



Committee on Earth Observation Satellites

Recovery Observatory (RO)

Haiti Hurricane Matthew RO Status and Next Steps

Presentation to WGD #10

Napoli September 5th, 2018

Agwilh Collet, Helene de Boissezon, CNES

Jens Danzeglocke, DLR

Deodato Tapete, Francesca Cigna, ASI

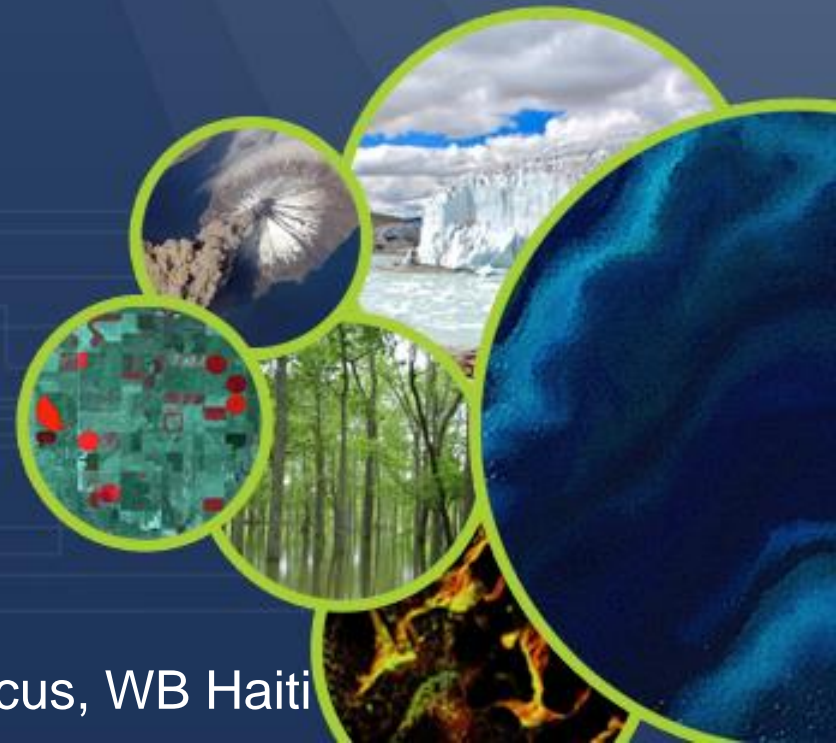
Jean Philippe Malet, CNRS / EOST

Anne Puissant, LIVE / UNISTRA

Giorgio Boni, CIMA

Andrew Eddy, RO Secretary

with contributions of NASA, NOAA, Copernicus, WB Haiti





□ Haiti Recovery Observatory

- Key elements since WGD09
- Mission : User Workshop #2
- CNES activities with IRD / SERTIT
- EOST Terrain Motion products, LIVE detect mineral extraction sites
- DLR – TerraSAR-X contribution
- ASI – Terrain motion products
- Copernicus EMS R&R N50 & N51
- Links with NASA, NOAA, WB Haiti
- Next Steps



Hurricane Matthew
in Haiti
Oct 4th 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 - 2ndUser Workshop (PàP + Les Cayes)**

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

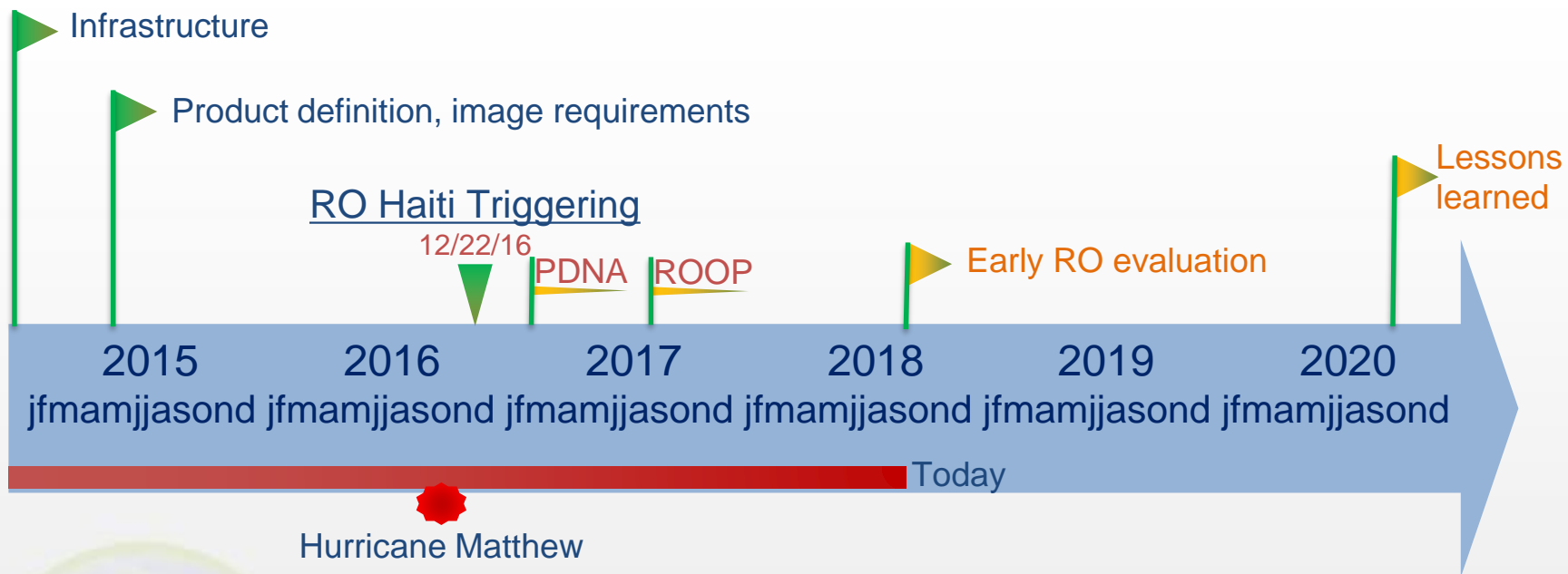


- Finalization of the **CNES / CNIGS MOU** (on going signatures)
- Continued **engagement of space agencies** (ASI, CNES, DLR, ESA, NASA, NOAA)
- Activation of the **Copernicus Risk and Recovery Service** by the Delegation of the European Union to Haiti
- Drafting by Haitian partners of a **Capacity 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



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	Optical THR, radar THR
Watershed / Flood	ONEV/ Agriculture Ministry	CIMA Foundation	MNT 1m/20cm and radar THR
Terrain Motion / Mining quarries	BME / Public Work Ministry	EOST, ASI	CSK, Pléiades, Spot6/7
Vector Borne Disease risk	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)**



**Hurricane Matthew
in Haïti**
10/04/16

**Malawi, Nepal
Demonstrators**



**Missions to Haiti
(2 to 3 per year)**

1st
31 Jan – 3 Feb

1st

1st User Workshop
29 May – 2 June

Technical Review

5-8 Dec

2nd User Workshop
8 – 11 May

8 – 11 May

External Mission

Generic RO
WB + UNDP DC



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



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 borne diseases risk, coral reefs, air pollution, anthropogenic impact on Macaya, non aedificandi areas monitoring
 - **3rd Steering Committee** held after the workshop



Introduction by the Minister of Planning



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)**

• **Generic RO Working meeting with WB / GDRR :
decision of G-RO White Paper CNES-WB-UN-EU, with WB peer review**





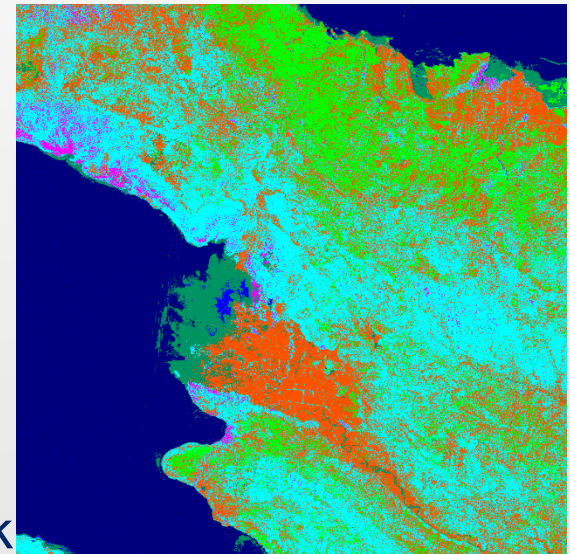
- Internship CNES (April-September 2018)
Adaptation of IOTA2 chain on Haiti for land use with S2

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)

■	Culture
■	Forêt
■	Bâti
■	Route
■	Eau
■	Mer
■	Zone d'inondation



- SERTIT activities on going (Feasibility tests):
 - Monitoring Anthropogenic impact : Macaya Park
 - Non-aedificandi areas Monitoring Port Salut (non housing area)
 - Monitoring UNEP protected areas

