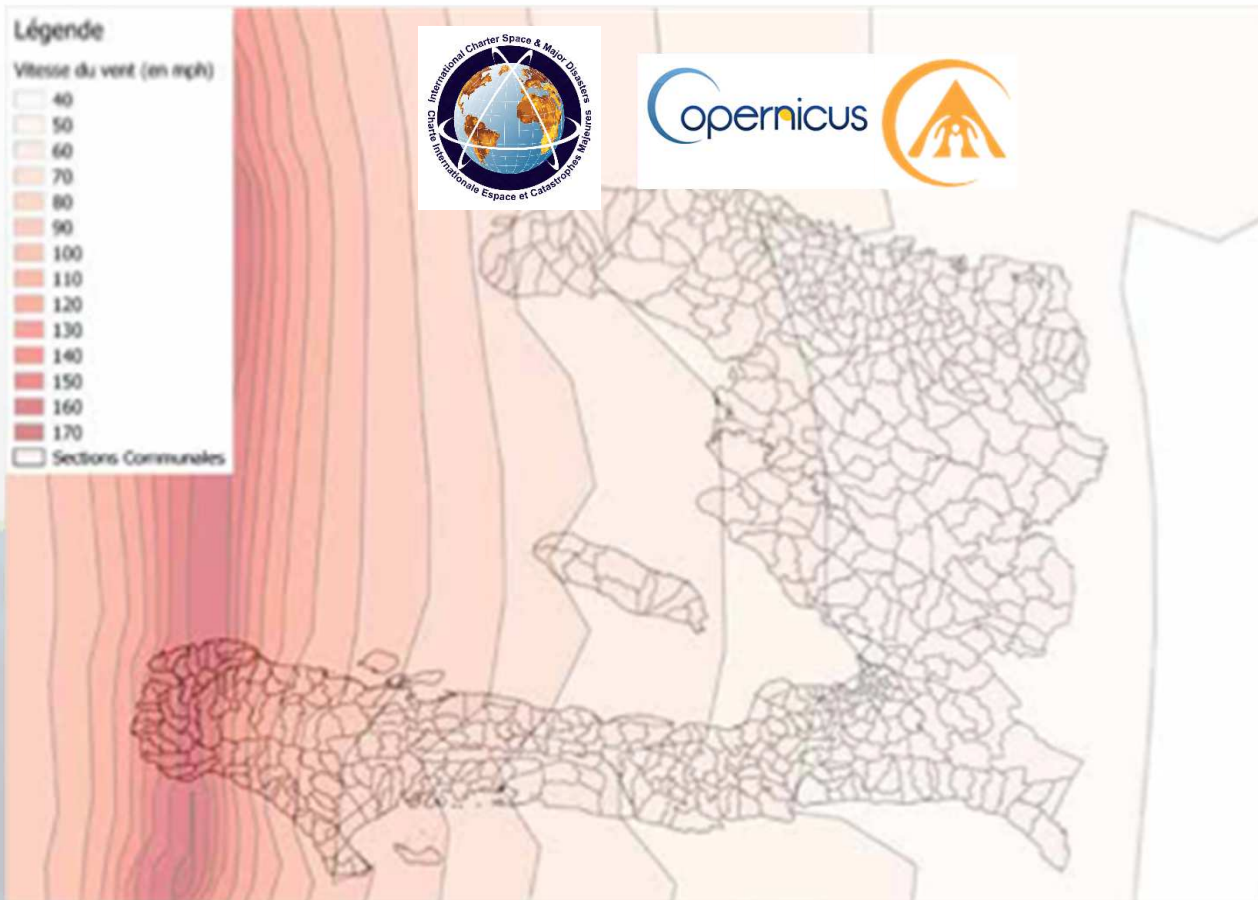




- Hurricane Matthew
- Creation of RO Pilot on post Matthew
- Main sectors of activity
- Capacity Development
- Linkages to international community, Int. Charter, ...
- RO pilot evaluation
- RO pilot legacy and lessons-learnt for RO demonstrator & G-RO

# Hurricane Matthew in Haiti (4-5 October, 2016)



Source : Vitesse du vent pour section communale,  
National Hurricane Center/University College London/CNIGS Spatial Team, Octobre 2016.

- 546 dead, 128 missing, 439 injured (PDNA)
- Winds of over 230 km/h, more than 600mm of rain in 24 hours
- Devastating storm surge in Jérémie, les Cayes, Port-Salut cities
- Devastating winds throughout Macaya park (major woodland impact) and in agricultural areas (lost season)



**GFDRR**  
Global Facility for Disaster Reduction and Recovery



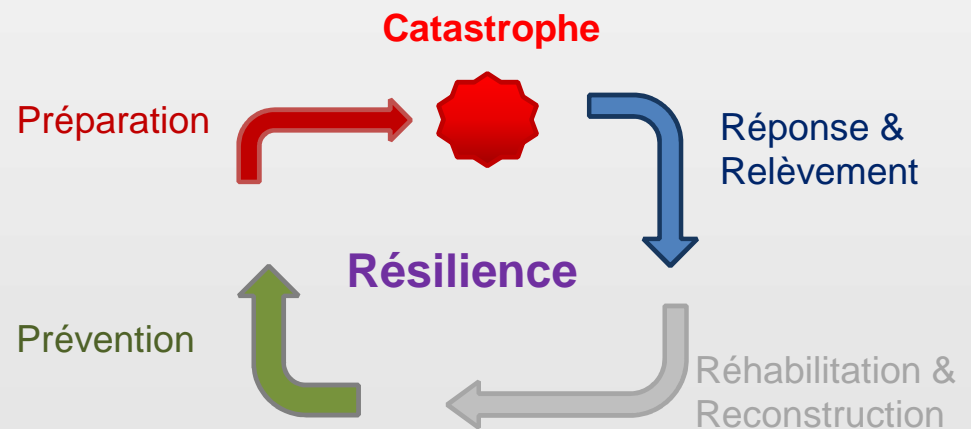
Request for  
RO Pilot  
activation  
(Nov 2016)

