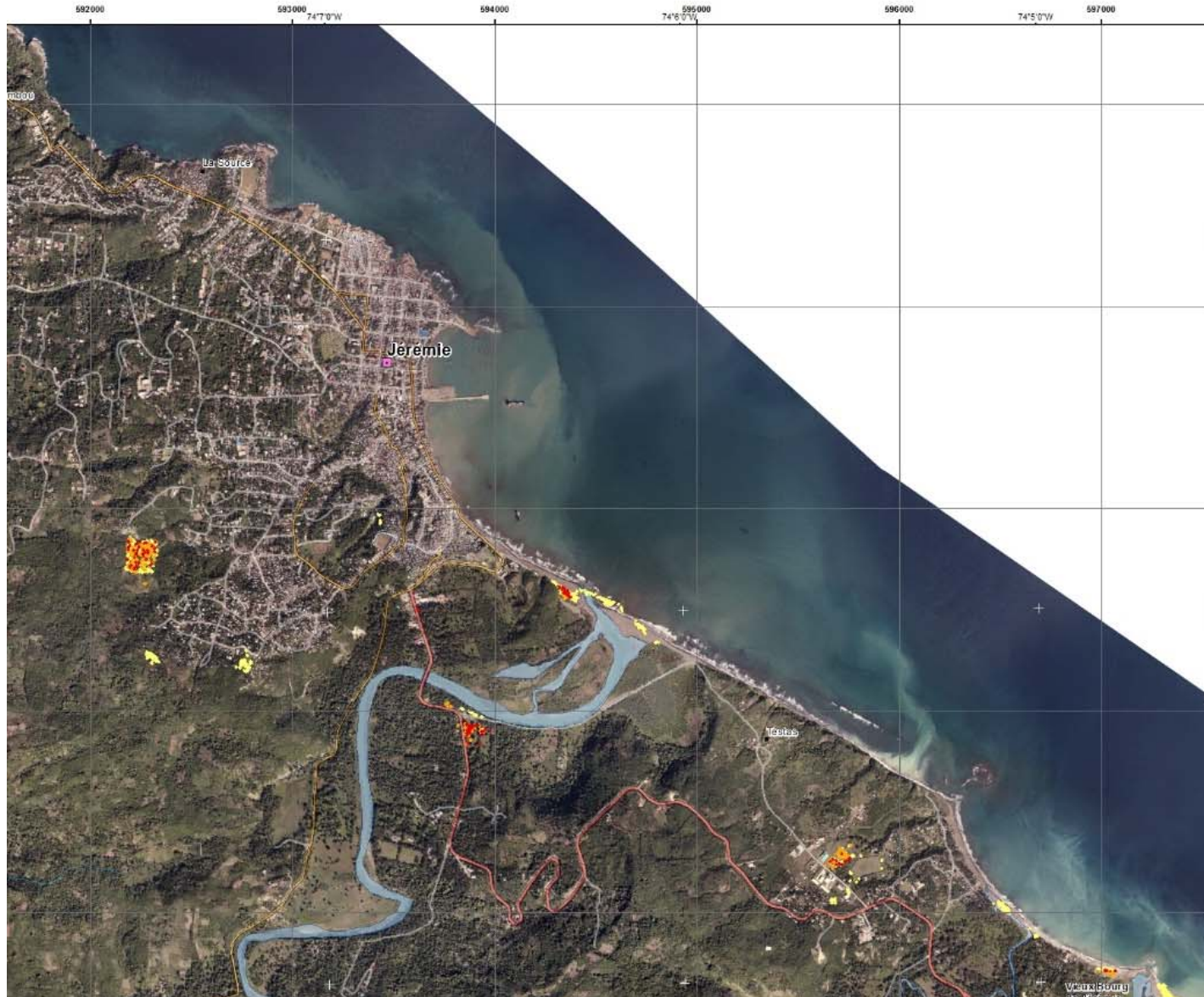
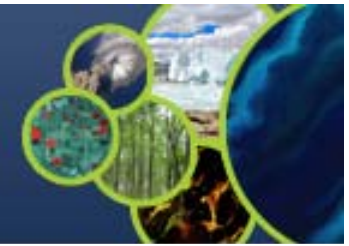
Area : Les Cayes and Jérémie