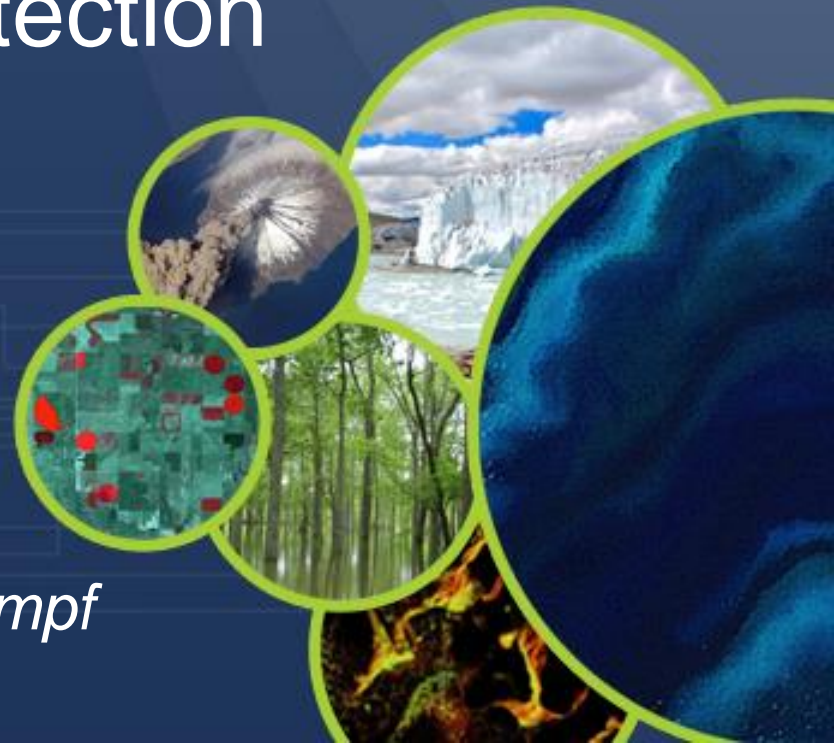


**Recovery
bservatory** Haïti

Automatic Landslide Detection and Mapping from VHRO images

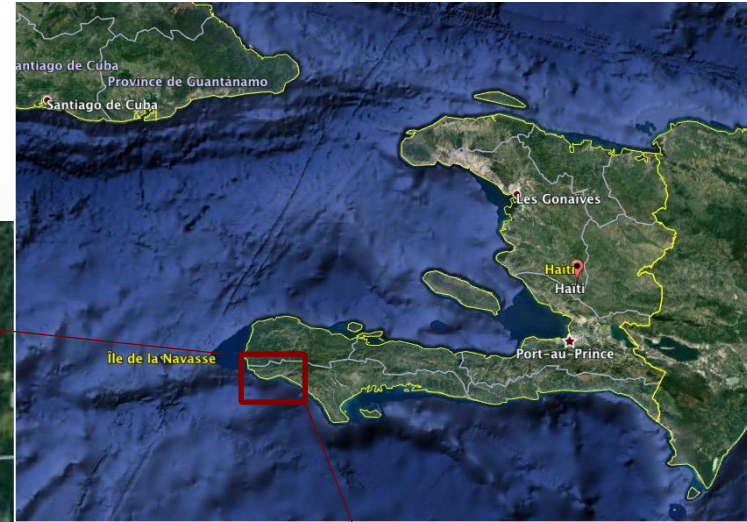
CNRS-EOST

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



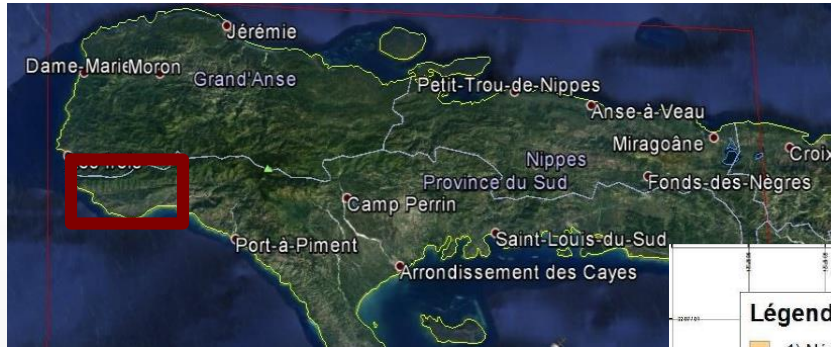


Haiti – Les Anglais Cordillera



Also focus of Landslide Pilot

Post-hurricane landslide detection and mapping: Haiti

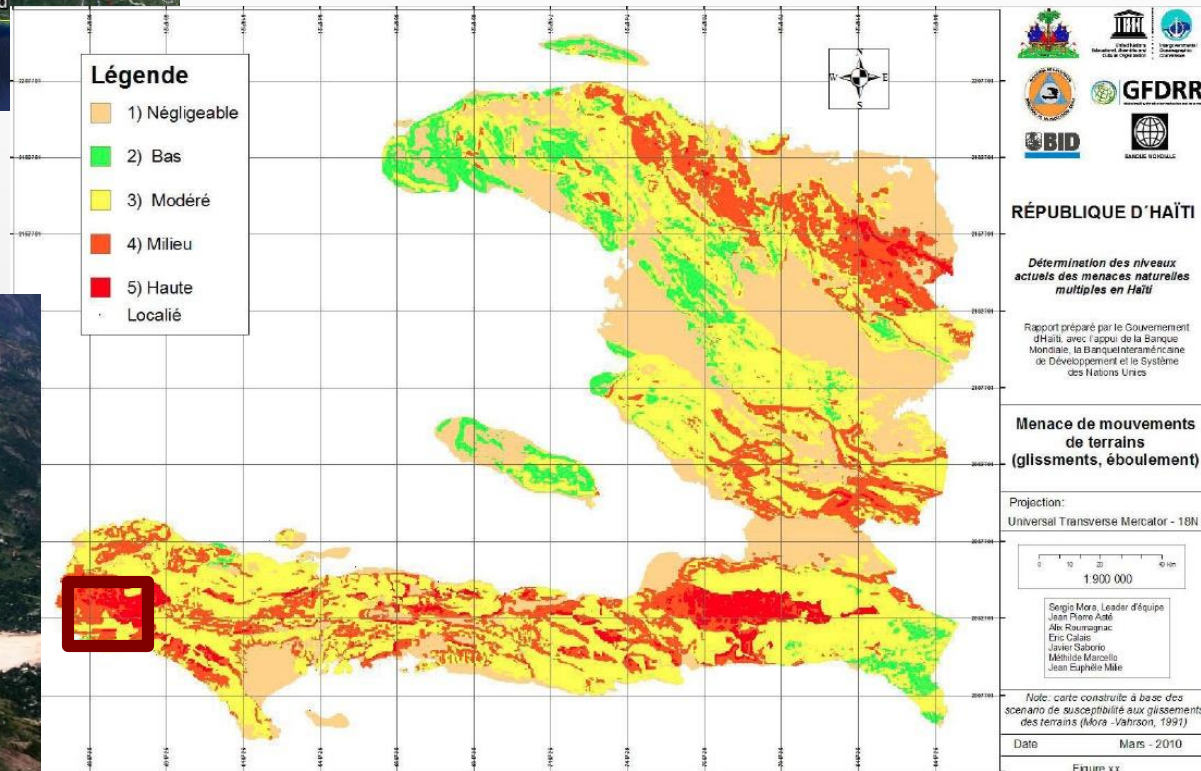


First landslide susceptibility map for the country

Topography = first driver of landsliding

Map created without landslide information

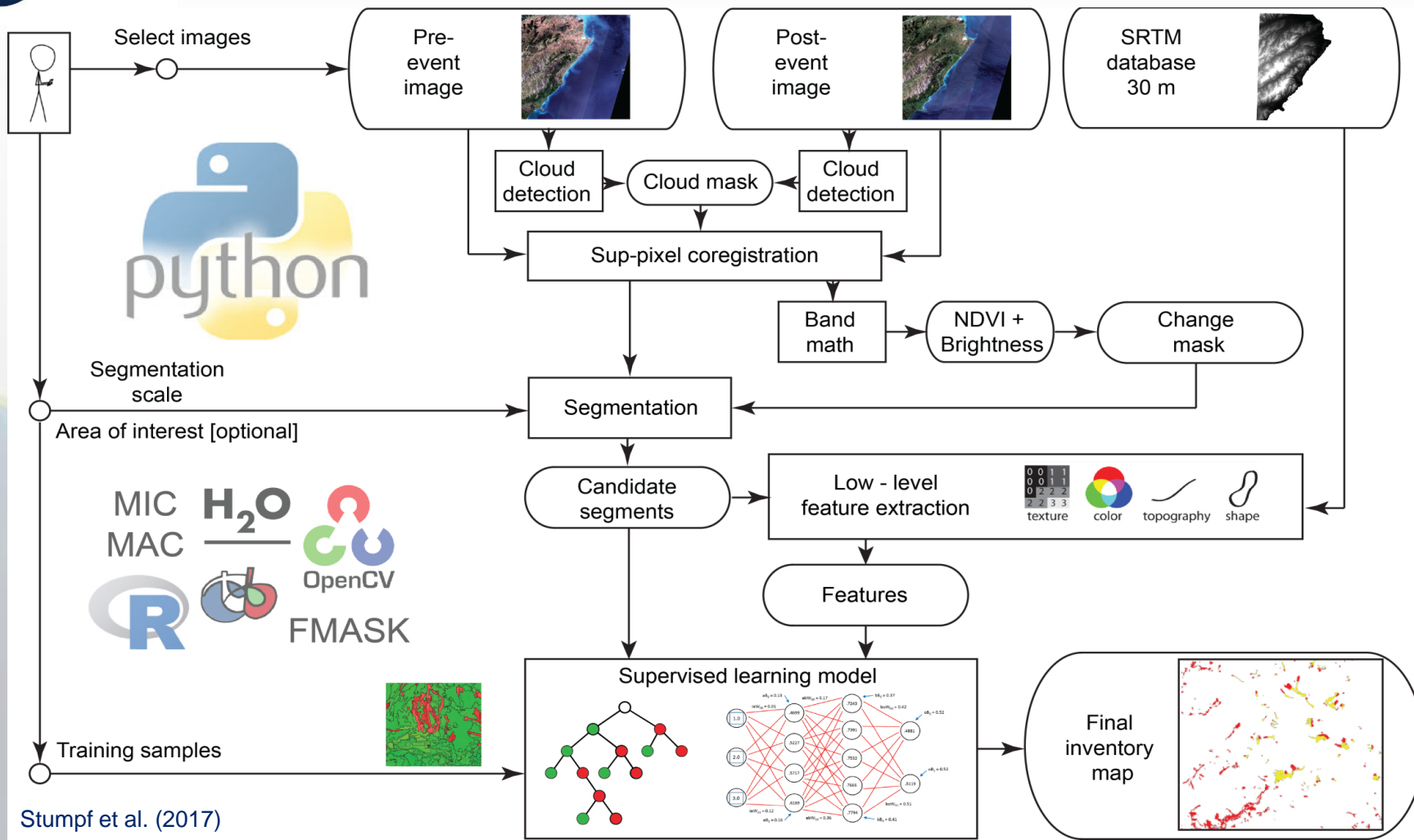
Landscape after Matthews
Major rain events





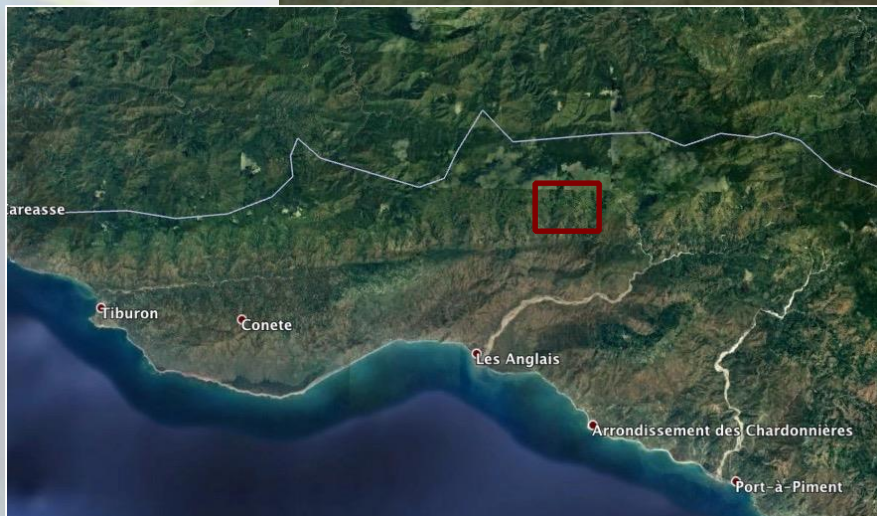
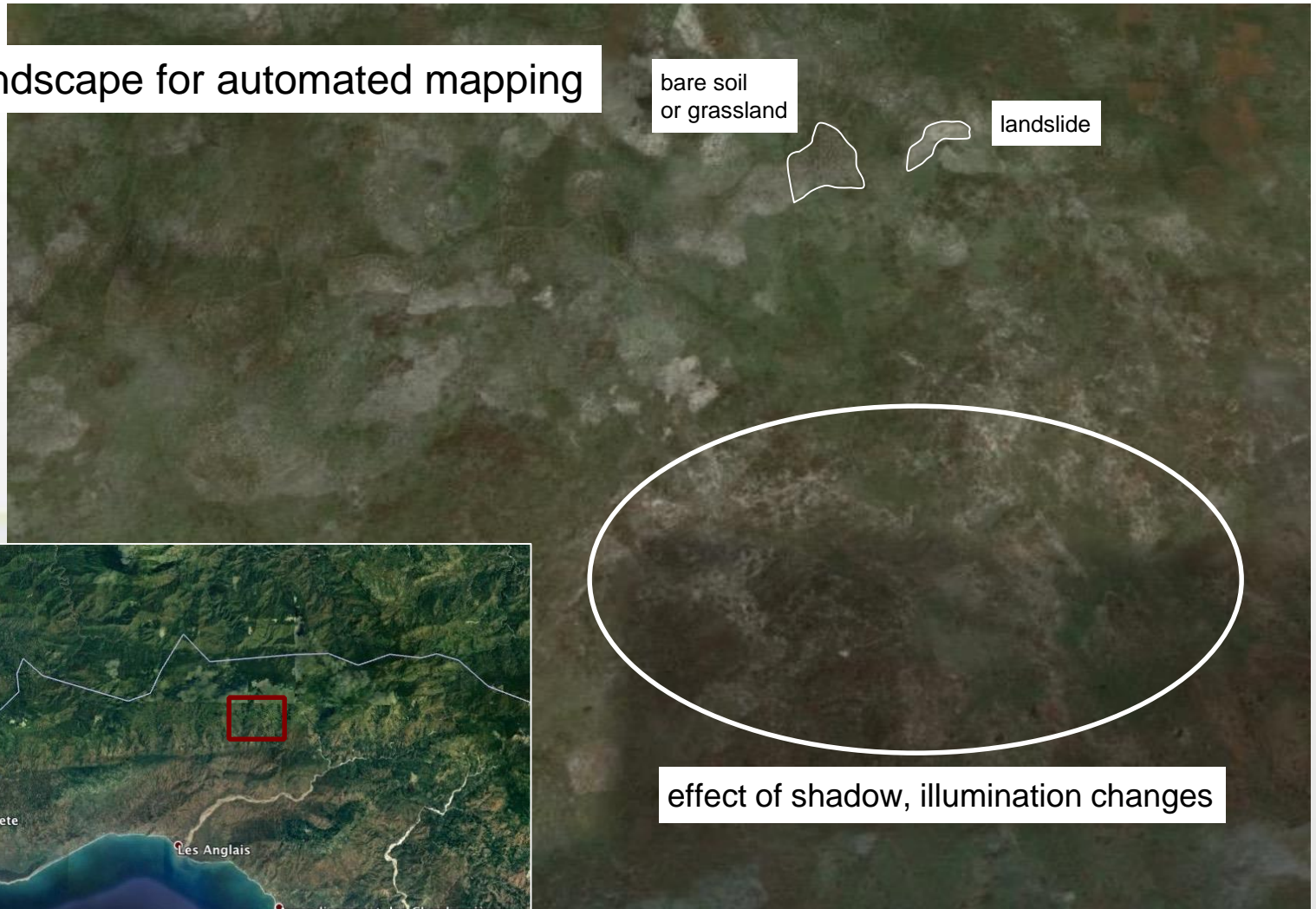
ALADIM: Automated Landslide Detection and Inventory Mapping

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

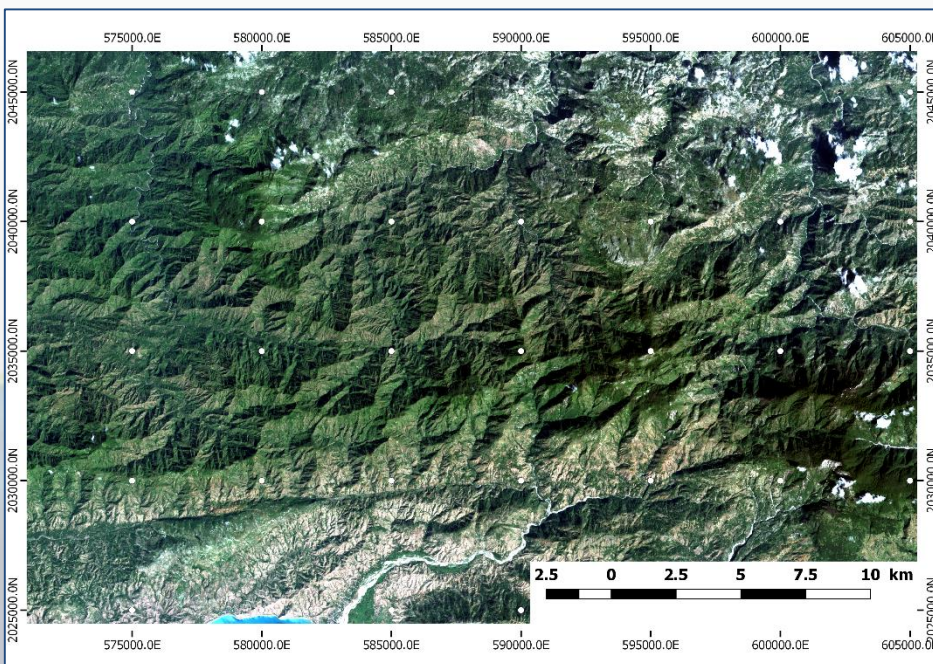
SPOT 7 – Post Matthew
2017 February

500m

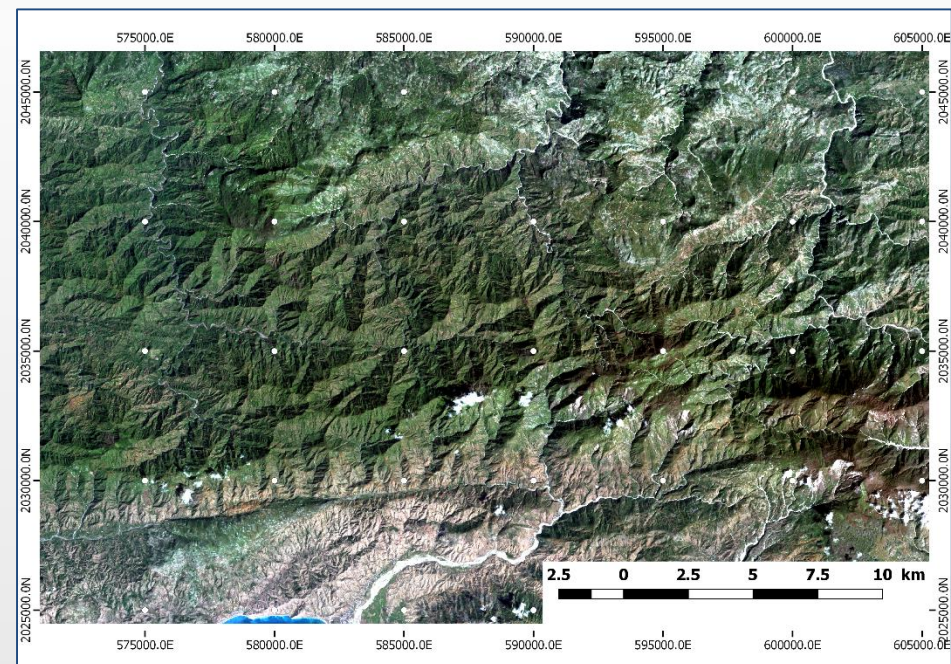
Channel deposits are difficult to map (they may add ~30% of affected areas)
Shadows on West and North slopes may cause underestimation of the total landsliding
Many bare soils Difficult for automated mapping



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



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



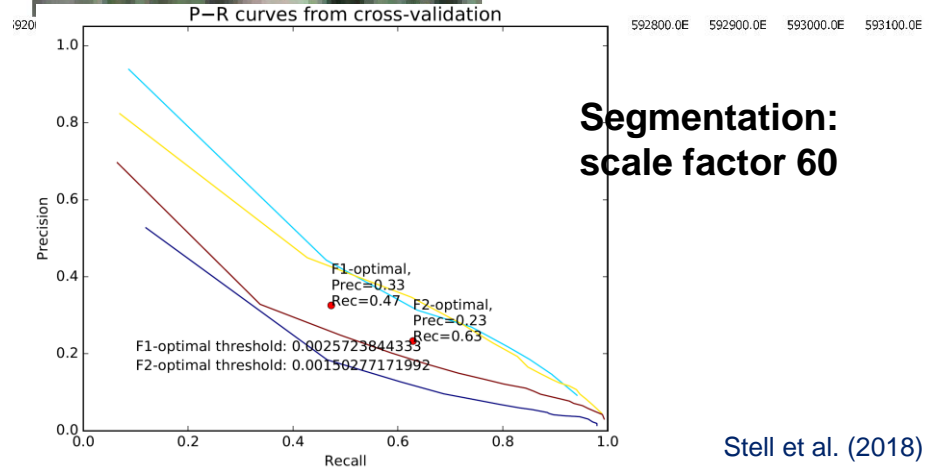
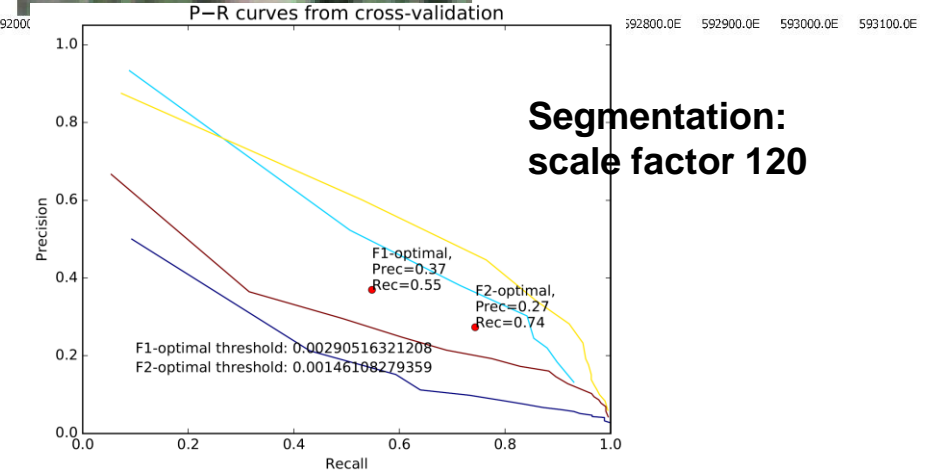
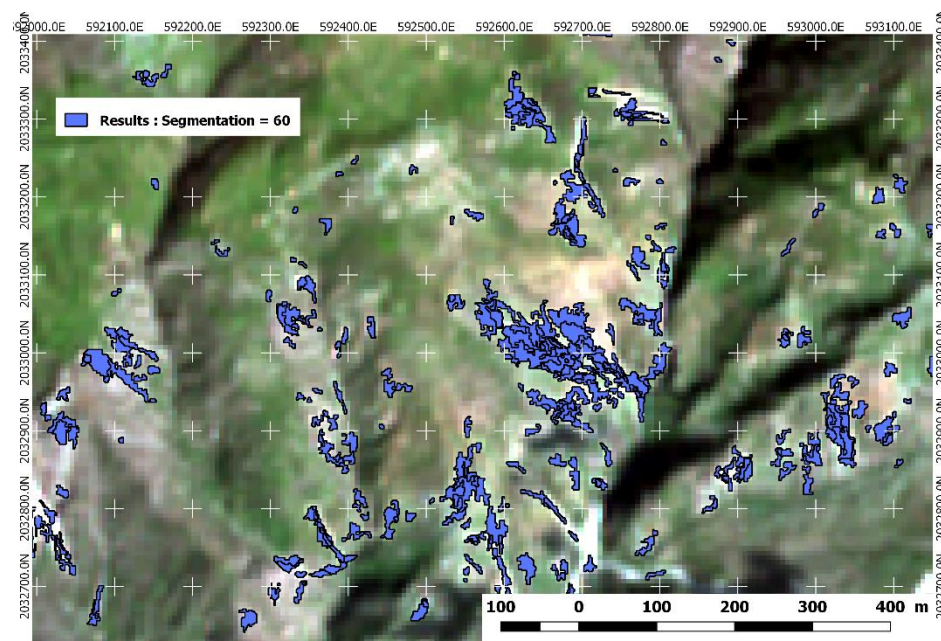
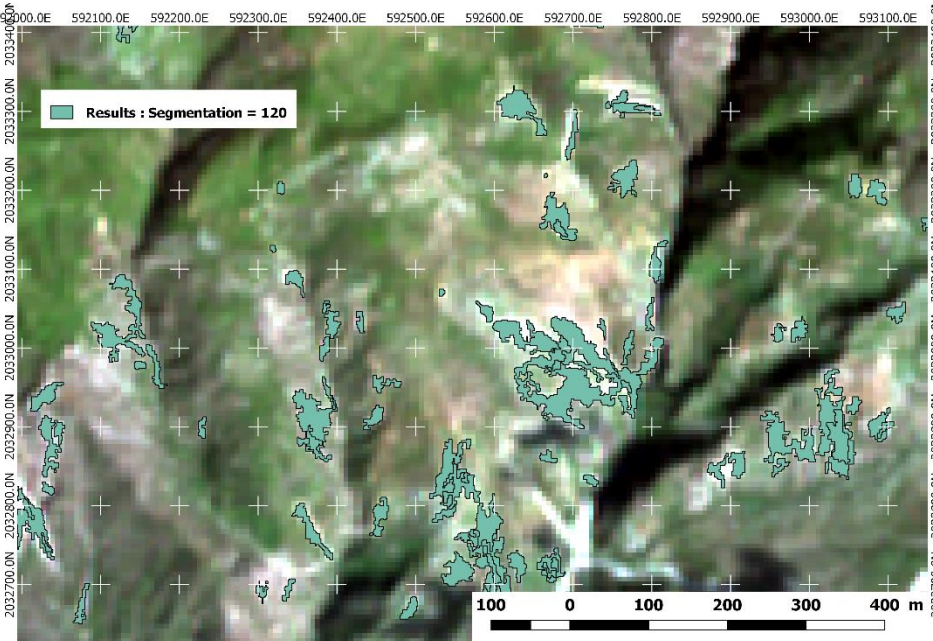