# CEOS WGDisasters

## « Recovery Observatory » (RO)

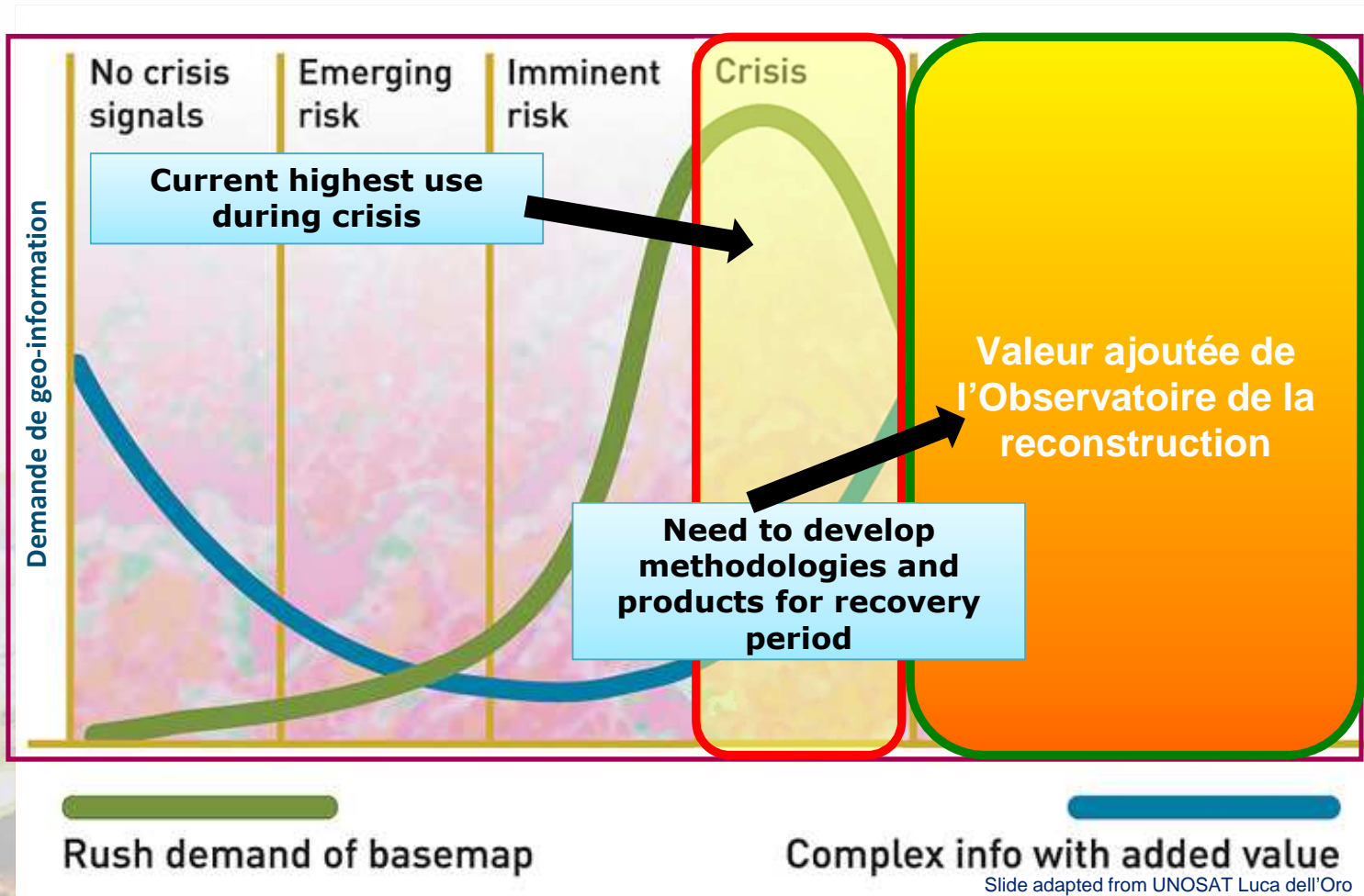


- *Satellite images not only for emergency response, but for post-crisis and recovery / reconstruction too.*
- *Collaborative effort to increase ease of access to satellite imagery and derived information products for all post crisis steps.*
- *Concrete actions bringing together national actors and international stakeholders, answering concrete needs along recovery timeline.*





# Geo-Information required in Response & Post-crisis / Recovery





Open and free collection of **satellite images & derived maps** at several scales during months / years after Disaster

**Strong Capacity Building component fitted to local users**



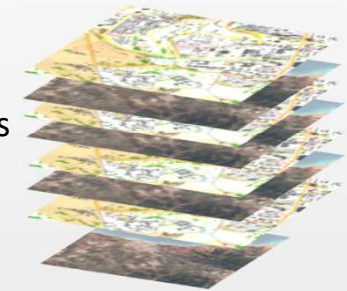
**Field data (indispensable):** terrain validation data, aerial and drone data, statistics, cartography, ....

## Overview area

**Mid-scale products from Sentinel data at 10m -20m resolution**

- LandCover/LandUse change in open areas
- Gain or loss of vegetation
- ....

**Update frequency:** every 10 days to 6 months



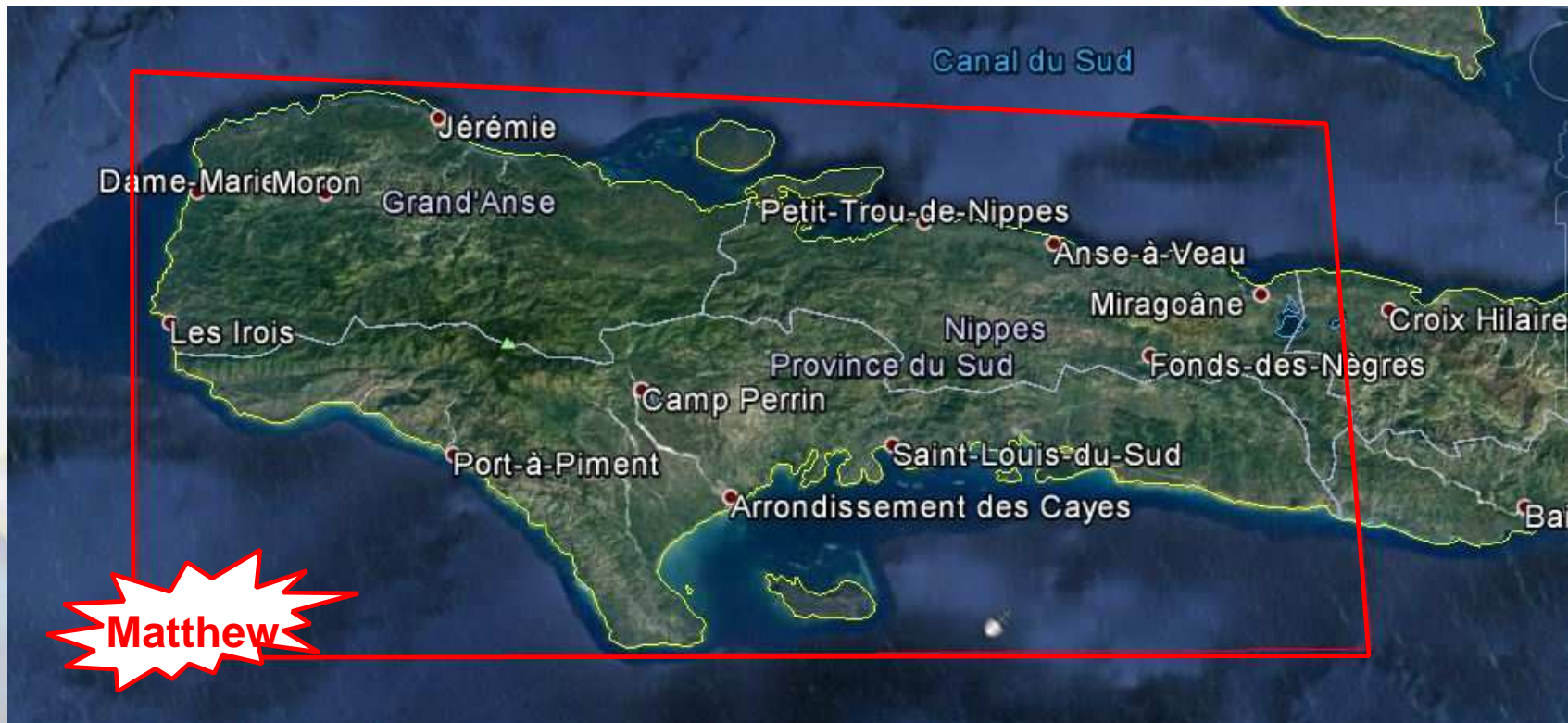
## Hot spot zooms

**Large scale products from very high resolution data : 0,5 – 3m**

- Urban areas, settlements, IDP camps
- Protected areas, sensitive areas
- Infrastructures, ...