- Reference map
- Damage assessment
- IDP Camps Identification
- IDP Camps monitoring
- Landuse / Landcover
- Reconstruction + 18 months





# Copernicus EMSN50&51

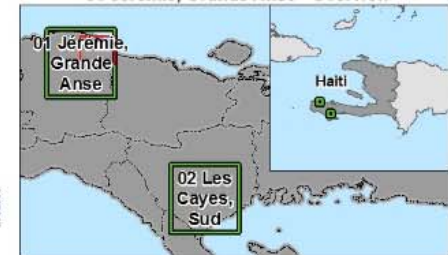


Glide Number: (N/A) Product N.: Identification IDP camps Map, v1, English Activation ID: EMSN-050

## Post Mathew Damage Assessment and Monitoring of Recovery Activities in the South Region of Haiti

### Identification of IDP camps Map

#### 01 Jérémie, Grande Anse - Overview



#### Cartographic Information

1:15,000

Full color A1, low resolution (100 dpi)



Grid: WGS 1984 Zone 18N map coordinate system  
Tick marks: WGS 84 geographical coordinate system

#### Legend

##### Identification of IDP camps at three different time stages

- T1
- T2
- T3

##### Transportation

- AP030 - Primary Route
- AP030 - Secondary Route
- AP030 - Local Route
- AQ040 - Bridge Line

##### Boundaries

- AOI
- Communes C/NGS

##### Hydrography

- BH140 - River Line
- BH140 - River Area

##### Population

- AL020 - BU A First Order
- AL020 - BU A Second Order
- AL020 - BU A Village
- AL020 - Suburb/Neighb.
- AL020 - Hamlet

#### Map Information

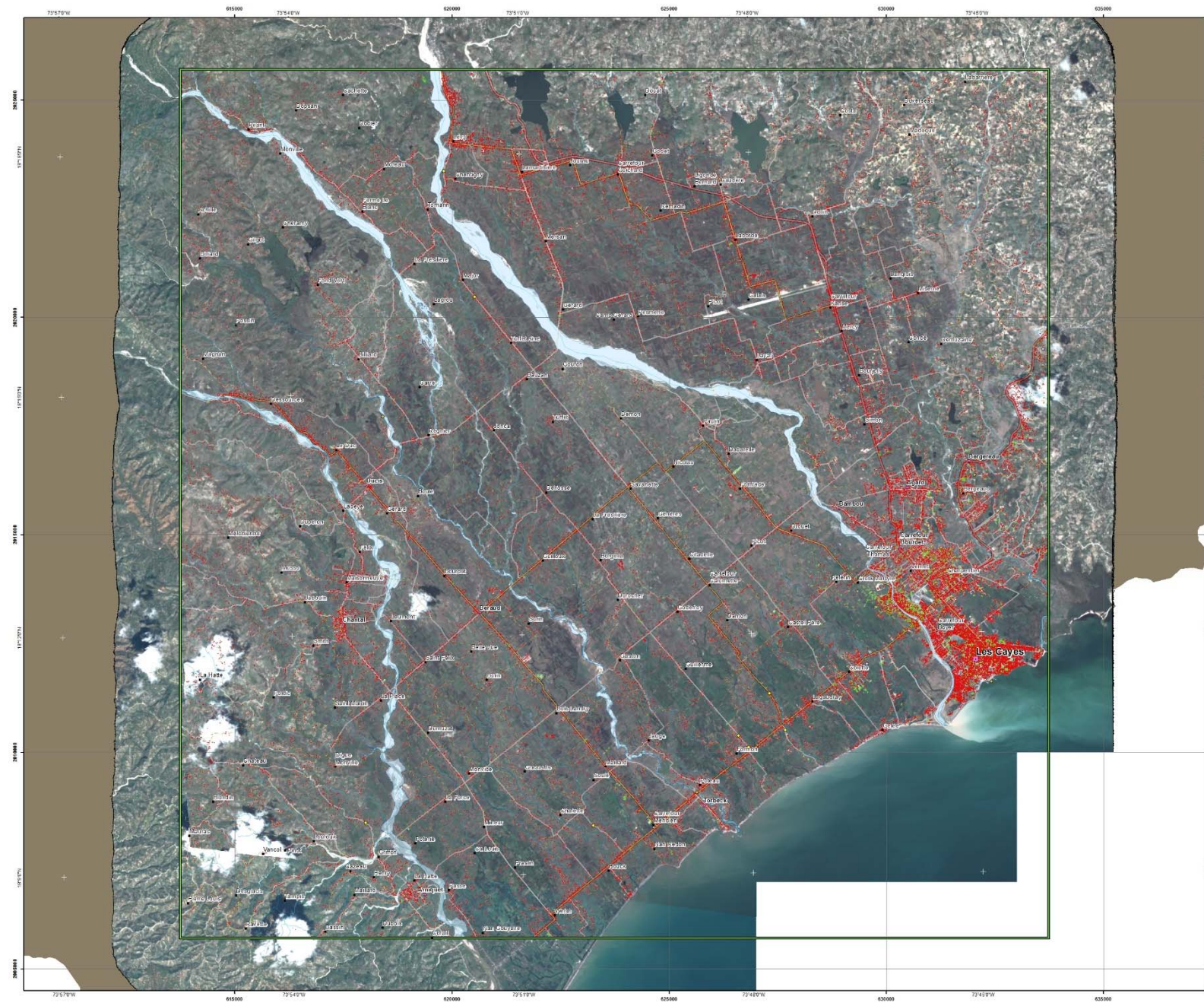
Pre-disaster situation analyses for two locations in Haiti: Jeremie (Grand Anse) and Les Cayes (Sud). Post-disaster damage assessment after the hit of Cyclone Mathew, monitoring of reconstruction activities of the areas and evolution of Internally Displaced People camps approximately one year after the event.