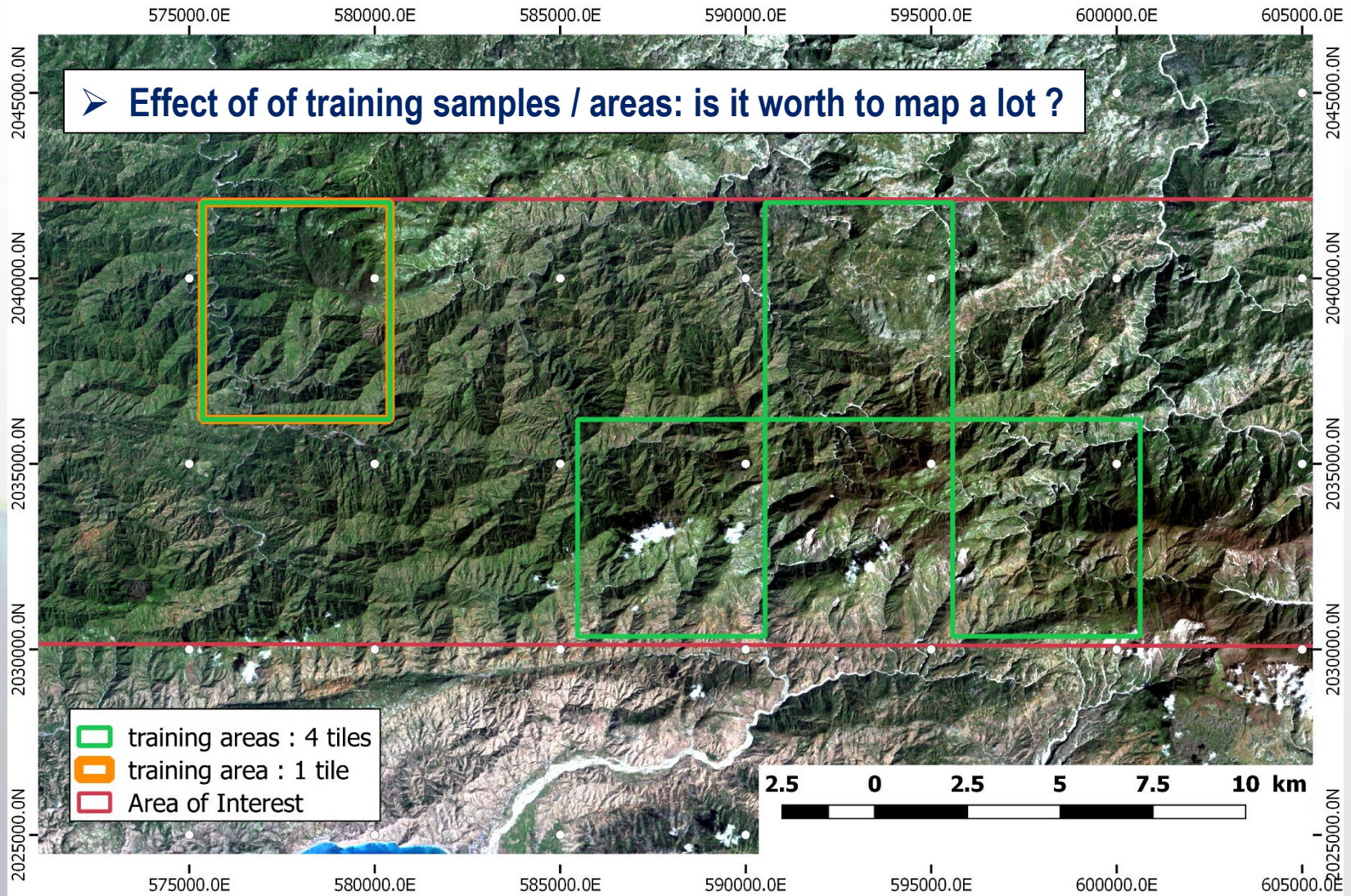
Experiments on different parameters were run in order to obtain the 'best' results

- **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.



Effect of segmentation: → better results for a coarse segmentation







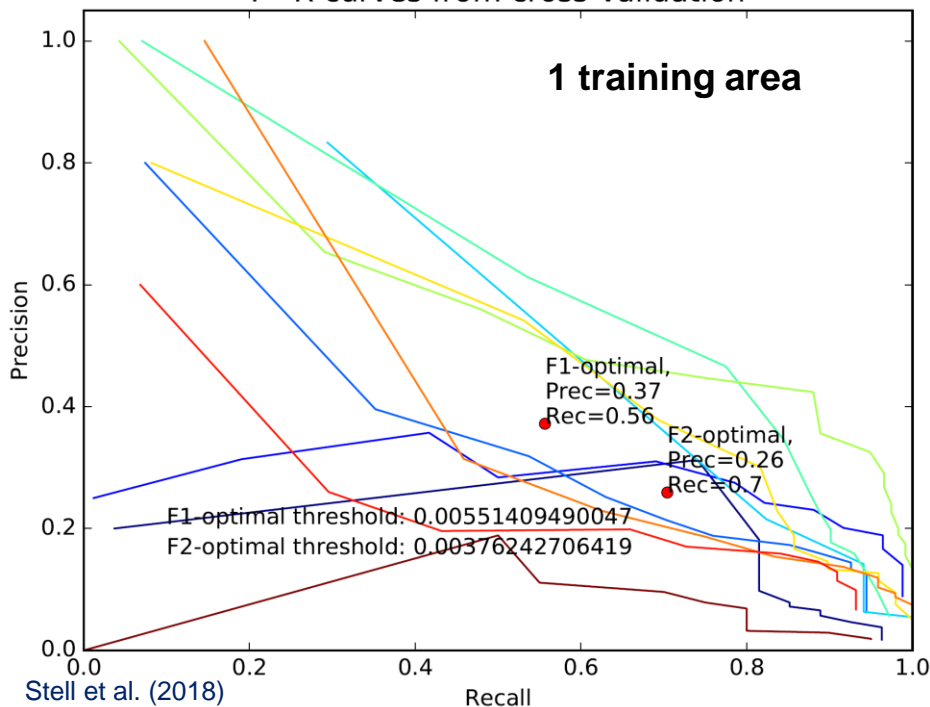
➤ Effect of training samples / areas: is it worth to map a lot ?

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

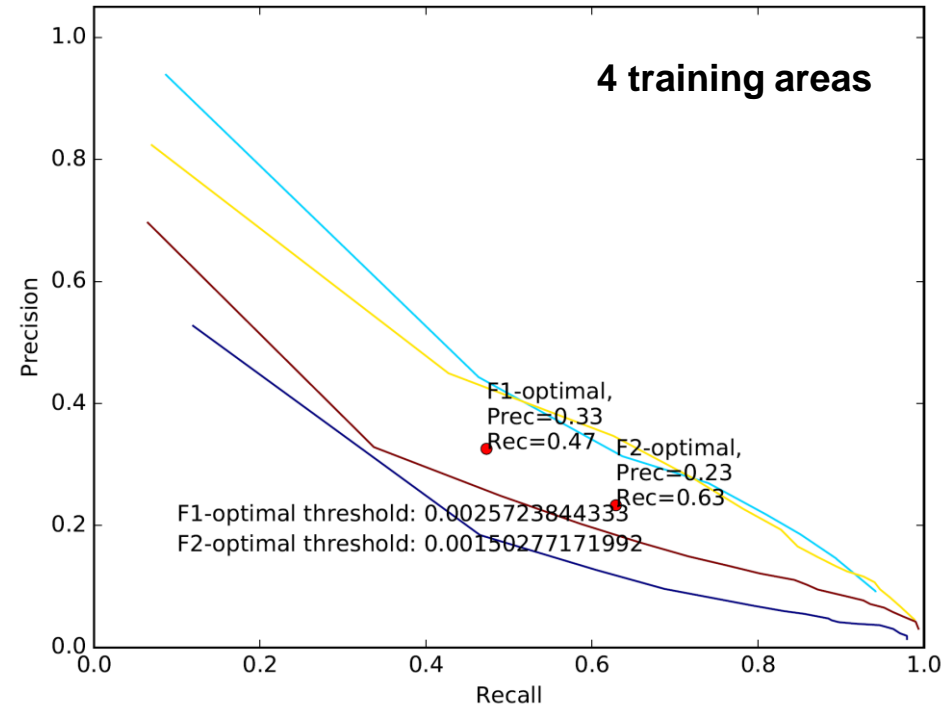
- of the complexity of the landscape (many anthropogenic activities, mining + agricultural fields)
- of the small size of the landslides (shallow and small)
- of the specificities of the images with a lot of shadows