**Update frequency:** every 2 to 4 months

# Matthew Hurricane in Haiti EO for "Recovery" phase



**Haiti Recovery Observatory (RO) covers three departments:  
Grand'Anse, Sud, and Nippes**



# RO Haiti partners



Gouvernement de la République d'Haïti

Ministère de l'Environnement



AthenaGlobal  
wisdom



THE WORLD BANK



RÉPUBLIQUE D'HAÏTI  
PRIMATURE

CIAT

Comité Interministériel  
d'Aménagement du Territoire



CNIGS

Centre National de l'Information Géo-Spatiale



UNEP



SERTIT

UniQ

Université Quisqueya



UNIVERSITÉ  
D'ÉTAT D'HAÏTI







**CNES:** set up of RO infrastructure, full-time project manager for three years, two missions a year to Haiti, consultant support for strategic coordination and support to workshops, user consultations and SC, support to value-adding during early months (feasibility testing, new products); SPOT, Pleiades data



**ASI:** CSK data, dedicated terrain motion research effort to develop Sentinel-1 processing chain on GEP for Haitians, participation in RO SC and missions to Haiti, funding for CIMA for watershed analysis and use of RASOR risk management tool over RO area



**DLR:** full TSX coverage of area at 3 m every three months for duration of project (change detection baseline for ASI terrain motion work)



**ESA/EC:** Copernicus activations (3 RO dedicated, in addition to initial response), Sentinel-1 and 2 imagery, GEP platform for SAR processing



**NASA:** advice on air quality issues

**CSA / Roscosmos / JAXA / USGS / CNES :** Charter activation data access



ROSCOSMOS



USGS  
science for a changing world





### Role of Haitian end-user partners:

- Information on reconstruction projects
- Collection of needs and prioritized requirements for geospatial information
- Linkages with local UE, WB, UNDP teams (and UNEP, IADB, ....)
- Recommandations on the content and dissemination of RO products (national, local)
- Feedback on usefulness of RO and RO products, improvement of concept



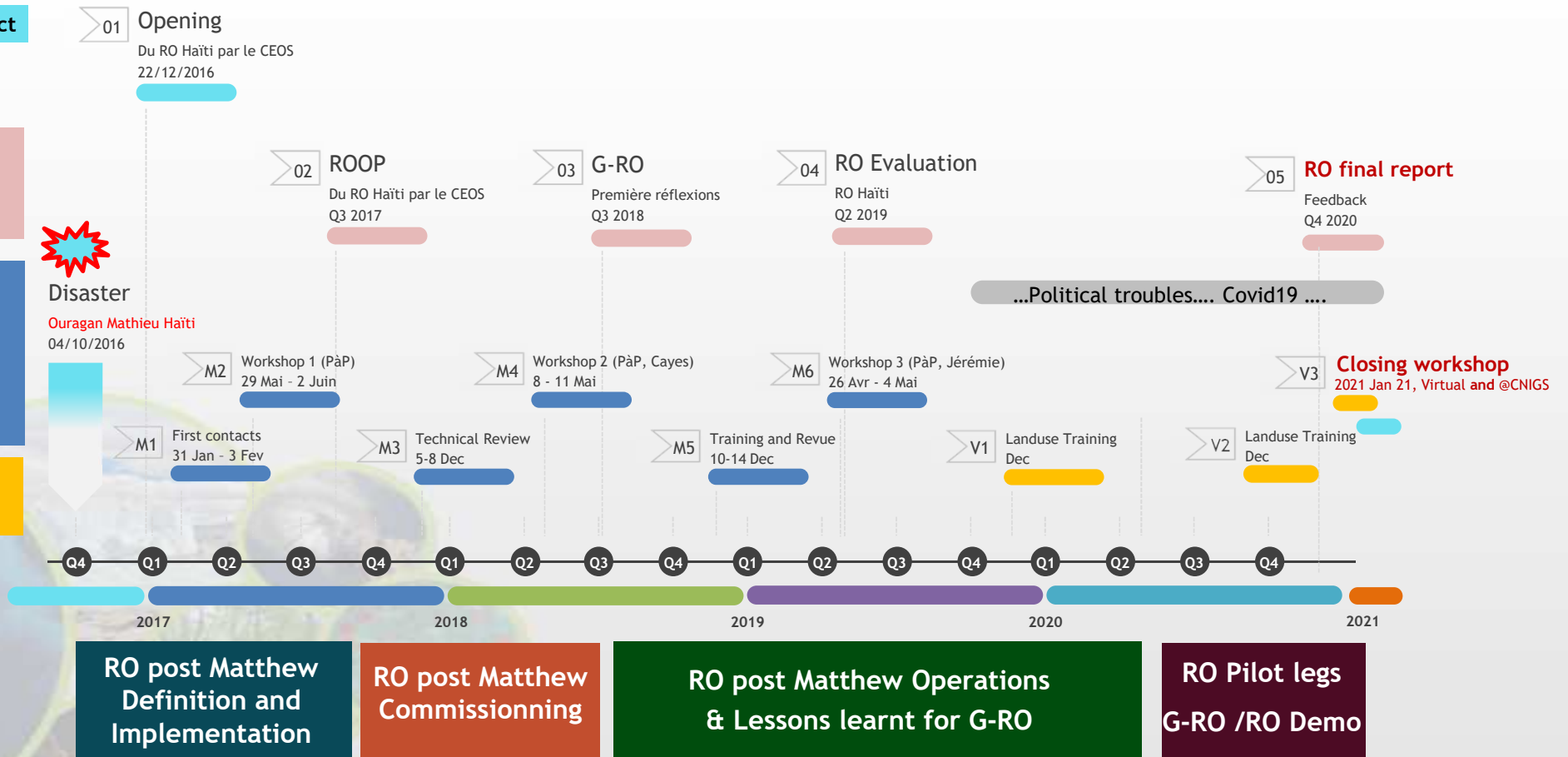
4 years co-led project



**Users interface :**  
needs collection,  
feedback, lessons-  
learnt, team work

**Face to face work:**  
6 working sessions  
6 conferences  
5 St. Committees  
4 trainings sessions  
1 training in France  
Daily joint work