The core user of the map is Centre National d'Information Géospatiale (CNGIS) of Haiti and local administrative authorities in charge of planning.

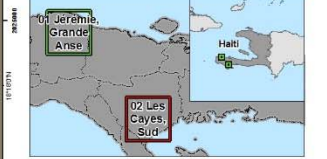
The scope of the map production is to generate a general reference content to support activities of administration in reconstruction work of damages caused by Cyclone Mathew (October 2016).

EMSN050 - Haiti	
AOI	01 Jérémie, Grande Anse
Event type	Cyclone Mathew





Slide Number: (N/A)      Activation ID: EMSN 010  
 Product N.: Damage Assessment Map, v1, English  
**Post Mathew Damage Assessment and Monitoring of Recovery Activities in the South Region of Haiti**  
**Damage Assessment Map**  
**02 Les Cayes, Sud - Overview**



**Cartographic Information**  
 1:40,000      Full color A1, low resolution (100 dpi)  
 0 0.75 1.5 3 Kilometers  
 Grid: WGS 1984 Zone 18N map coordinate system  
 Tick marks: WGS 84 geographical coordinate system

- Legend**
- |                             |                          |                        |
|-----------------------------|--------------------------|------------------------|
| <b>Damage Assessment</b>    | <b>Transportation</b>    | <b>Boundaries</b>      |
| Layers at IT                | AP030 - Primary Roads    | ACH - ACH              |
| AL015 - General Building    | AP030 - Secondary Roads  | CH025 - Communes CH025 |
| States at IT                | AP030 - Local Roads      |                        |
| AL015 - Vehicle damage      | AP010 - Car Tracks       |                        |
| AL015 - Damage              | AD040 - Bridge Line      |                        |
| <b>Other Damaged Assets</b> |                          |                        |
| Type                        |                          |                        |
| ● Road                      |                          |                        |
| ○ Wall/Fence                |                          |                        |
| ● Bridge                    |                          |                        |
| ● Pylon                     |                          |                        |
| ● Other                     |                          |                        |
| <b>Hydrography</b>          | <b>Population</b>        |                        |
| ● BR160 - River Line        | AL020 - SU Final Order   |                        |
| ● BR140 - River Map         | AL020 - SU General Order |                        |
|                             | AL020 - SU A Village     |                        |
|                             | AL020 - Suburb/height    |                        |
|                             | AL020 - Island           |                        |

**Map Information**  
 Post-mathew mission analysis for two locations in Haiti: Jérémie (Grand Anse) and Les Cayes (Sud). Post-mathew damage assessment after the 10th of Cyclone Mathew, monitoring of reconstruction activities of the assets and evolution of Internally Displaced Persons camps in proximity with areas affected by the event.  
 The core user of the map is Centre National d'Information Géospaciale (CNIIG) of Haiti and local administrative authorities in charge of planning.  
 The scope of the map production is to generate a general reference content to support activities of administration in reconstruction work of damages caused by Cyclone Mathew (October 2016).