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

P-R curves from cross-validation

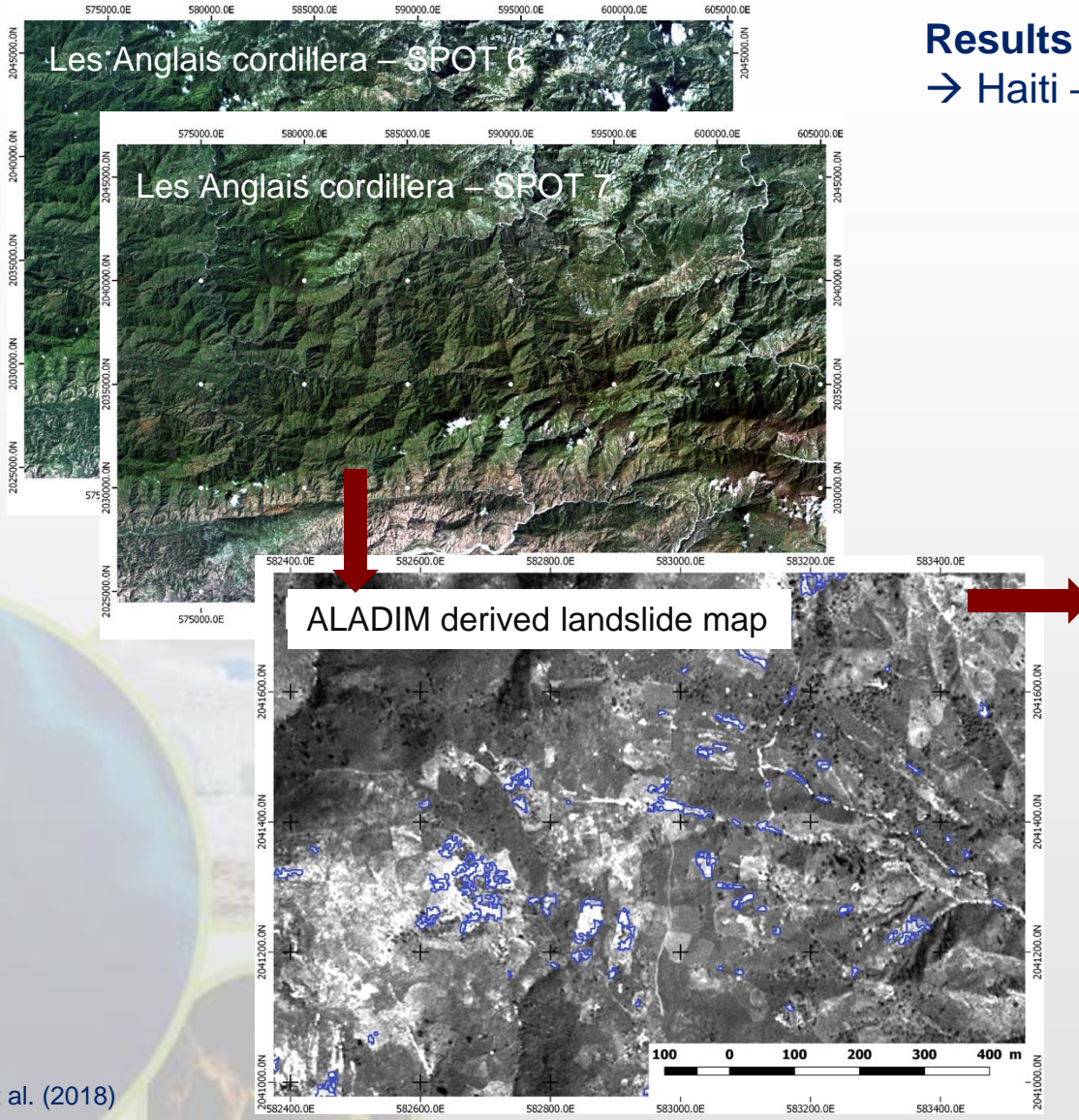


P-R curves from cross-validation

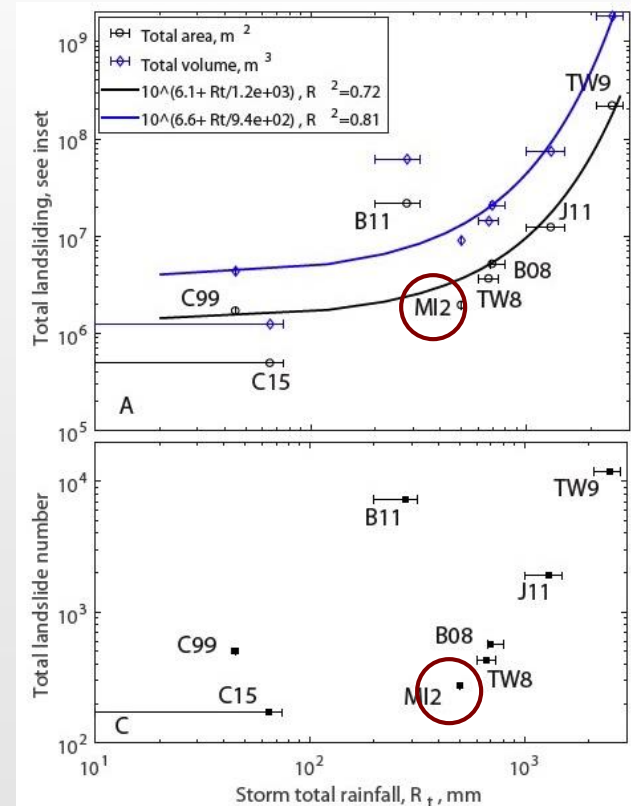




Results of ALADIM-Caribbean: → Haiti – post-Matthews landslides



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

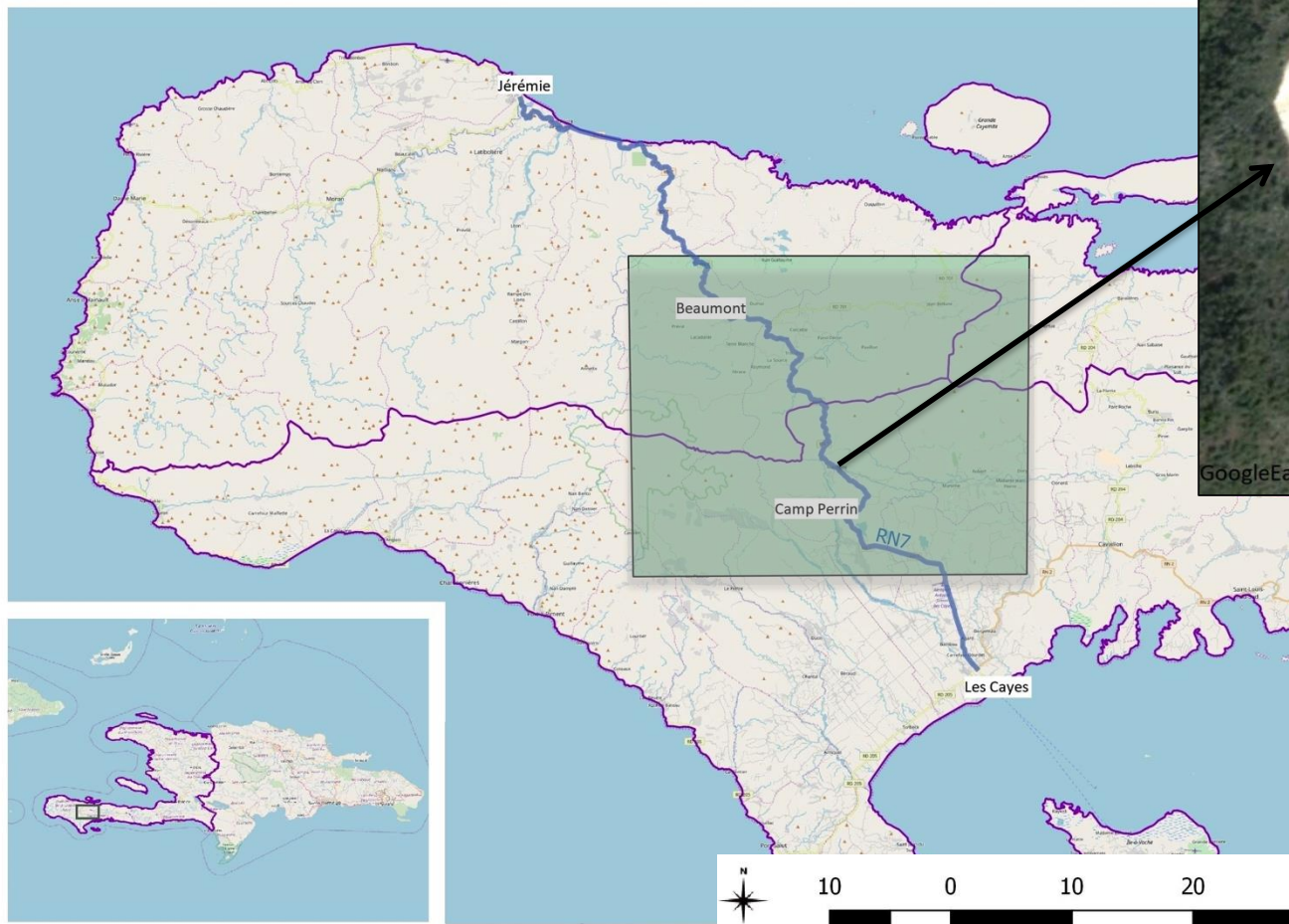
LIVE UMR 7362 CNRS / UNISTRA
Department of Geography
anne.puissant@unistra.fr



Committee on Earth Observation Satellites



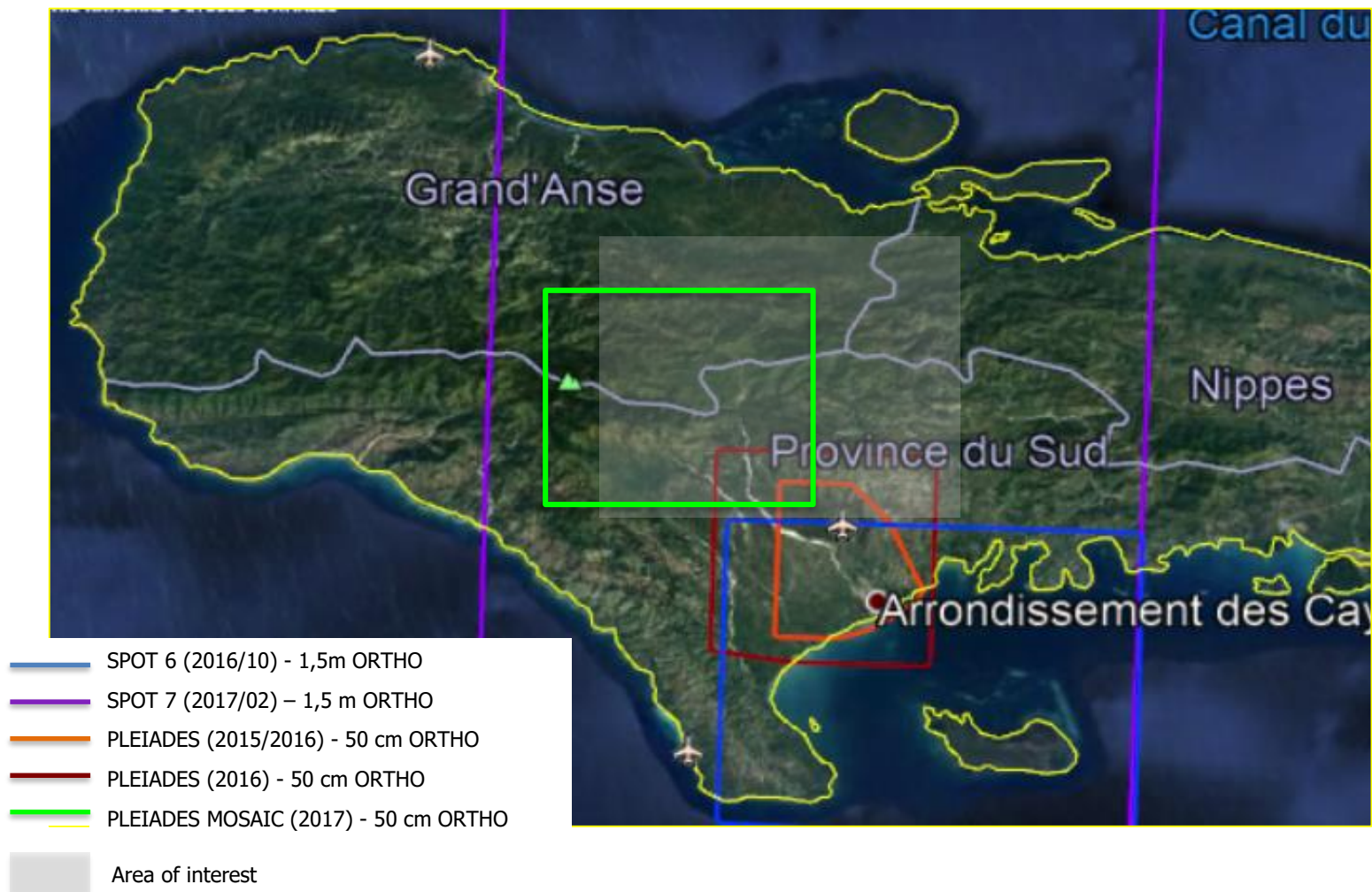
ROI: area with intense & non-regulated mineral extraction sites



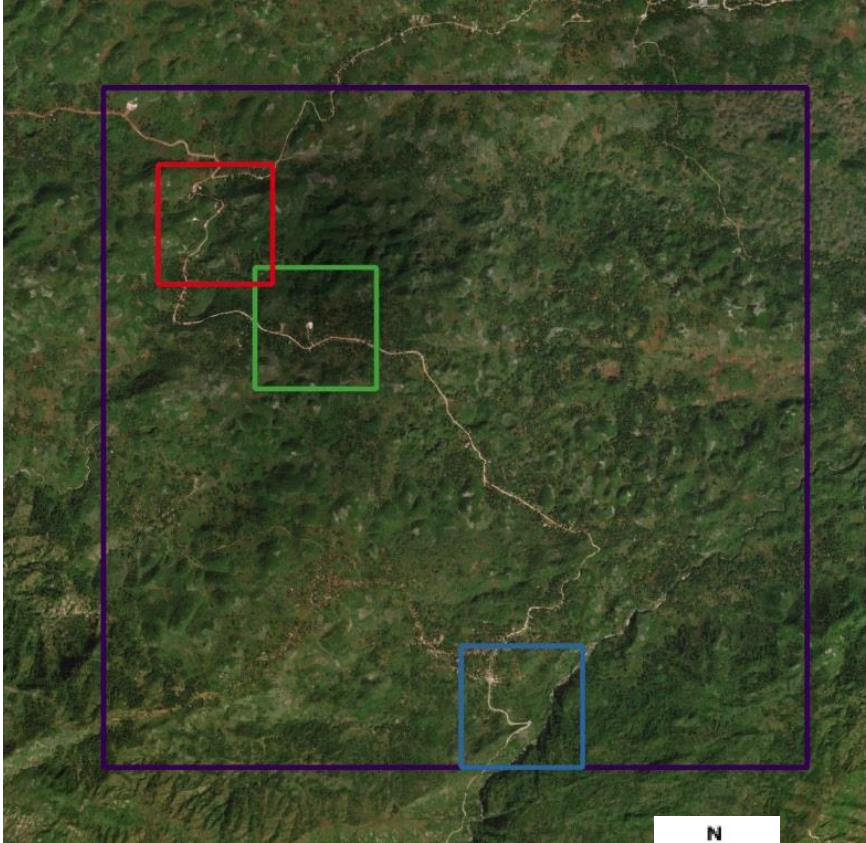
Légende

- Departemental limits
- Area of interest
- RN7
- Fond: OSM Standard

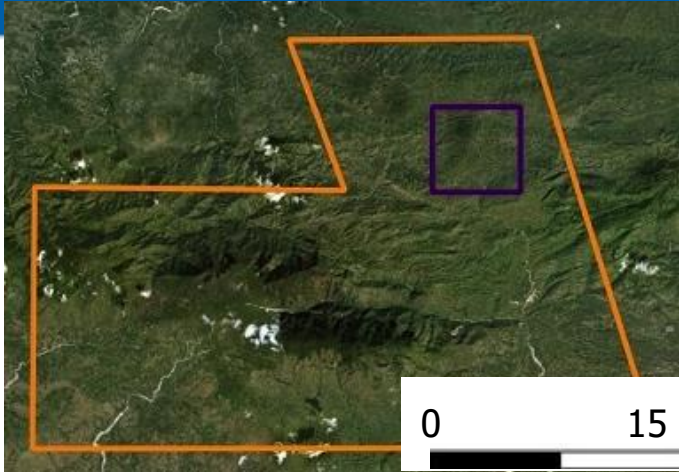
Image dataset (SPOT / PLEIADES)



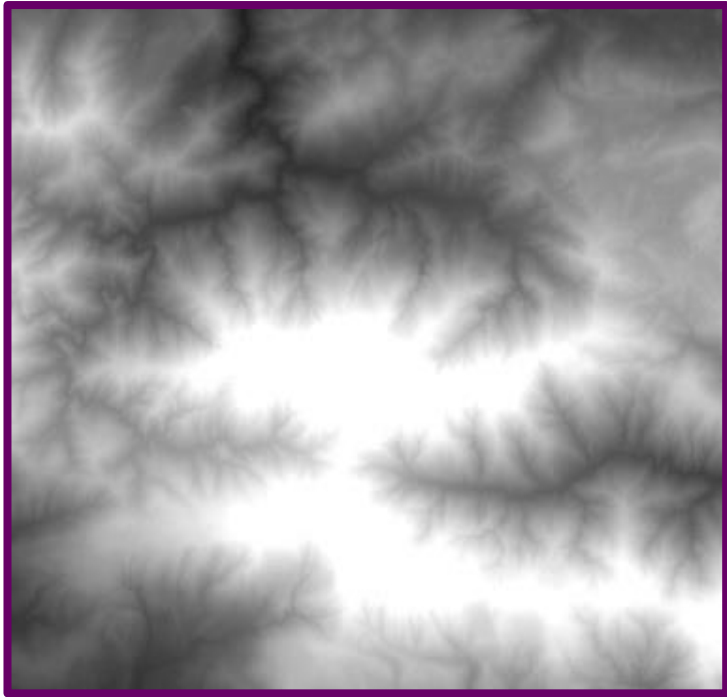
Test areas



PLEIADES (2017) - 50 cm P+MS ORTHO

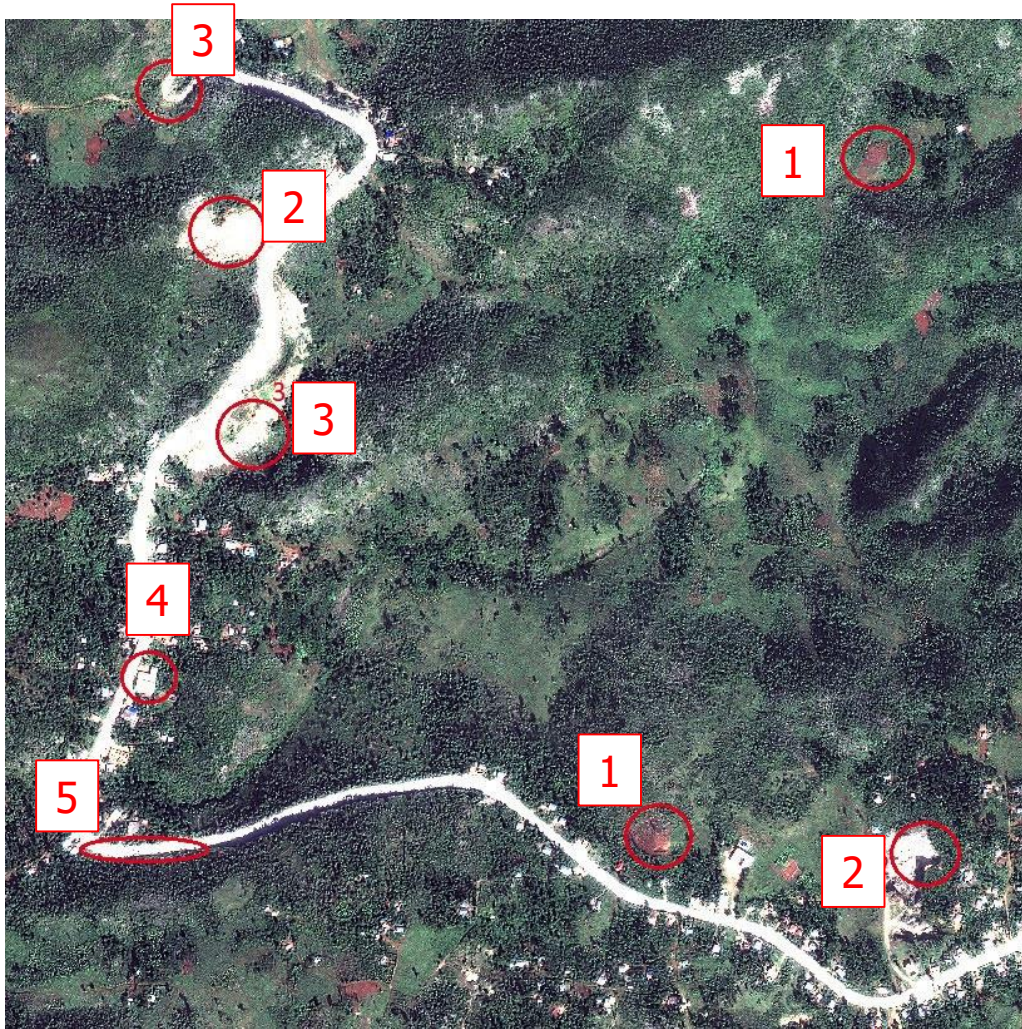


MOSAIC PLEIADES (2017) - 50 cm ORTHO

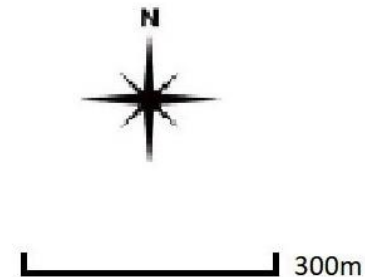


LiDAR DSM (2014 - 1,5m)