**Remote work:**  
2 training sessions,  
Closure workshop







## CIAT : Inter-Ministries Committee for Land Planning

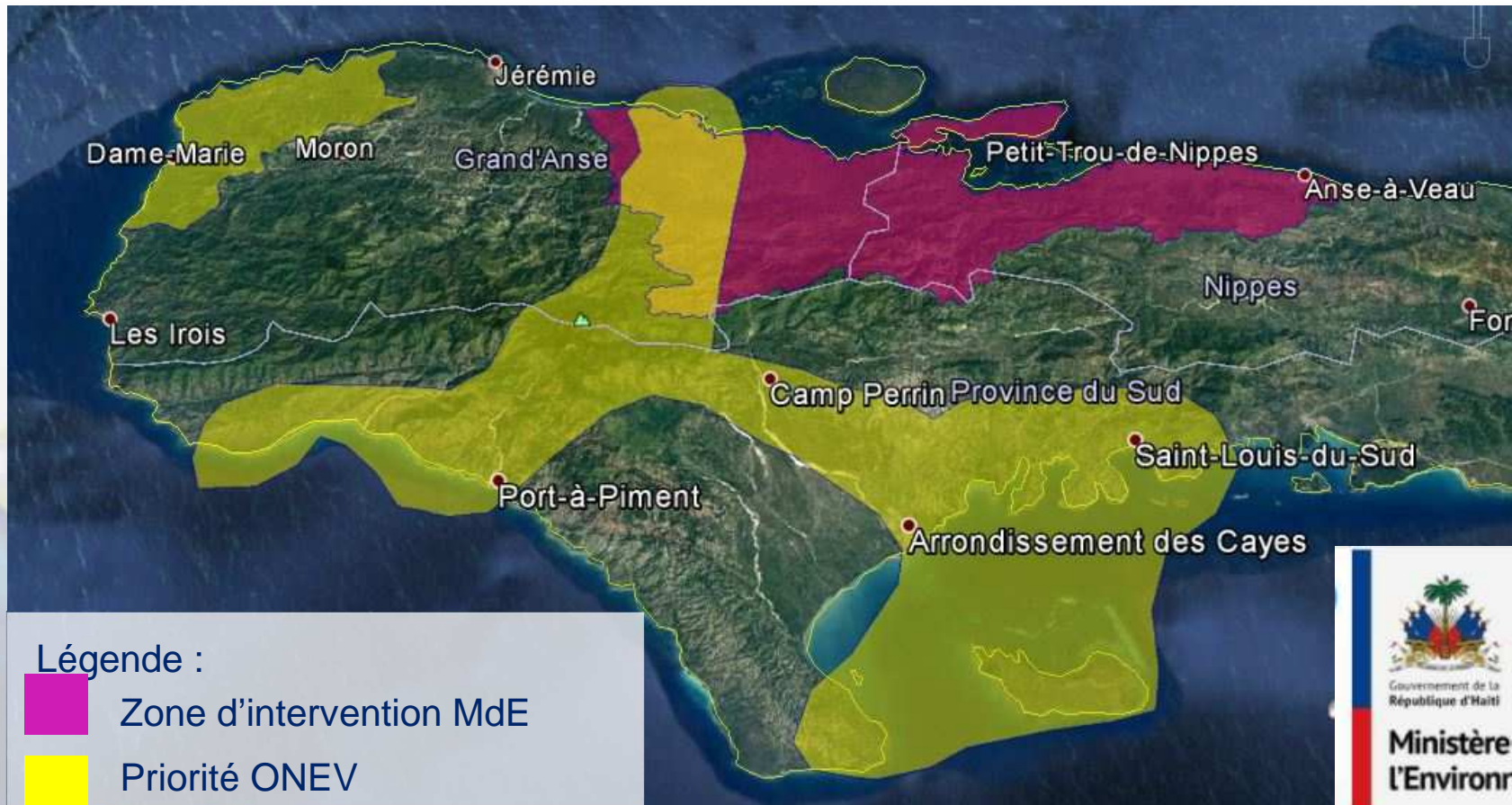
Légende :