EMSN010 - Hait	
ACH	CH025 - Les Cayes Sud
Level type	Country (A1) level

**Data Sources**  
 Post-mathew imagery 11/10/2016 (10/11/2016), satellite by Airbus DS acquired in EMSN010, GSD: 5.5 m, approx. 0.6% cloud coverage, and SPOT 7 by CNIG (2016), resolution by EMSN010, GSD: 1.8 m, approx. 0% cloud coverage, provided under Copernicus by the European Union and ESA, all rights reserved.  
 Vector layers: Damage assessment layers are building footprints and other assets. Building footprints were manually digitized and colored using pre-event imagery. Other data is derived by visual interpretation using post-event imagery. Other damaged assets are represented by a point of observation where type of asset and status at IT are noted. Transportation Network primary source is OpenStreetMap. Other damaged assets, hydrographic features source is CNIIG, area from vector manually updated over pre-event imagery. Placed Points primary source is CNIIG. Administrative boundaries source is CNIIG.  
 Inset maps: Administrative boundaries source is CH025 and CH025.

**Dissemination/Publication**  
 Map products are available in the Copernicus EMS Portal at the following URL: <http://emergency.copernicus.eu/portal/0101010>  
 Delivery methods are CH025, CH025 and vector.  
 No restrictions on the publication of the mapping apply.  
 All products are of the European Union.

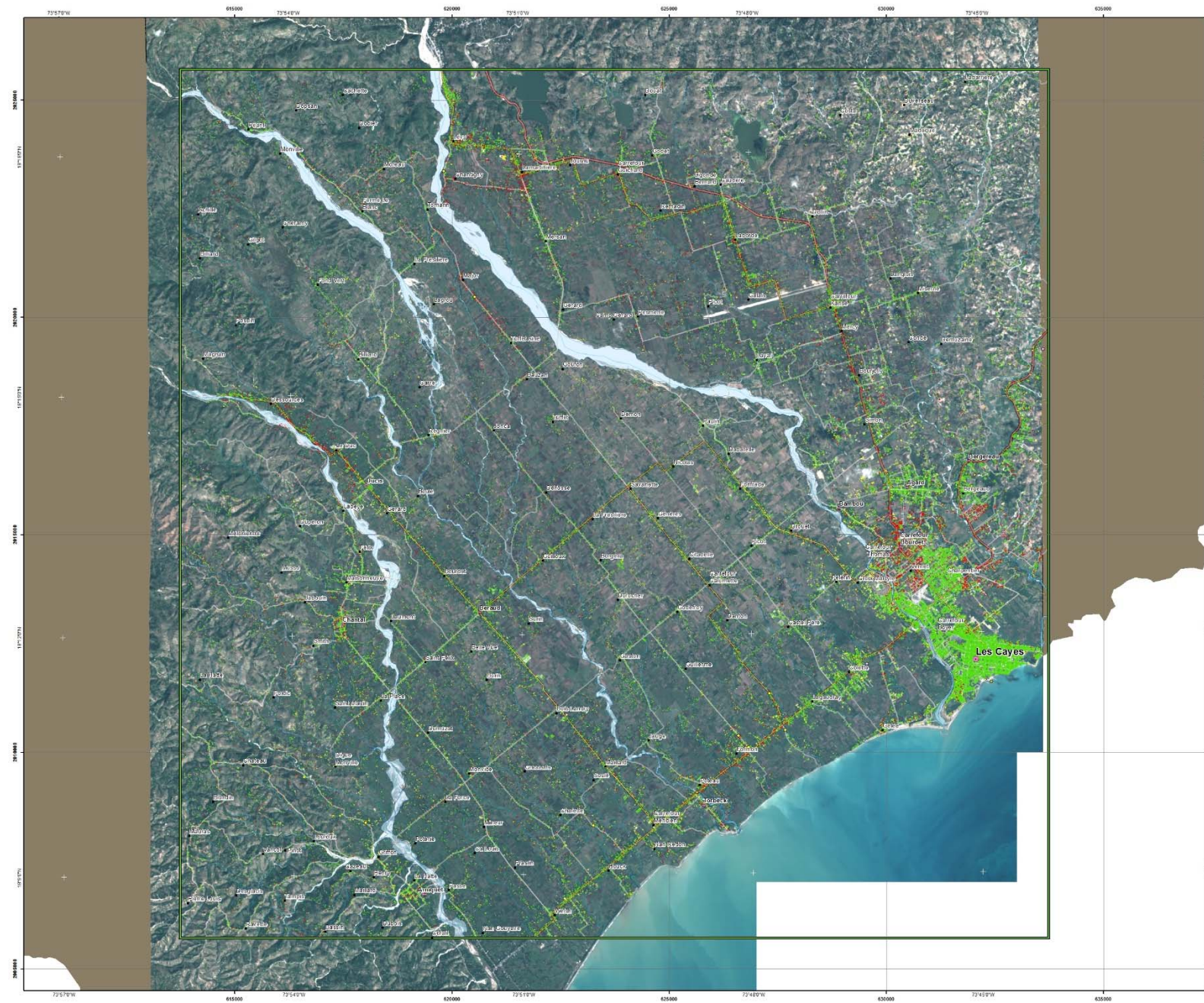
**Disclaimer**  
 The products disseminated in the framework of current mapping in this and recovery mode activation are realized to the best of our ability, optimizing the available data and information. All geographic information has limitations due to data acquisition date and integration of the original data sources. Its liability concerning the contents or the use thereof is assumed by the producer and by the European Union. The products are compliant with Copernicus EMS Risk and Recovery Product Portfolio specifications.