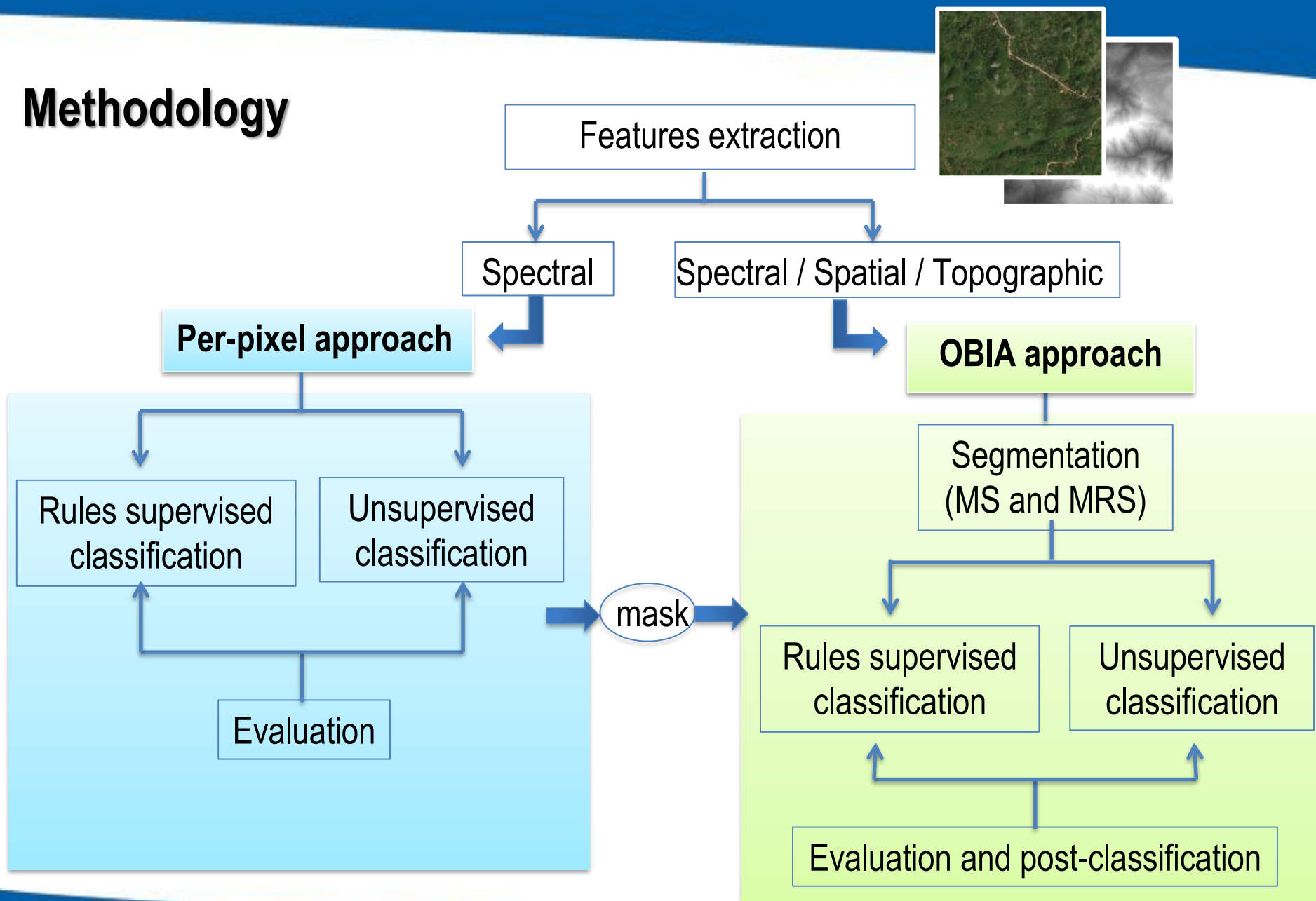
Definition of landcover classes



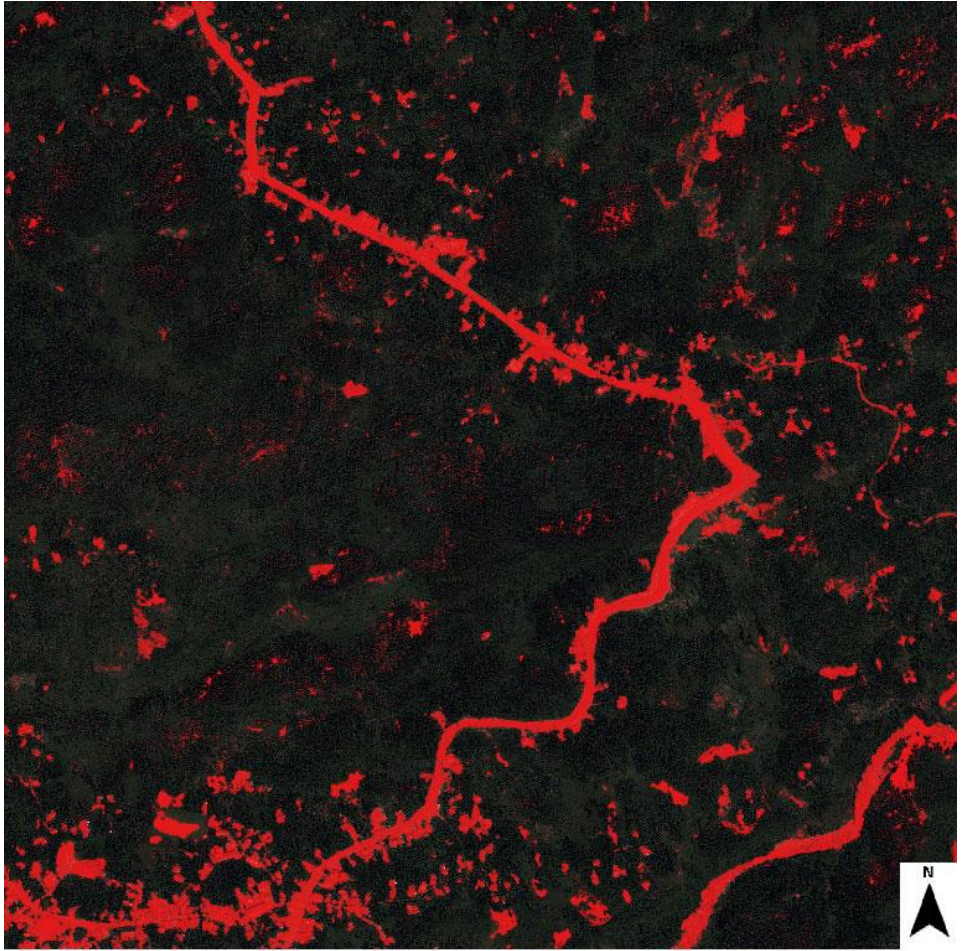
1. Bared soils (red soils, e.g laterite)
2. Mineral extraction surfaces
3. Other mineral surfaces (limestone)
(possible mineral extraction surfaces)
4. Houses
5. Roads



Methodology





Per-pixel approach for vegetation masking



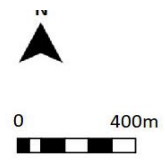
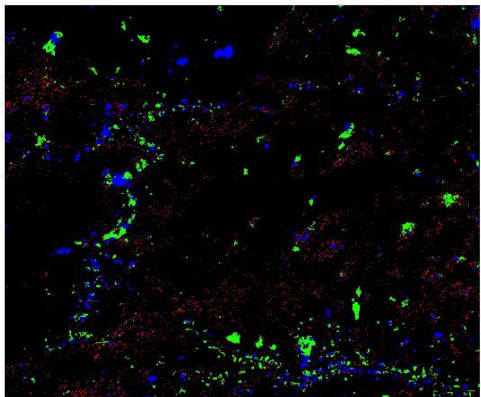
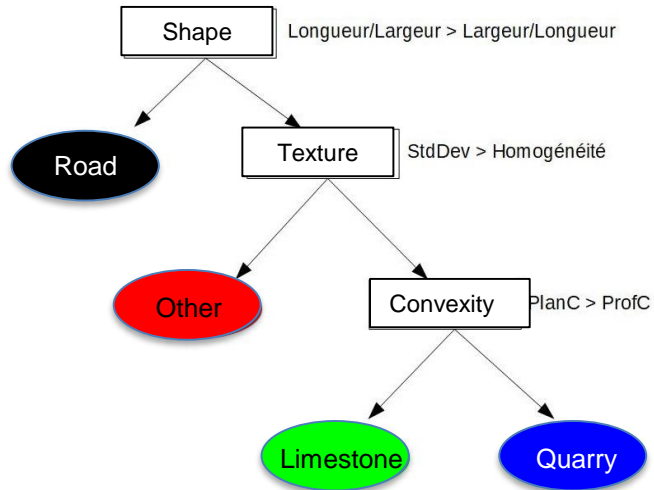
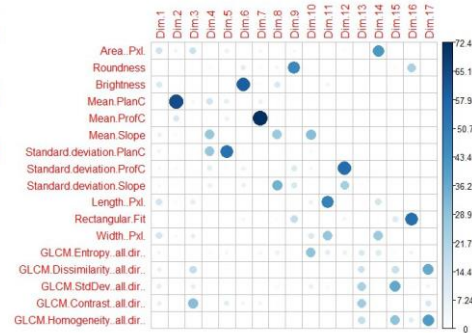
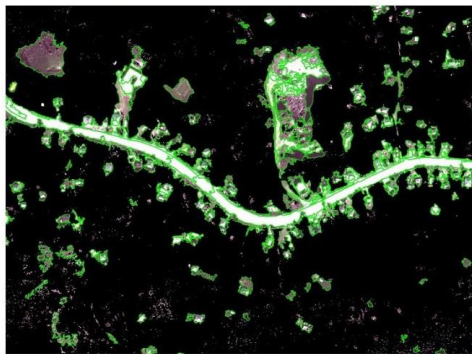
Surfaces minérales

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

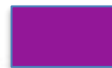
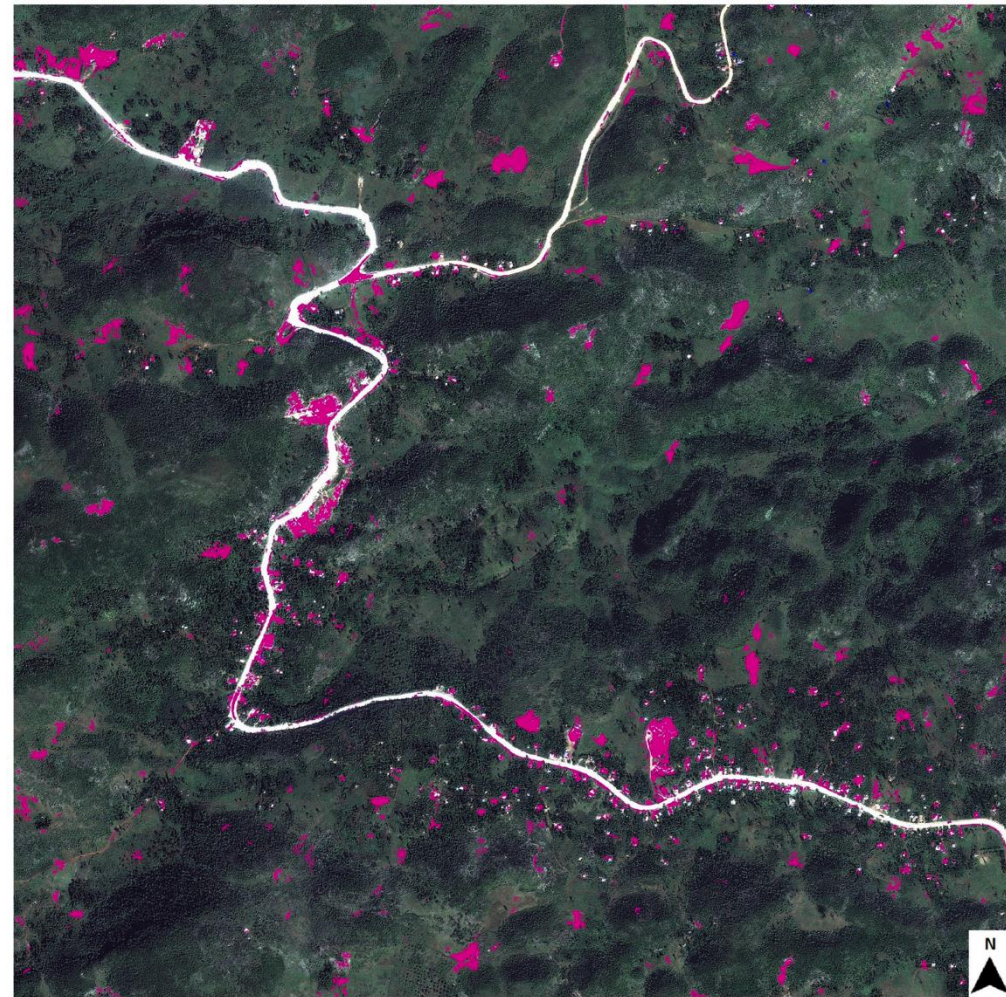
- Meanshift segmentation (OTB)
- Knowledge extraction : PCA based on spectral, spatial, texture and topographic features
- Rules based supervised classification -> decision trees
- Results and evaluation



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, texture and topographic features
- Rules based supervised classification -> decision trees
- Results and evaluation
- Post-classification (majority filter)

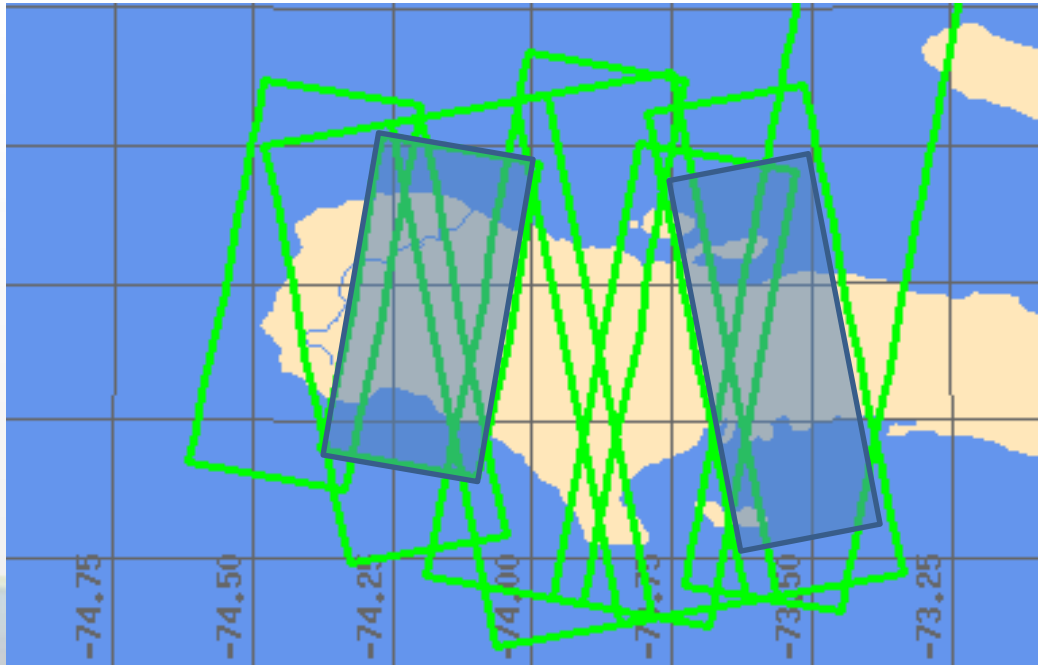


Potential quarries

250 0 250 500 750 1000 m

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)



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)

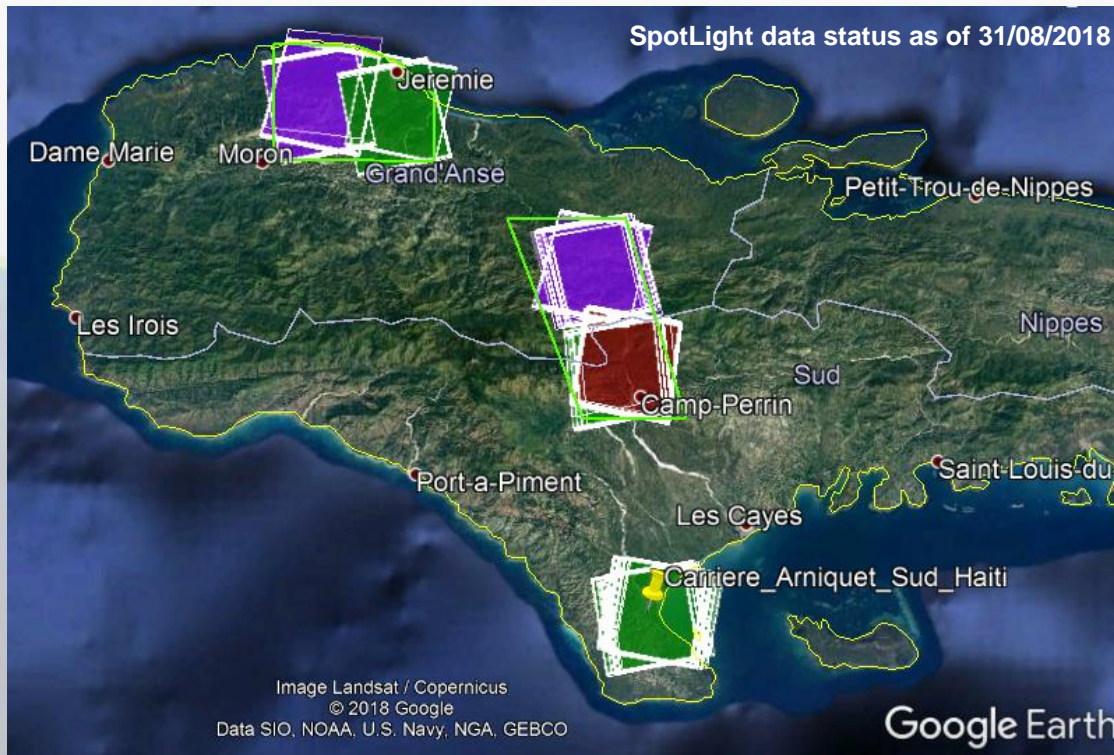
- Jeremie (urban + rural)
- Camp-Perrin (rural + road network)
- Carriere Arniquet (rural + mining)