-  Côtes
-  Végétation
-  Habitations spontanées
-  Autres zones d'intérêts

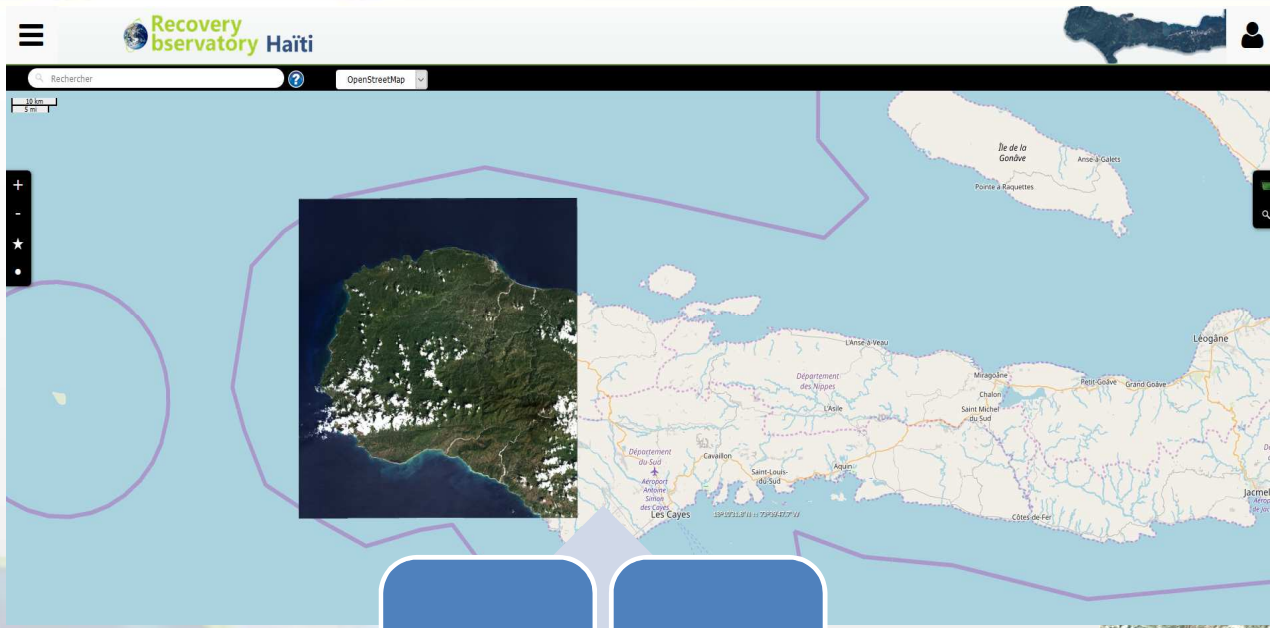




**ONEV : National Observatory of the Environment and Vulnerability**

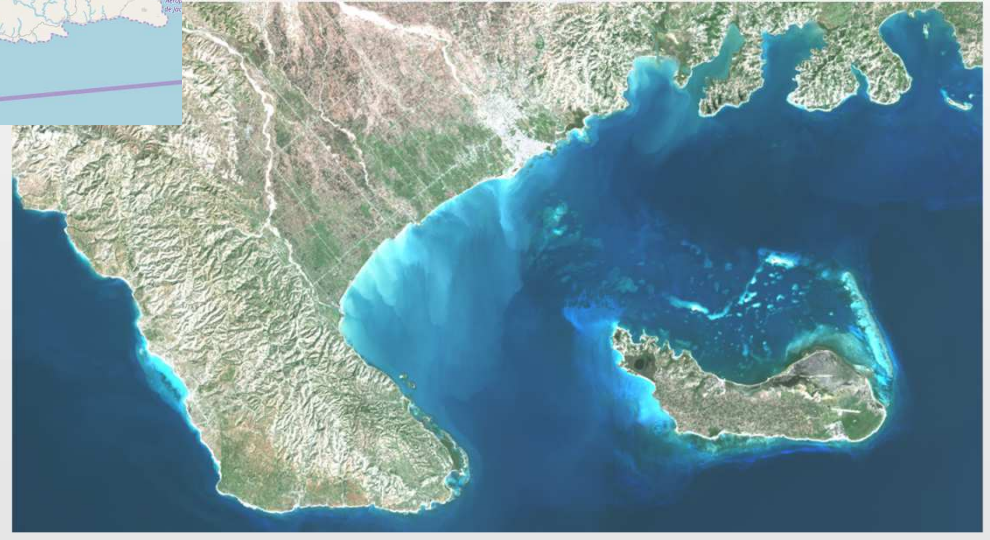
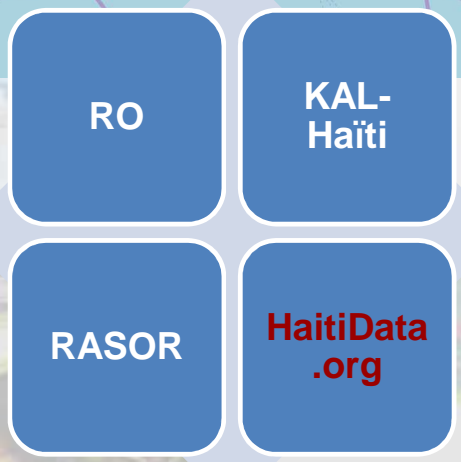






RO implemented on Dotcloud infrastructure (from WGISS)

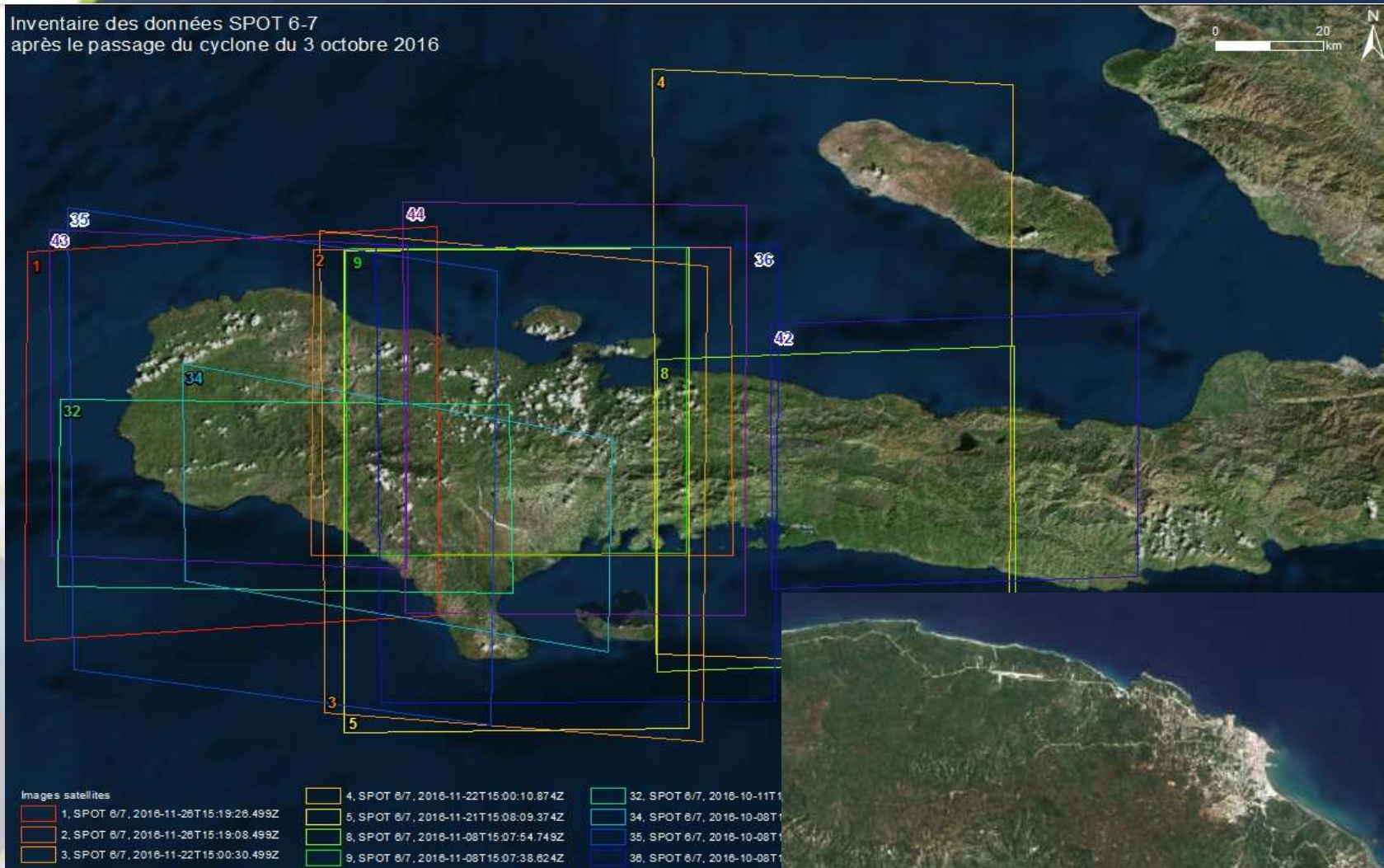
Synergy with other geospatial platforms in Haiti (specifically **HaitiData.org**)