**Map Production**  
 The present map shows the post-mathew Damage Assessment layers of Building Footprints and Other Damaged Assets. The 10/11/2016 (10/11/2016) satellite imagery and the 11/10/2016 (10/11/2016) satellite imagery are used in the map. The 10/11/2016 (10/11/2016) satellite imagery is a composite by other reference cartographic layers such as Transportation Network, hydrographic Features and Administrative Boundaries.  
 They are all incorporated in the CH025 scheme georeferenced and updated by means of visual interpretation of post-event imagery.  
 The estimated geometric accuracy of this product is 1:250 to 1:500 or better, from relative control accuracy of the acquisition stage.  
 The estimated thematic accuracy of this product is 80% or better as it is based on visual interpretation of post-event imagery.  
 All satellite images have been radiometrically enhanced and orthorectified.  
 Only the area enclosed by the Area of Interest has been analyzed.

**Contact**  
 Map produced on 03/09/2018 by Indra Sistemas S.A. and Covadis under contract 200911 with the European Commission. All products are of the European Commission.  
 E-mail: [gs-emergency@copernicus.eu](mailto:gs-emergency@copernicus.eu), [gs-emergency@copernicus.eu](mailto:gs-emergency@copernicus.eu)  
 Web: <http://emergency.copernicus.eu>

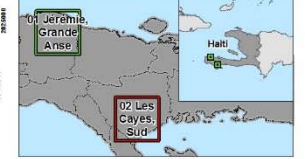






Glide Number: (N/A) Product N: Reconstruction Map, v1, English Activation ID: EMSN 030

**Post Mathew Damage Assessment and Monitoring of Recovery Activities in the South Region of Haiti**  
**Monitoring of Reconstruction Activities Map**  
**02 Les Cayes, Sud - Overview**



**Cartographic Information**  
 1:40,000 Full color A1, low resolution (100 dpi)

0 0.75 1.5 3 Kilometers

Grid: WGS 1984 Zone 18N map coordinate system  
 Tick marks: WGS 84 geographical coordinate system

- Legend**
- Monitoring of Reconstruction Layers in ES**
    - AL030 - Concrete Building Sites at 0
    - AL031 - 4rd visible damage
    - AL032 - 2nd damaged
    - AL033 - 3rd damaged
    - AL034 - 4th damaged in ID
  - Transportation**
    - AP030 - Primary Route
    - AP031 - Secondary Route
    - AP032 - Local Route
    - AP033 - Cart Track
    - AD040 - Bridge Line
  - Boundaries**
    - CH - ACH
    - CH005 - Communes CH005
  - Other reconstructed Assets**
    - Type**
      - AL020 - SU Final Order
      - AL021 - SU General Order
      - AL022 - SU A/Water
      - AL023 - SU A/Water
      - AL024 - Suburb/height
      - AL025 - A/water
    - Road**
    - Waterline**
    - Bridge**
    - Pyln**
    - Other**
  - Population**
    - AL020 - SU Final Order
    - AL021 - SU General Order
    - AL022 - SU A/Water
    - AL023 - SU A/Water
    - AL024 - Suburb/height
    - AL025 - A/water
  - Hydrography**
    - BH140 - River Line
    - BH140 - River Area