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

- 3-year long tailored monitoring campaign [[started on 1st 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

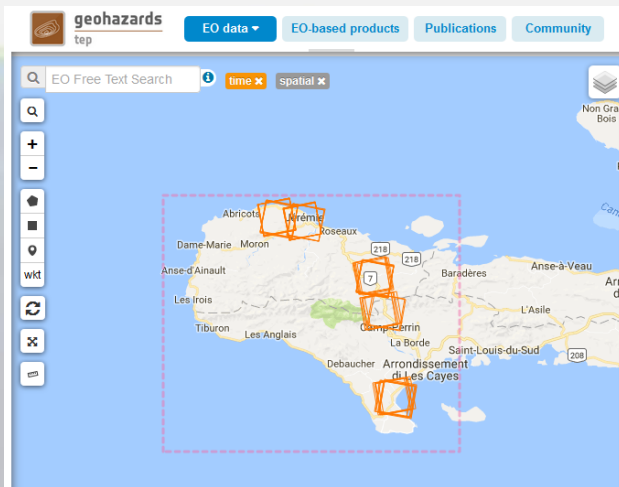
~16 scenes per site, per geometry

(as of 31/08/2018)

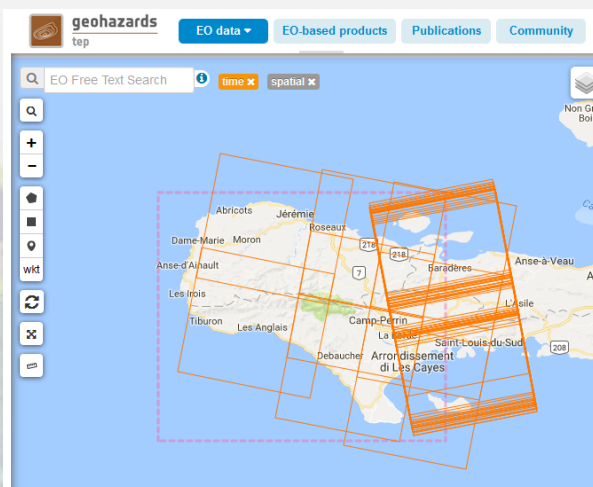


Exploitation of ESA's Geohazards Exploitation Platform (GEP)

- 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



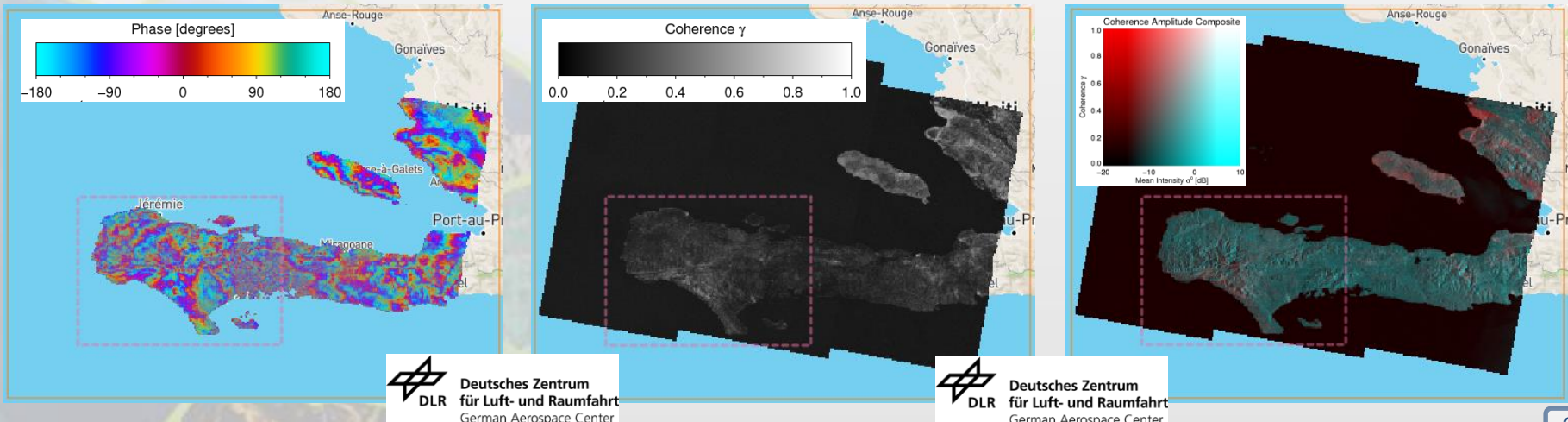
- Task 2: Start testing GEP hosted processing services [*Jun 2018 - present*]
 - **Sentinel-1 Medium Resolution InSAR Browse:** service allowing detection of deformation and surface change, systematically running for selected areas (>20% CEOS seismic active areas, 22 active volcanoes in EU, Latin America, 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





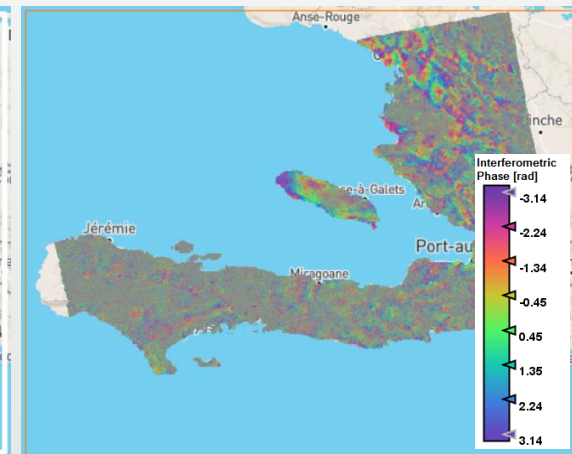
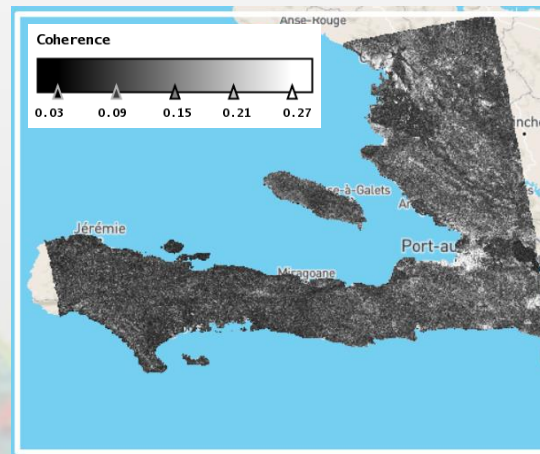
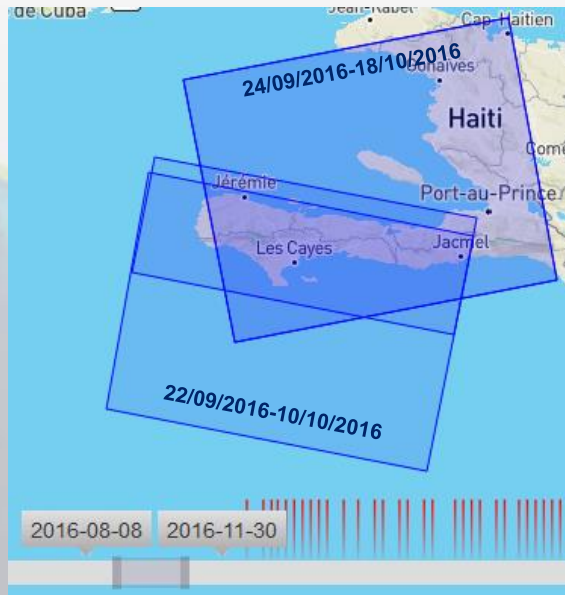
- Task 2: Start testing GEP hosted processing services [*Jul 2018 - present*]
 - **SNAP InSAR**: interferometric processor for Sentinel-1 TOPSAR IW SLC data performed through SNAP (Sentinel Application Platform) - Sentinel-1 Toolbox (S1TBX)

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

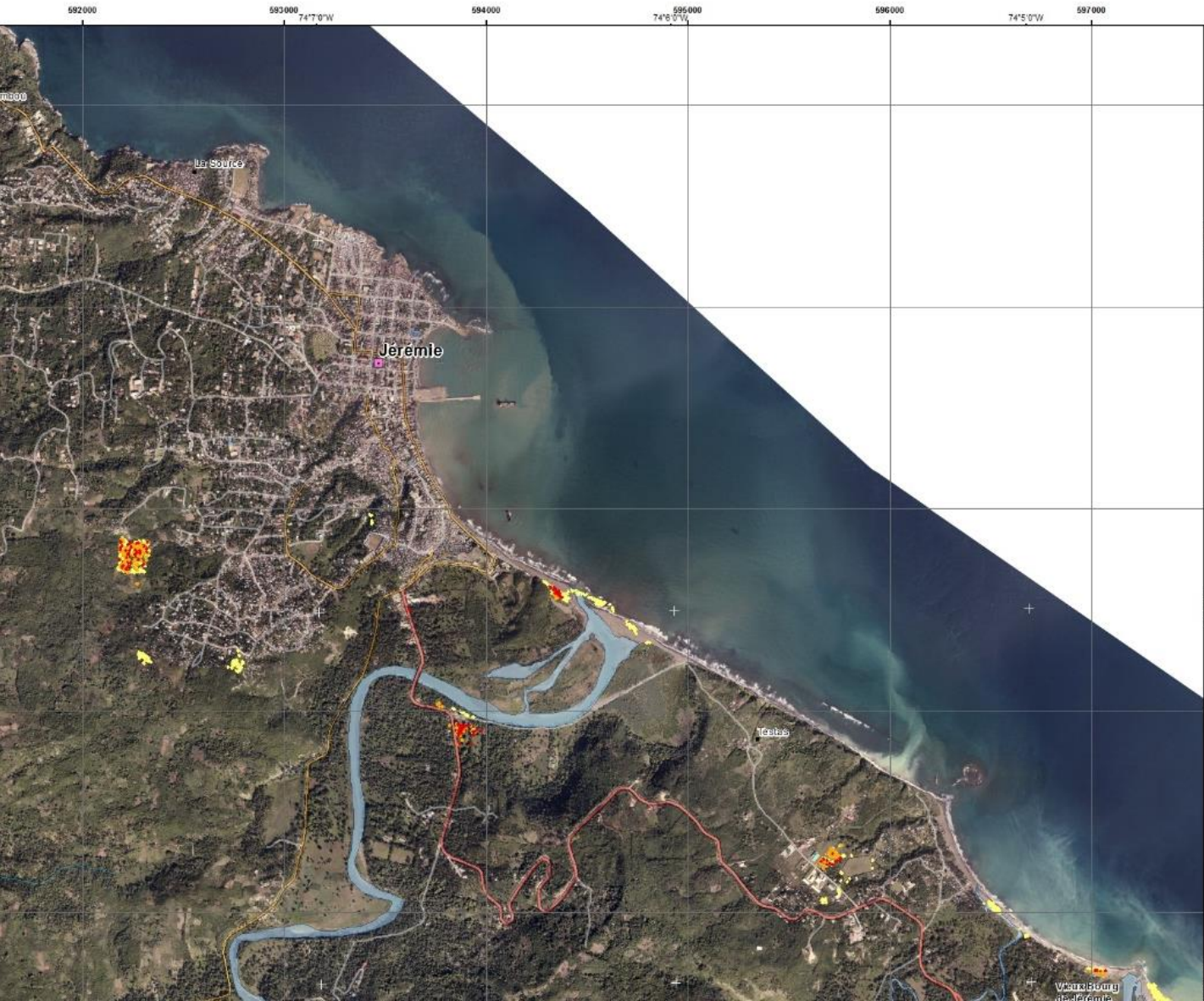
➤ Dissemination & capacity building

- Presentation of GEP trials at *ESA Φ -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

- EMSN050 “Cities”

Area : Les Cayes and Jérémie

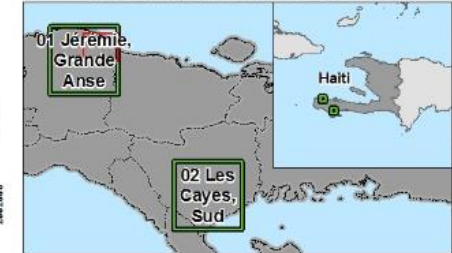
- Reference map
- Damage assessment
- IDP Camps Identification
- IDP Camps monitoring
- Landuse / Landcover
- Reconstruction + 18 months



Glide Number: (N/A) Product N.: Identification IDP camps Map, v.1, 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)

0 0.25 0.5 1 Kilometers

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
- 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
- Boundaries**
 - AOI
 - Communes CNIGS

Map Information

Pre-disaster situation analyses for two locations in Haiti: Jérémie (Grand Anse) and Les Cayes (Sud). Post-disaster damage assessment after the hit of Cyclone Mathew, monitoring of reconstruction activities of the assets 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 (CNIGS) 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

72575W 61500 72545W 62000 72515W 62500 72485W 63000 72455W 63500

Legend

Hydrography

- BH140 - River Line
- BH140 - River Area

Transportation

- AP030 - Primary Route
- AP030 - Secondary Route
- AP030 - Local Route
- AP010 - Cart Track
- AQ040 - Bridge Line

Points of Interest

- Hospital/Health Facility
- Fire Station
- Police
- Pharmacy
- Sport Facility
- Place Of Worship
- Cemetery
- Prison
- Educational Facility
- Government/Embassy
- Public/Social Facility
- University/Research
- Post Office
- Gas station
- Commercial
- Bank
- Accommodation
- Landmark/Monument
- Drinking Water
- Water Tower

Population

- AL020 - BUA First Order
- AL020 - BUA Second Order
- AL020 - BUA Village
- AL020 - Suburb/Neighb.
- AL020 - Hamlet

Physiography

- CA030 - Elevation Spot
- CA010 - Index Contour
- CA010 - Interm. Contour
- BA010 - Land Boundary

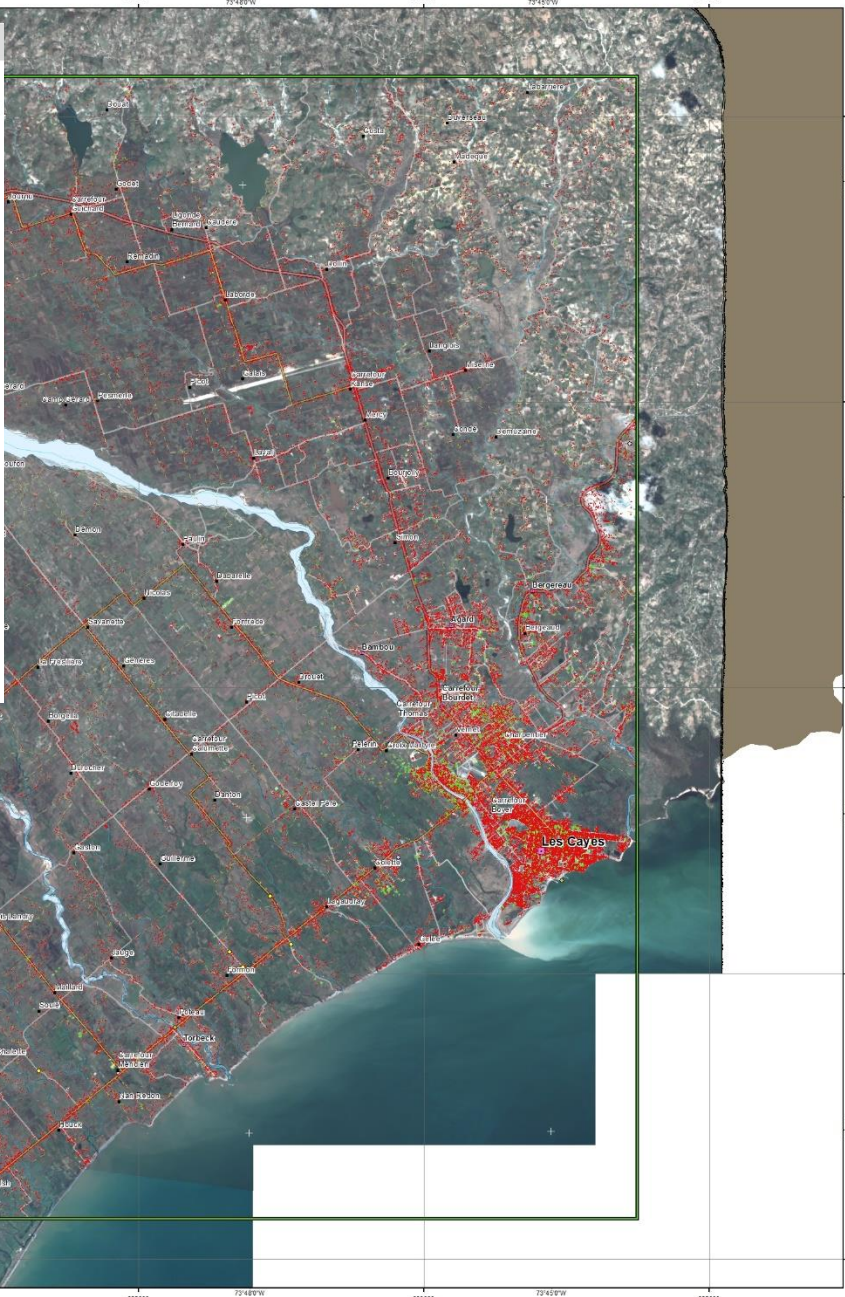
BuildA t1

Status at t1

- 1-Not visible damage
- 2-Damage

Boundaries

- AOI
- Communes



Guide Number (N/A) Product N.: Damage Assessment Map, v1, English Activation ID: EMB01_000
Post Mawth 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, high resolution (100 dpi)
 Grid: WGS 1984 Zone 18N map coordinate system
 Tick marks: WGS 84 geographical coordinate system