Inventaire des données SPOT 6-7  
après le passage du cyclone du 3 octobre 2016

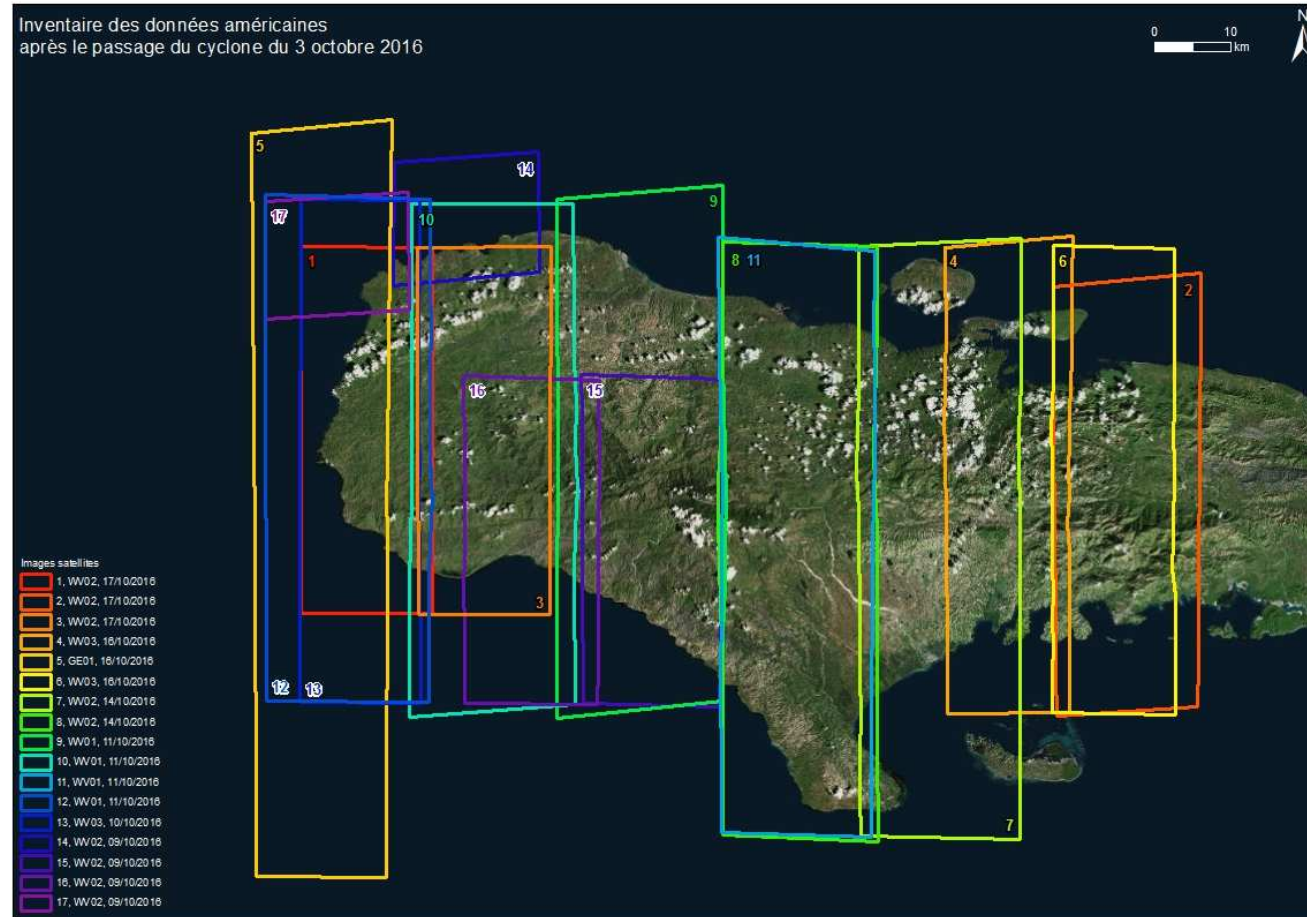




## Post event : From 09/10/2016 To 17/10/2016

### Pre event :

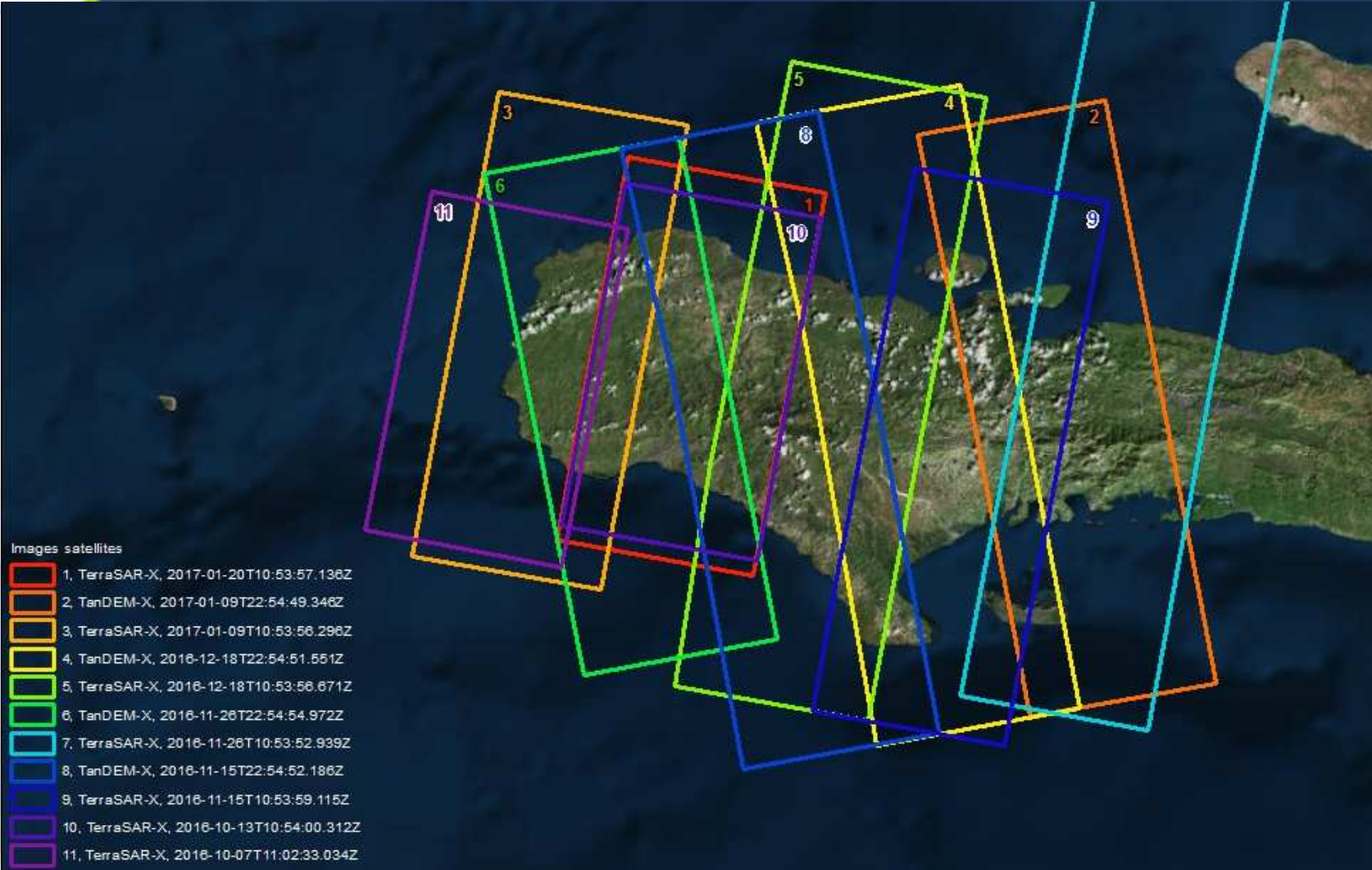
- WV02 28/09/2016
- WV02 29/08/2016
- WV02 13/08/2016
- WV01 07/08/2016
- WV02 27/07/2016
- WV02 17/07/2016
- WV02 06/07/2016
- WV02 07/06/2016
- WV01 12/06/2016
- GEO1 07/06/2016
- WV01 28/03/2016
- WV01 23/02/2016