**Map Information**

Pre-mathew situation analysis for two locations in Haiti: Jérémie (Grand Anse) and Les Cayes (Sud). Pre-mathew damage assessment after the hit of Cyclone Mathew, monitoring of reconstruction activities and evaluation of internally displaced Persons camps representing only one area for the coast.

The core user of the map is Centre National d'Information Géospatiale (CNIGS) of Haiti and local administrative authorities in charge of projects.

The scope of the map production is to generate a general reference context to support activities of administration in reconstruction work of damages caused by Cyclone Mathew (October 2016).

EMS0200 - Haiti	
ACH	CH005 - Les Cayes Sud
Level type	Coding: 0/1/2/3/4

**Data Sources**

Pre-mathew imagery: 10 Photos: 18 m CBRS (2011), established by Airbus DS (acquired in 06/02/2016, USGS, 0.5 m, approx. 7% cloud cover), provided under Copernicus by the European Union and ESA, all rights reserved.

Vector layers: Monitoring of reconstruction activities: Water and other features. Building footprints were manually digitized and coded status using pre-event imagery. Status at 0 was identified by visual observation using post-event imagery. Other damaged assets are represented by a point observation using post-event imagery. Other data used: Transportation network primary source is Copernicus, at Copernicus; Contributions. Hydrographic features source is CH005, area here were manually updated using pre-event imagery. Population: Primary source is CH005 Administrative boundaries source is CH005 and OADM.

Real maps: Administrative boundaries source is CH005 and OADM.

**Dissemination/Publication**

Map products are available in the Copernicus EMS Portal at the following URL: <http://emergency.europa.eu/portal/02030000/020305>

Delivery methods are: CH005 2D and vector.

No restrictions on the publication of the mapping apply.

All products are of the European Union.

**Disclaimer**

The product delivered in the framework of current mapping in this and recovery mode addition are realized to the best of our ability, optimizing the available data and information. All geographic information has limitations due to data resolution, date and integration of the original data sources. Its liability concerning the contents or the use thereof is assumed by the producer and by the European Union. The products are compliant with Copernicus EMS Risk and Recovery Product specifications.

**Map Production**

The present map shows the post-event Monitoring of Reconstruction activities levels of building Footprints and other Assets in CH02 Les Cayes, Sud. Status of features in both layers was coded in this stage 03, approximately one year after the hit of Cyclone Mathew. They are accompanied by other reference context layers such as: Transportation Network, Hydrography, Population, Place and Administrative Boundaries.

They are all registered in the CH005 administrative boundaries and updated by means of a visual interpretation of post-event imagery.

The estimated geometric accuracy of this product is 1.25m CE90 or better, from relative control accuracy of the non-processed imagery.

The estimated thematic accuracy of this product is 90% or better as it is based on visual interpretation of non-processed imagery.

All satellite images have been radiometrically enhanced and orthorectified.

Only the area enclosed by the Area of Interest has been analyzed.

**Contact**

Map produced on 04/09/2018 by Indra Sistemas S.A. and Covadis under contract 200911 with the European Commission. All products are of the European Commission.

For more information contact: Covadis (india@covadis.com), Indra Sistemas S.A. E-mail: gis-emergency@india.es or gis-emergency@copernicus.eu