Legend

Damage Assessment Layers at t1 Status at t1 1-Not visible damage 2-Damage Other Damaged Assets Type Road Bridge Pylon Other Hydrography BH140 - River Line BH140 - River Area	Transportation AP030 - Primary Route AP030 - Secondary Route AP030 - Local Route AP010 - Cart Track AQ040 - Bridge Line Population AL020 - BUA First Order AL020 - BUA Second Order AL020 - BUA Village AL020 - Suburb/Neighb. AL020 - Hamlet Boundaries AOI Communes CHUG
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Map Information
 The main map was produced for the location in Haiti, namely Grand Anse and Les Cayes (Sud). Post-mawth damage assessment after the hit of Cyclone Mawth, monitoring of reconstruction activities in the assessment area of the impact of Cyclone Mawth, monitoring approximately one year after the event.
 The core user of the map is Centre National d'Information Géospasiale (CNIGIS) 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 Mawth (October 2015).
 The map production is based on the Copernicus Emergency Response Service (ERS) data sources.
 The map production is based on the Copernicus Emergency Response Service (ERS) data sources.
 The map production is based on the Copernicus Emergency Response Service (ERS) data sources.

Data Sources

AOI	Les Cayes, Sud
ERS	ERS
ERS	ERS

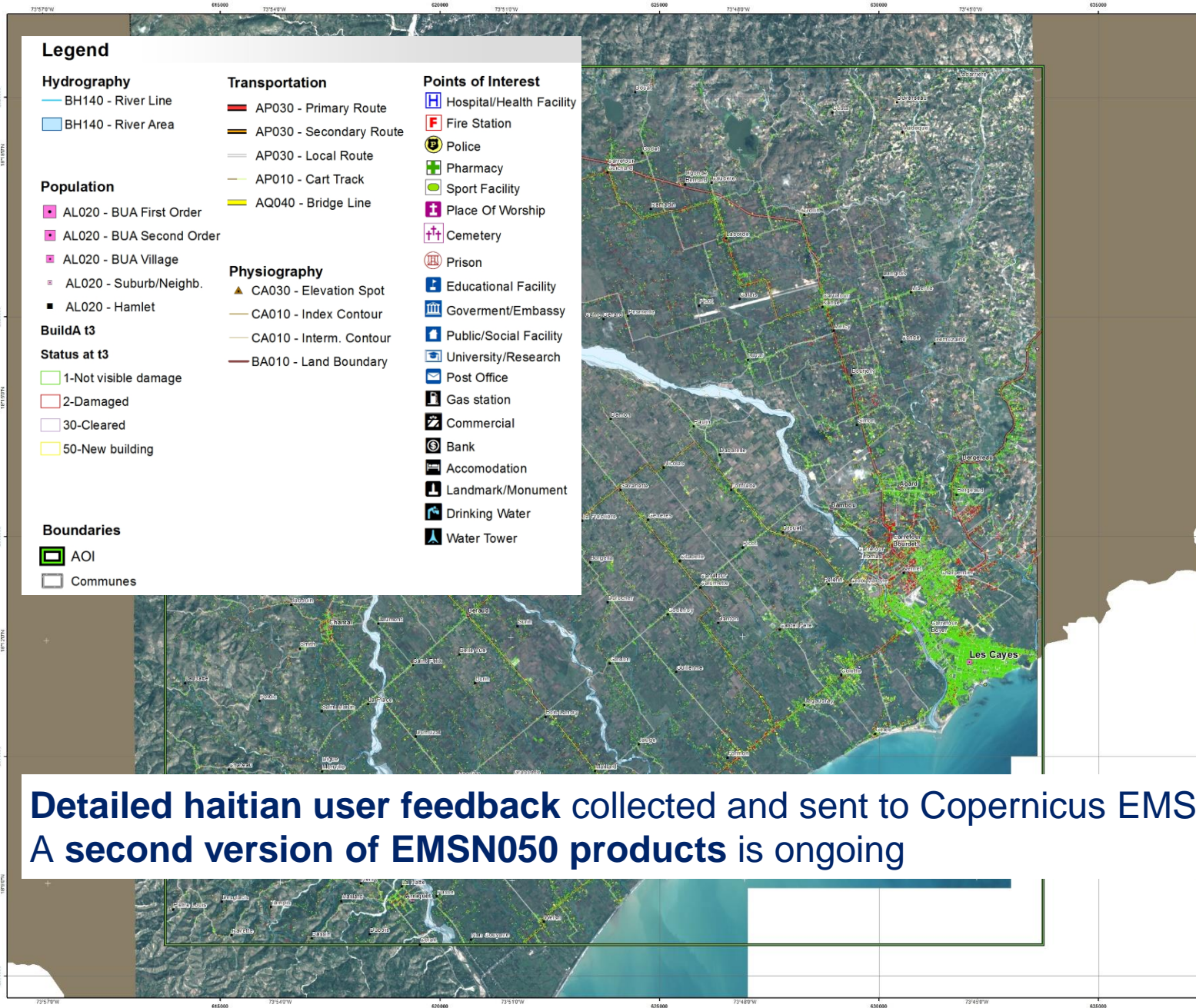
Dissemination/Publication
 Map products are available in the Copernicus ERS Portal at the following URL: <http://emergency.copernicus.eu/portal/>
 Copying, reuse, or distribution of this map is prohibited without the express written permission of the Copernicus ERS. All products are © of the European Union.

Disclaimer
 The products elaborated in the framework of current mapping in Risk and Recovery mode attention are provided to the best of our ability, optimizing the available data and information of geographic information that is relevant due to water, reception, date and interpretation of the original data sources. No liability concerning the contents of the use thereof is assumed by the producer and by the European Union. The products are compliant with Copernicus ERS Risk and Recovery Product Portfolio specifications.

Map Production
 The present map shows the post-mawth Damage Assessment Layers of Building Footprints and Other Damaged Assets in 02 Les Cayes (Sud) State of Haiti in 01/01/2016. The map is based on the original data sources. No liability concerning the contents of the use thereof is assumed by the producer and by the European Union. The products are compliant with Copernicus ERS Risk and Recovery Product Portfolio specifications.

Contact
 Map produced on 03/05/2016 by Indra Sistemas S.A. and Geovis under contract 200311 under the Copernicus Commission. All products are © of the European Commission. Name of the process (specific quality control): Indra Sistemas S.A. E-mail: go-ers-haiti@copernicus.eu http://emergency.copernicus.eu/mapping

72575W 61500 72545W 62000 72515W 62500 72485W 63000 72455W 63500



Legend

- Hydrography**
 - BH140 - River Line
 - BH140 - River Area
- Population**
 - AL020 - BUA First Order
 - AL020 - BUA Second Order
 - AL020 - BUA Village
 - AL020 - Suburb/Neighb.
 - AL020 - Hamlet
- BuildA t3**
- Status at t3**
 - 1-Not visible damage
 - 2-Damaged
 - 3-Cleared
 - 50-New building
- Boundaries**
 - AOI
 - Communes
- Transportation**
 - AP030 - Primary Route
 - AP030 - Secondary Route
 - AP030 - Local Route
 - AP010 - Cart Track
 - AQ040 - Bridge Line
- Physiography**
 - CA030 - Elevation Spot
 - CA010 - Index Contour
 - CA010 - Interm. Contour
 - BA010 - Land Boundary
- Points of Interest**
 - Hospital/Health Facility
 - Fire Station
 - Police
 - Pharmacy
 - Sport Facility
 - Place Of Worship
 - Cemetery
 - Prison
 - Educational Facility
 - Government/Embassy
 - Public/Social Facility
 - University/Research
 - Post Office
 - Gas station
 - Commercial
 - Bank
 - Accommodation
 - Landmark/Monument
 - Drinking Water
 - Water Tower

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

Legend

- Monitoring of Reconstruction Layers in t3**
 - BuildA t3
 - 1-Not visible damage
 - 2-Damaged
 - 3-Cleared
 - 50-New building
- Other Reconstruction Assets**
 - Road
 - Wall/Fence
 - Bridge
 - Pylon
 - Other
- Population**
 - AL020 - BUA First Order
 - AL020 - BUA Second Order
 - AL020 - BUA Village
 - AL020 - Suburb/Neighb.
 - AL020 - Hamlet
- Boundaries**
 - AOI
 - Communes CHIGS

Map Information

The metadata matrix analysis for the location in Haiti, namely Grand Anse and Les Cayes (UD), was conducted by the Copernicus Emergency Response Team (CERT) as part of the Post-Mathew Damage Assessment and Monitoring of Recovery Activities in the South Region of Haiti. The map shows the evolution of internally displaced people camps approximately one year after the event.

The core user of the map is the Centre National d'Information Géospatiale (CNIGS) 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).

AOI	Les Cayes, Sud
BuildA t3	BuildA t3
Cartography	Copernicus

Data Sources

Post-event imagery ©: Planet Labs © CNIGS (2016), estimated by Airbus DS (acquired on 05/20/2016, 950 5.5 m, approx. 7% cloud coverage), provided under Copernicus by the European Union and ESA, all rights reserved.

Vector layers: Monitoring of reconstruction activities layers are building footprints and other assets. Building footprints were manually digitized and coded status with present integrity. Status at t3 was classified by visual interpretation using post-event imagery. Other damaged assets are represented by a point of observation where type of asset and status at t3 are coded. Transportation network primary source is Copernicus, at Copernicus, at Copernicus. Physiographic features source is CHIGS, area lines were manually digitized over pre-event imagery. Population figures primary source is CNIGS (2016) and boundaries source is CHIGS.

Inset maps: Administrative boundaries source is CHIGS and GADP.

Dissemination/Publication

Map products are available in the Copernicus EMS Portal at the following URL: <http://emergency.copernicus.eu/infomaps/020505>
 Delivery methods are raster or vector, in any format.
 All products are © of the European Union.

Contact

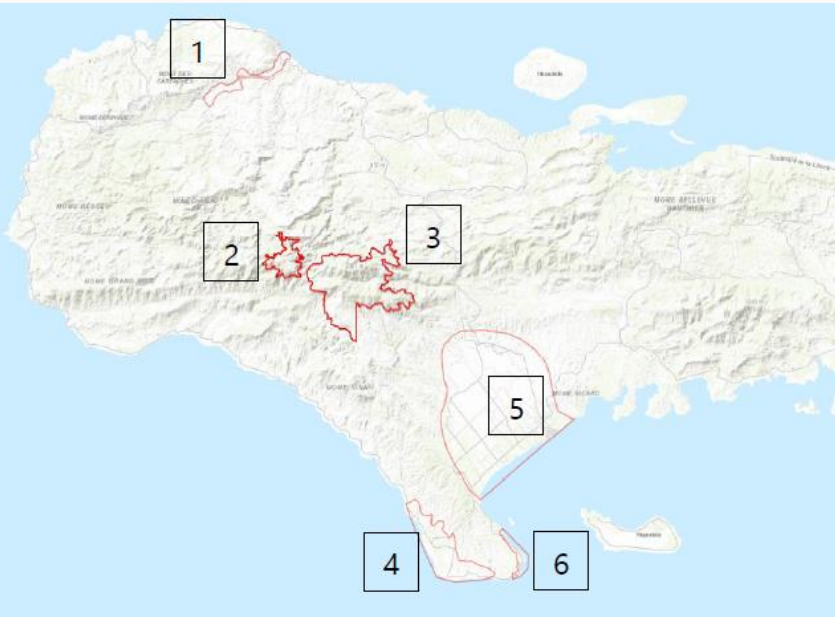
Map produced on 04/05/2016 by Indra Sistemas S.A. and Geovis under contract 20511 with the European Commission. All products are © of the European Commission.
 Name of the person in charge (quality control): Indra Sistemas S.A.
 E-mail: go-ems@copernicus.eu
 http://emergency.copernicus.eu/infomaps

Detailed haitian user feedback collected and sent to Copernicus EMS RRM in July
 A second version of EMSN050 products is ongoing

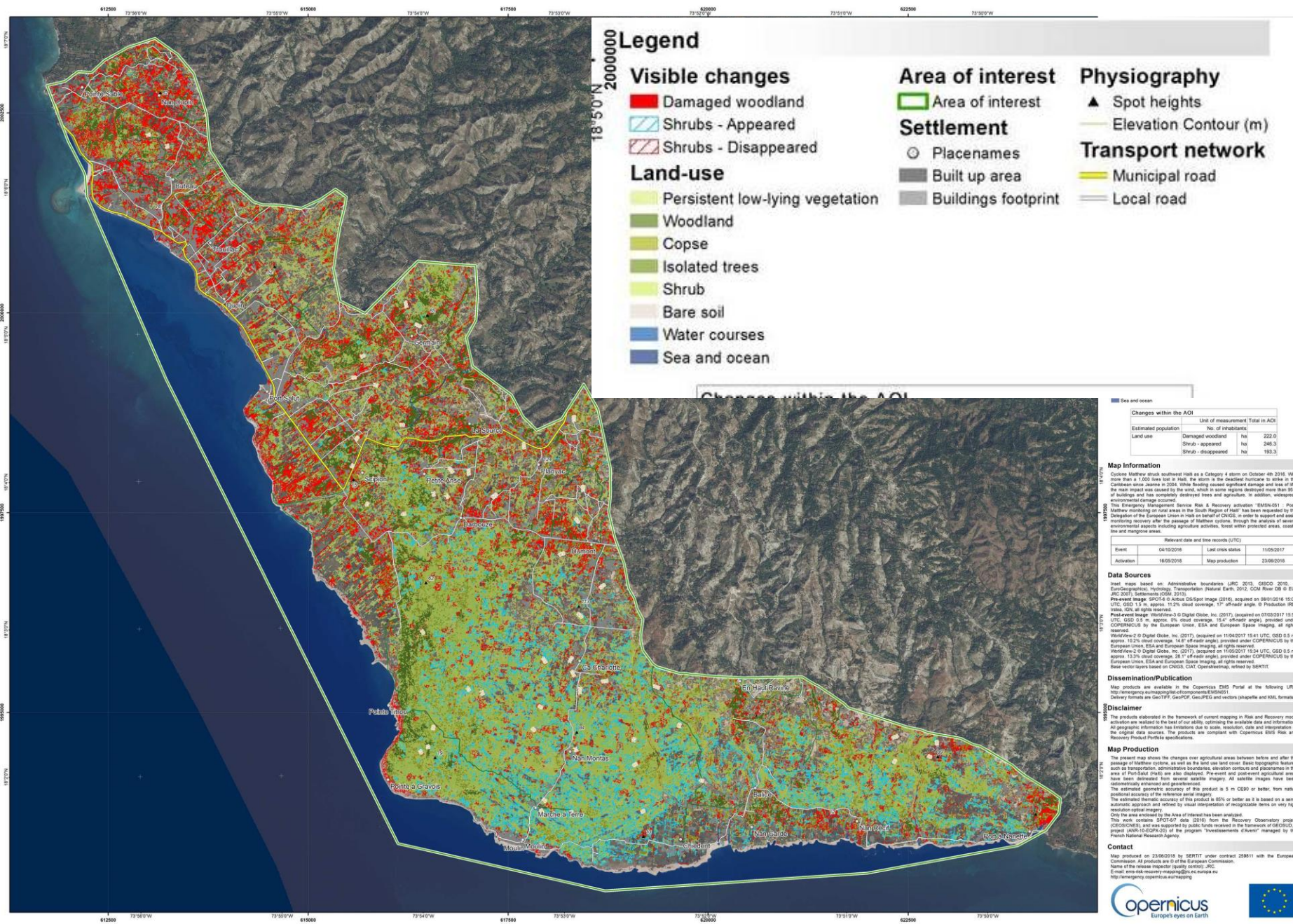


- EMSN051 “ Environmental”

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



Legend

- Visible changes**
- Damaged woodland
 - ▨ Shrubs - Appeared
 - ▨ Shrubs - Disappeared
- Land-use**
- Persistent low-lying vegetation
 - Woodland
 - Copse
 - Isolated trees
 - Shrub
 - Bare soil
 - Water courses
 - Sea and ocean

- Area of interest**
- Area of interest
- Settlement**
- Placenames
 - Built up area
 - Buildings footprint

- Physiography**
- ▲ Spot heights
 - Elevation Contour (m)
- Transport network**
- Municipal road
 - Local road

Changes within the AOI

Land use	List of measurement		Total in AOI
	Estimated population	No. of inhabitants	
Damaged woodland	ha	222.0	
Shrub - appeared	ha	246.3	
Shrub - disappeared	ha	193.3	

Map Information

Cyclone Matthew struck southwest Haiti as a Category 4 storm on October 4th 2016, with more than a 1 000 mm fall in rain, the storm hit the devastated hurricane zone in the Caribbean since Jamaica in 2004. While flooding caused significant damage and loss of life, the main impact was caused by the wind, which in some regions destroyed more than 90% of buildings and has completely destroyed trees and agriculture. In addition, widespread environmental damage occurred.