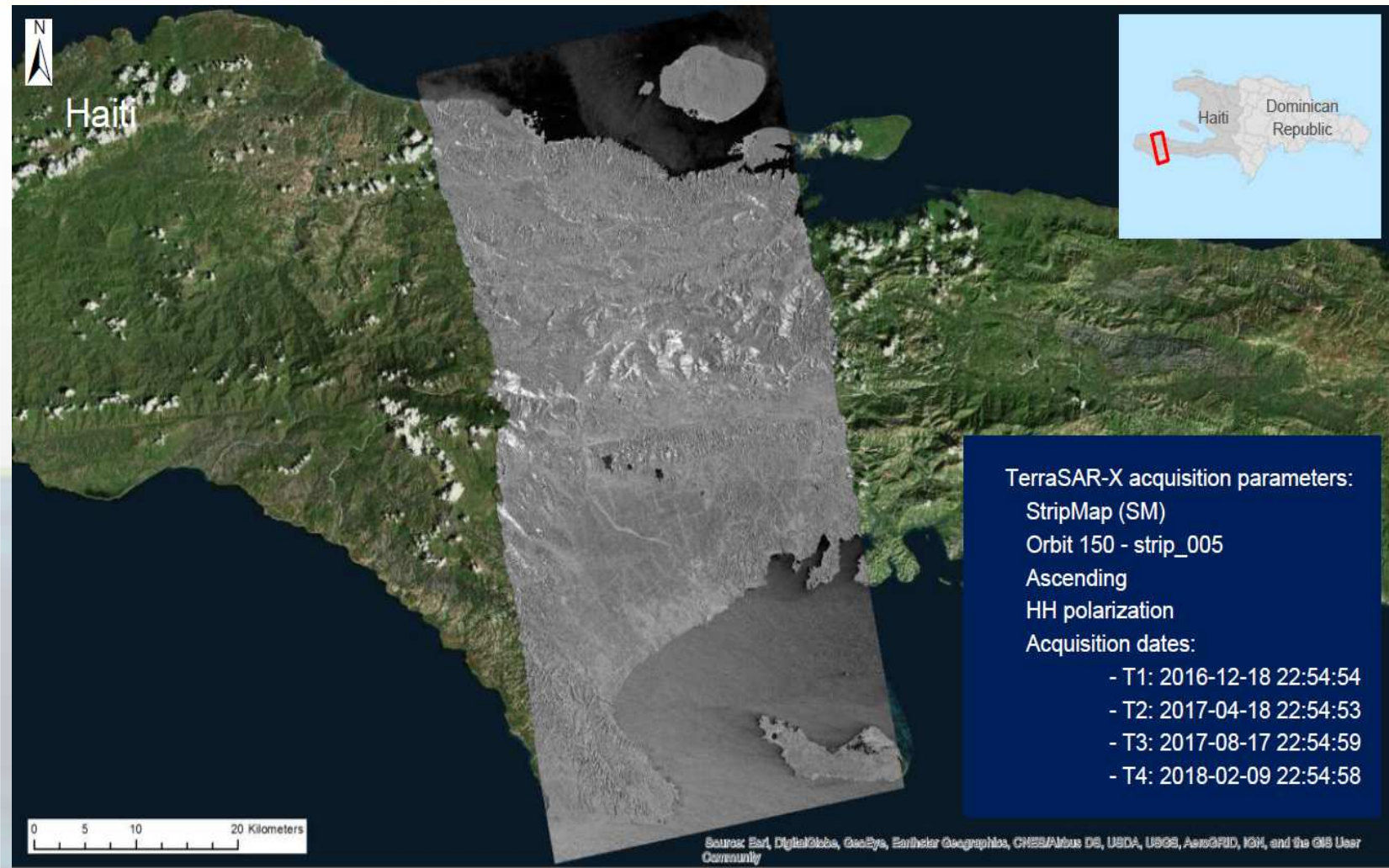






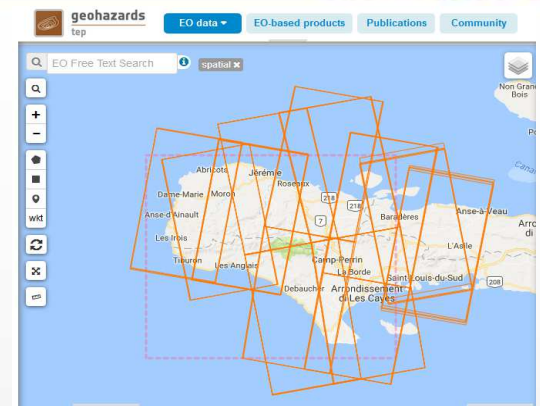






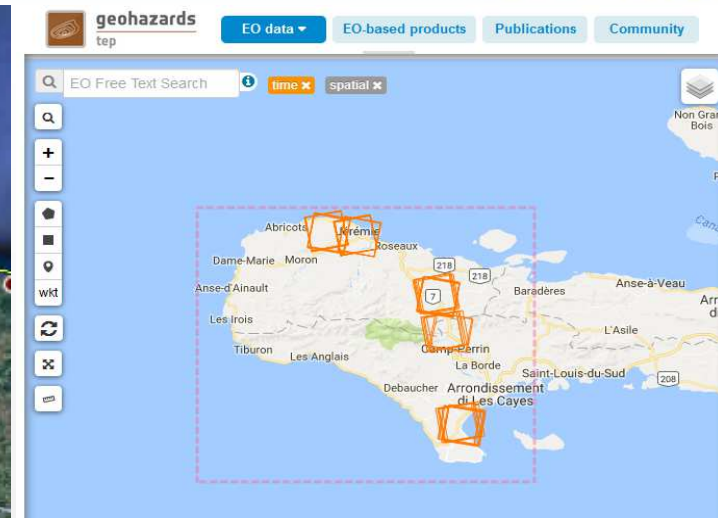
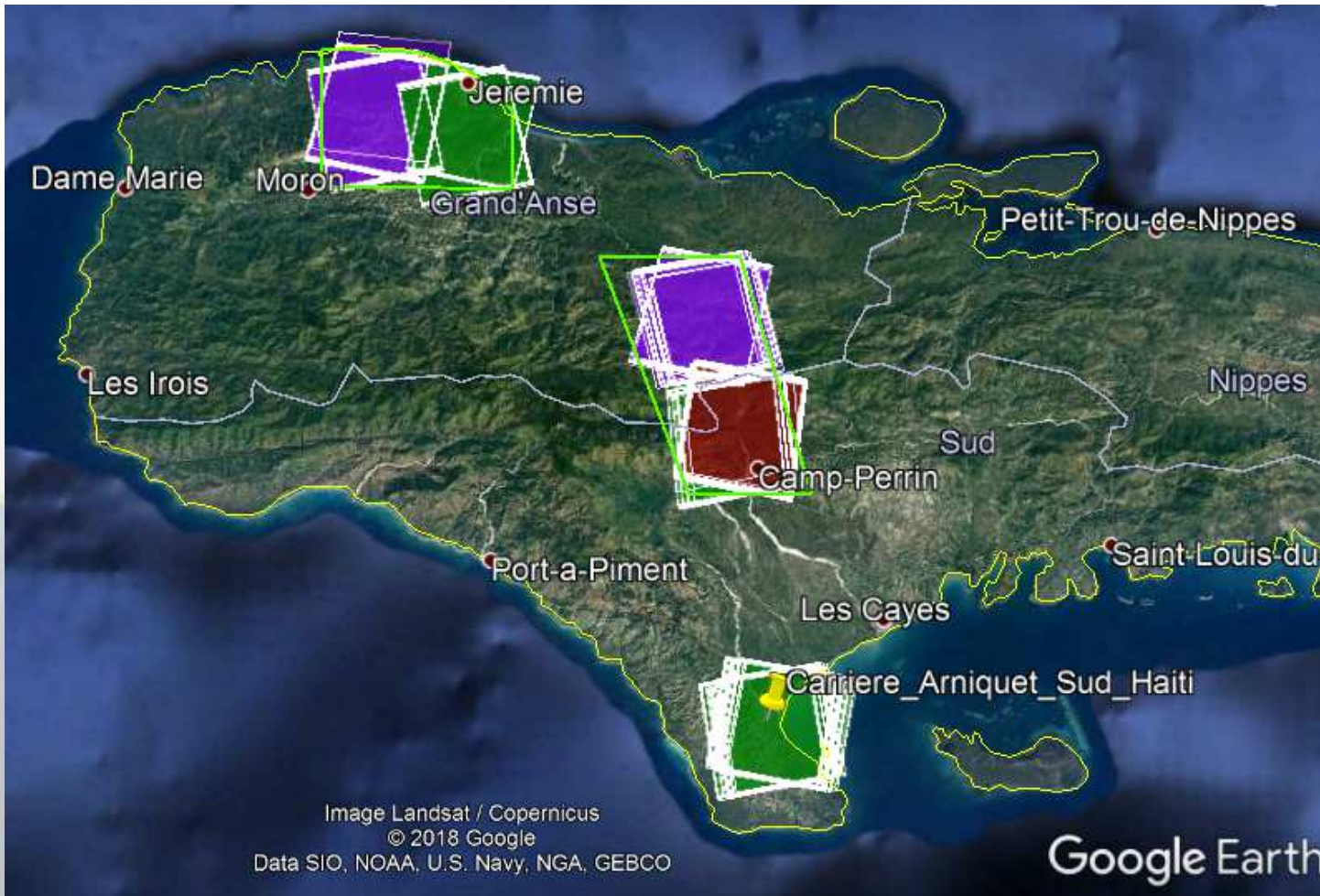
TerraSAR-X acquisition parameters:  
 StripMap (SM)  
 Orbit 150 - strip\_005  
 Ascending  
 HH polarization  
 Acquisition dates:  
 - T1: 2016-12-18 22:54:54  
 - T2: 2017-04-18 22:54:53  
 - T3: 2017-08-17 22:54:59  
 - T4: 2018-02-09 22:54:58

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Available on GEP !












Available on GEP !

# Table of thematic areas covered by RO



RO : Tableau des thématiques produits (FR) Avril 2019

	Produit	Utilisateur-clef	Elaboration	Données satellites
	Cartographie du bâti	CIAT / Ministère de la Planification	CNES/SERTIT, Copernicus EMS R&R	Pléiades, WorldView-3
	Mouvements de Terrain Détection de Changement	BME / URGeo	ASI, CNES/EOST	COSMO-SkyMed, Pléiades, Spot 6/7, TerraSAR-X
	Bassins Versants	ONEV / Ministère Agriculture	ASI/CIMA Foundation	Pléiades, COSMO-SkyMed
	Agriculture	Ministère Agriculture	Copernicus EMS R&R	Sentinel-2, Spot 6/7, GeoEye-1, WorldView-2
	Suivi du Parc Macaya	ANAP / ONEV / Ministère Environnement	Copernicus EMS R&R, CNES/SERTIT	Spot 6/7
	Impact Environnemental	ONEV / Ministère Environnement	Copernicus EMS R&R	Sentinel-2, Spot 6/7, Pléiades, WorldView-2
	Occupation du sol	Tous	CNIGS, CNES	Sentinel-2

**Seven thematic areas** addressed, with different **technical readiness levels** :




Operational products (« off the shelf »), Scientific / R&D product