Map: emergency.copernicus.eu/maps/02

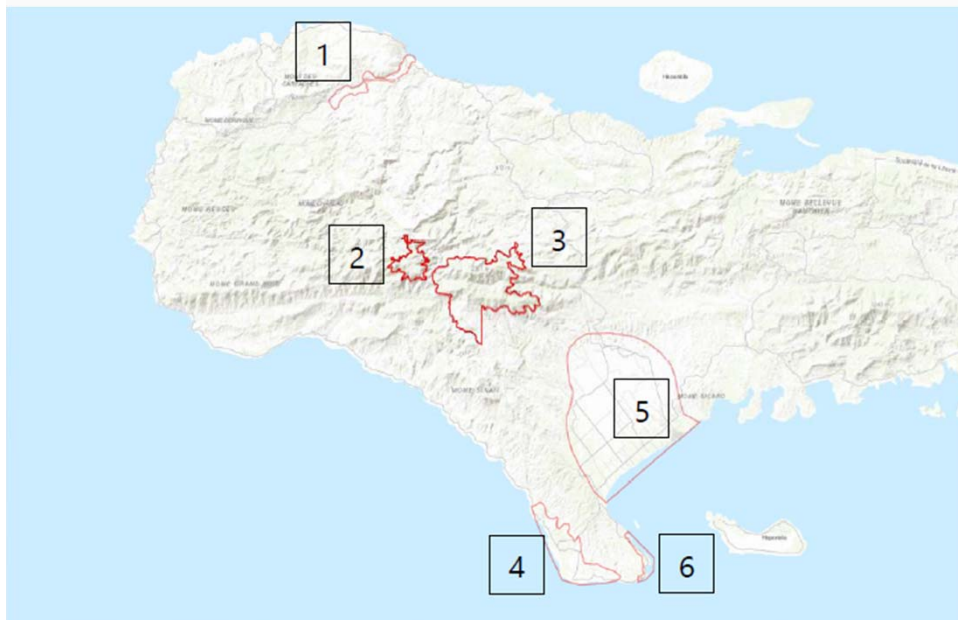






- EMSN051 “ Environmental”

Area : Macaya Park, Port Salut, Les Cayes+Jérémie, Pointe Abacou and Costa line.



- Agricultural activities
- Coastal Line evolution
- Macaya Park classification and monitoring forest damage
- Mangrove monitoring











# Links with NASA, NOAA, WB Haiti



## WB Haiti - Les Cayes Agriculture



### Links with a new WB « post Irma » agriculture study in Les Cayes

- How does Climate Change change impact agriculture?
- Understand local impact of Climate Change
- Pioneering work on how one could make a sustainable plain irrigation system

Exchanges of Data (satellite images / ground observations) and sharing results

Another “post Irma” WB study should benefit from RO data in the coming months

### NOAA

Discussions about vector borne diseases evaluation, further expression of interest by Health ministry. Will use L8 and NOAA images but need public health statistical data (accessibility TBC during next mission)