This Emergency Management Service Risk & Recovery activation (EMSR-001 - Post-Matthew monitoring on rural areas in the South Region of Haiti) has been requested by the Delegation of the European Union in Haiti on behalf of CNGO, in order to support and assist monitoring recovery after the passage of Matthew cyclone, through the analysis of several environmental aspects including agriculture activities, forest within protected areas, coastal line and mangrove areas.

Relevant date and time records (UTC)

Event	04/10/2016	Last cross status	11/05/2017
Activation	16/05/2016	Map production	23/06/2016

Data Sources

Inset maps based on Administrative boundaries (JRC 2013), GISC0 2010, © EuroGeographics, Historical Transportation (Natural Earth, 2015), CGIAR Earth 08 to 10 (JRC 2007), Settlements (GSD 2013).

Pre-event image: SPOT4 1S Active Digital Image (2016), acquired on 08/10/2016 15:04 UTC, GSD 1.5 m, approx. 17° off-nadir angle, 0° Protection ROI.

Post-event image: Sentinel-2 Digital Globe, Inc. (2017), acquired on 07/10/2017 11:55 UTC, GSD 0.5 m, approx. 9° off-nadir angle, 15.4° off-nadir angle, provided under Copernicus by the European Union, USA and European Space Imaging, all rights reserved.

VectorV2 © Digital Globe, Inc. (2017), acquired on 11/04/2017 15:41 UTC, GSD 0.5 m, approx. 15.7% off-nadir angle, provided under Copernicus by the European Union, USA and European Space Imaging, all rights reserved.

VectorV2 © Digital Globe, Inc. (2017), acquired on 11/05/2017 13:24 UTC, GSD 0.5 m, approx. 13.2% off-nadir angle, provided under Copernicus by the European Union, USA and European Space Imaging, all rights reserved.

Base vector layers based on CNGO, CART, Copernicus, and SERTT.

Dissemination/Publication

Map products are available in the Copernicus EMS Portal at the following URL: <http://emergency.europa.eu/infocentre/EMSR001>

Delivery formats are GeoTIFF, GeoPDF, GeoJPEG and vectors (shapefile and KMZ formats).

Disclaimer

The products elaborated in the framework of current mapping in Risk and Recovery mode activation are limited to the best of our skills, optimizing the available data and information available in the framework of the current mapping in Risk and Recovery mode activation. The products are compliant with Copernicus EMS Risk and Recovery Product Profile specifications.

Map Production

The present map shows the changes over agricultural areas between before and after the passage of Matthew cyclone, as well as the land use land cover. Basic topographic features such as transportation, administrative boundaries, elevation contours and place names in the area of Post-Sauz (this) are also displayed. Pre-event and post-event agricultural areas have been delineated from aerial satellite imagery. All satellite images have been automatically georeferenced and georectified.

The estimated geometric accuracy of this product is 5 m CE90 or better, from native resolution accuracy of the sensors.

The estimated thematic accuracy of this product is 95% or better as it is based on a semi-automatic approach and refined by visual interpretation of mapscale items on very high resolution optical imagery.

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

This work contains SPOT4/T-Data (2016) from the Recovery Observatory project (CERCORES), and was supported by public funds received in the framework of GSD/004 a project (ANR-10-EQPX-03) of the program "Investissements d'avenir" managed by the French National Research Agency.

Contact

Map produced on 23/06/2016 by SERTT under contract 256111 with the European Commission. All products are © of the European Commission.

Name of the release inspector (quality control): JRC.

E-mail: ema-risk-recovery-respond@ec.europa.eu

Help: <http://emergency.europa.eu/mapping>

2032500
44411

Legend

Monitoring of forest stands

- Regeneration under old stands
- No visible change
- Not analyzed

Vegetation classification

- Woodland
- Shrub
- Herbaceous vegetation
- Open space with little or no vegetation

Area of interest

- Area of interest

Administrative boundary

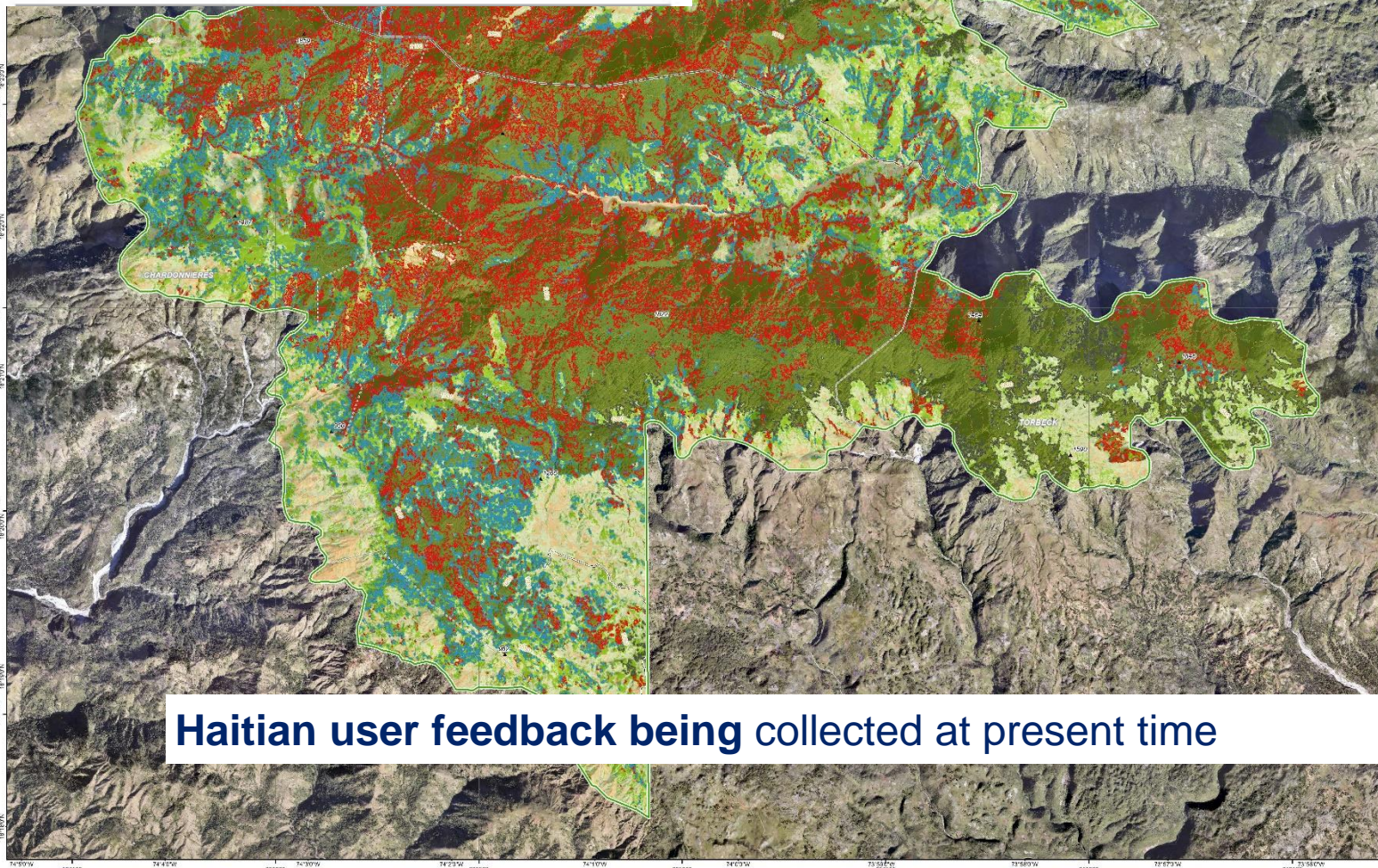
- Region
- Province

Physiography

- Spot Elevation Point
- Elevation Contour (m)

Transport network

- Local road



Glide Number: (N/A) Activation ID: EMSN-051
Product N.: 03MAM000000001-V1_English

Makaya Park (East) - HAITI Vegetation - 08/12/2017 Monitoring Map - Overview



Cartographic Information
1:25 000 Full color A1, high resolution (200dpi)



Full color A1, high resolution (200dpi)

Legend

- Monitoring of forest stands**
 - Regeneration under old stands
 - No visible change
 - Not analyzed
- Vegetation classification**
 - Woodland
 - Shrub
 - Herbaceous vegetation
 - Open space with little or no vegetation
- Area of interest**
 - Area of interest
- Administrative boundary**
 - Region
 - Province
- Physiography**
 - Spot elevation point
 - Elevation Contour (m)
- Transport network**
 - Local road

Changes within the AOI

Forest stands	Unit of measurement		Total in AOI
	ha	%	
No visible change	1759.2	2536.5	608.8
Regeneration	ha		
Not analyzed	ha		

Map information
 Cartographic scale: As shown from an Aerial photograph as Category 4 data on October 0th 2016, with more than a 1000 feet total in fall; the storm in the deadliest hurricane to strike in the Caribbean since 1928. The 2016 season was highly active with significant damage and loss of life. The main impact was caused by the wind, which in some regions destroyed more than 80% of buildings and has completely destroyed trees and agriculture. In addition, widespread environmental damage occurred.
 The Emergency Management, Strategic Risk & Recovery authority (EMSRADSR) - Makaya Park monitoring and forest areas in the South Region of Haiti has been requested by the Emergency Management, Strategic Risk & Recovery authority (EMSRADSR) in order to support and assist monitoring recovery after the passage of Matthew cyclone, through the analysis of several environmental aspects including agriculture activities, forest within protected areas, coastal tree and mangrove areas.

Recent date and time records (UTC)	
Point	last update: 06/12/2017
Address	last update: 26/09/2019

Data Sources
 Base map: based on Aerial photograph: IGN (2016) 1:50000 2016 © IGN
 Cartographic: IGN (2016) 1:50000 2016 © IGN
 Precipitation: based on the Copernicus Climate Change Service (C3S) data © Copernicus Climate Change Service (2016)
 Precipitation: based on the Copernicus Climate Change Service (C3S) data © Copernicus Climate Change Service (2016)
 Precipitation: based on the Copernicus Climate Change Service (C3S) data © Copernicus Climate Change Service (2016)
 Precipitation: based on the Copernicus Climate Change Service (C3S) data © Copernicus Climate Change Service (2016)

Dissemination/Publication
 Map products are available in the Copernicus Data Portal at the following URL: <https://data.copernicus.eu/>
 Delivery formats are GeoTIFF, GeoPDF, GeoJSON and vector (shapefile and KML formats).

Disclaimer
 The products delivered in the framework of contract mapping to this and former tasks and/or are related to the best of our ability, optimizing the available data and information. All geographic information has been checked by visual inspection, using the information of the original data sources. The products are constant with Copernicus EMS and Recovery Product Public Information.

Map Production
 The present map shows the monitoring of the damage assessment of forest stands observed on the 08/12/2017, more than one year after the passage of Matthew cyclone. Since the 08/12/2017, the forest stands have been monitored by the Copernicus Climate Change Service (C3S) and the Copernicus Climate Change Service (C3S) data. The Copernicus Climate Change Service (C3S) data was updated by point cloud data collected in the field in a project (Haiti) led by the Copernicus Climate Change Service (C3S) and the Copernicus Climate Change Service (C3S) data.

Contact
 Map produced on 20/09/2019 by SERTI under contract 259911 with the European Commission. All products are to be approved by the European Commission. Name of the release project: Coastal Control - JRC.
 For more information, please contact: copernicus@ec.europa.eu
 Map: <https://data.copernicus.eu/>



Haitian user feedback being collected at present time



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

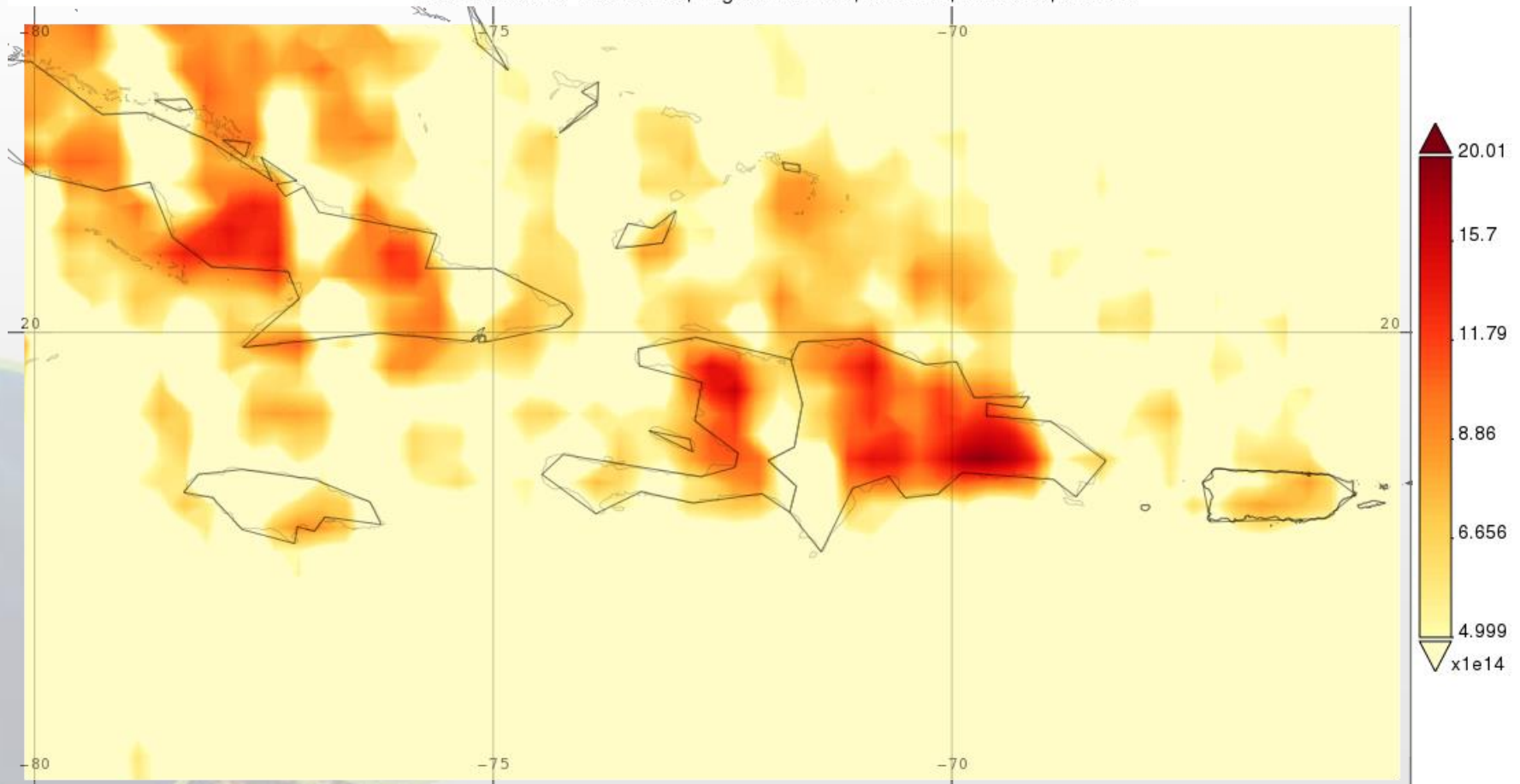
Discussions about vector borne diseases evaluation, further expression of interest by Health ministry. Will use L8 and NOAA images but need public health statistical data (accessibility TBC during next mission)



NASA (Jean Paul Vernier / Ivanco Marie)

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

Time Averaged Map of NO₂ Tropospheric Column (30% Cloud Screened) daily 0.25 deg. [OMI OMNO2d v003] 1/cm²
over 2018-06-01 - 2018-06-29, Region 80.2881W, 15.0366N, 64.9951W, 23.562N





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