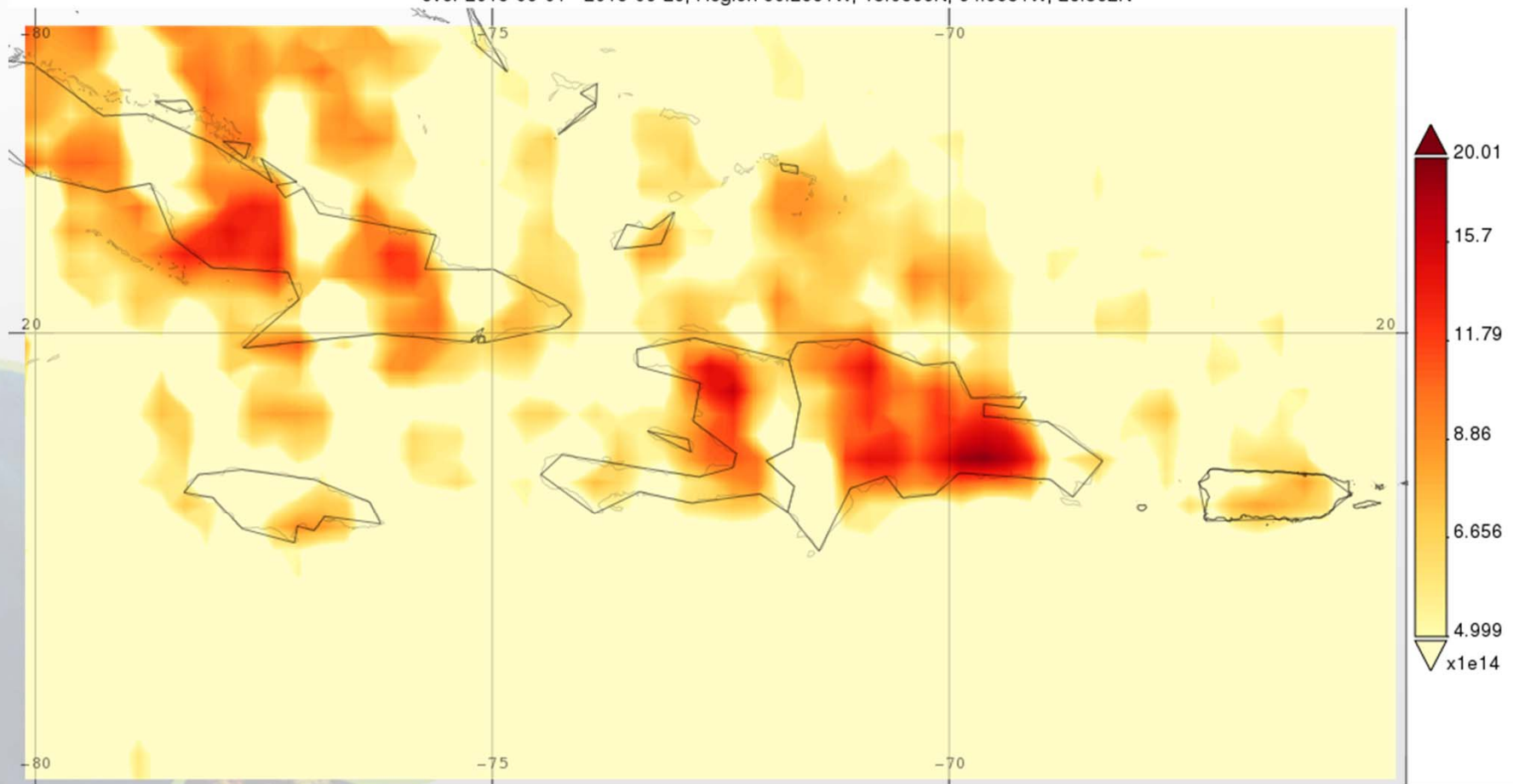
# Links with NASA, NOAA, WB Haiti



NASA (Jean Paul Vernier / Ivanco Marie)

preliminary map of nitrogen dioxide pollution over Haiti and the Dom. Rep.

Time Averaged Map of NO<sub>2</sub> Tropospheric Column (30% Cloud Screened) daily 0.25 deg. [OMI OMNO2d v003] 1/cm<sup>2</sup>  
over 2018-06-01 - 2018-06-29, Region 80.2881W, 15.0366N, 64.9951W, 23.562N





# Next Steps



## Jan - Sept 2017 – Haiti RO Definition

RO post Matthew definition mission with local authorities and WB

First Users Workshop RO

MOU discussions between Haitian users (lead CNIGS) and CNES

Implementation of the IT infrastructure

## Oct 2017- May 2018 – Start-Up Haiti RO

Incorporation of the first RO products in the infrastructure

User Animation: Technical Seminar, 2nd Workshop (Local, PAP)

Development of a “capacity building plan” and of a “thematic products plan”

RO Products validation by Haitian users

## Mid 2018 - 2020 – Haiti RO Operations – Definition and specification of Generic RO

First Haiti RO "early evaluation" report to Steering Committee and WB / UN / UE

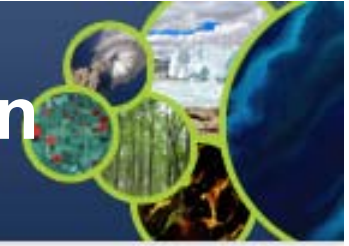
Users Workshop May 2019 and Final Users Workshop 2020

Regular images acquisitions and product generation, infrastructure updates, community animation, capacity building setting up

Preparation of the closing of the RO Haiti, evaluation and transfer strategies

Analysis of RO Haiti to derive Generic RO specifications





- Access to US VHR data (Copernicus activation) through NASA or other US partner ?
- Copernicus activation « 52 » on critical infrastructure – highways, ports, airports ?
- Possible new activation of Copernicus RRM for monitoring the evolution of :
  - urban areas (update of EMSN 050) ?
  - agricultural and Natural areas (update of EMSN 051) ?
- New contributions from agencies for capacity building ?
- Other possible contributions ?



Thank you  
Merci