In addition, the RO initiated important work at ONEV request relating to “air quality” and “coral reef monitoring”



# Thematic experts – always a team: one Haitian, one international expert



Produit	Utilisateur-clef 	Elaboration 	Point focal / Responsable thématique 	Institution
Cartographie du bâti	CIAT/Ministère de la planification (MPCE)	Copernicus EMS RRM ; SERTIT (faisabilité) / CNIGS	Rose-May GUIGNARD	CIAT
			Pierre Alexilien VERSAILLE	MPCE/ CNIGS
Occupation du sol	Tout utilisateur (données de référence)	CNES (méthodologie) / SERTIT (formation) /CNIG (production)	Jacques Philemon MONDESIR	MPCE / CNIGS
Impact environnemental	Ministère de l'environnement (MDE)	Copernicus EMS RRM	Pierre Emmanuel PHILIPPE	MDE/ Directeur des forêts
			Saint Phar JEAN	MDE/ ONEV
Agriculture	Ministère de l'agriculture (MARNDR)	Copernicus EMS RRM ; SERTIT (faisabilité) / CNIGS	Ognel PIERRE-LOUIS	MARNDR/ DRFS
			David TELCY	MPCE / CNIGS
Parc Macaya	ANAP / ONEV (MDE)	Copernicus EMS RRM ; SERTIT (faisabilité)	Saint Phar JEAN	MDE/ ONEV
Bassins Versants	ONEV (MDE) - Ministère de l'agriculture (MARNDR)	CIMA Foundation	Jean André PIERRE	MPCE/ CNIGS
			Pradel FORMONVIL	MPCE/ CNIGS
			Saint Phar JEAN	MDE/ ONEV
Mouvement de terrain / Evolutions des carrières	BME / Ministère des travaux publics (MTPTC)	ASI / GEP ESA; EOST / GEP ESA	Samuel GENEVA	MTPTC/ BME
			Steven SYMITHE	URGEO / BME / CNIGS
			Samira PHILIP	UNDP

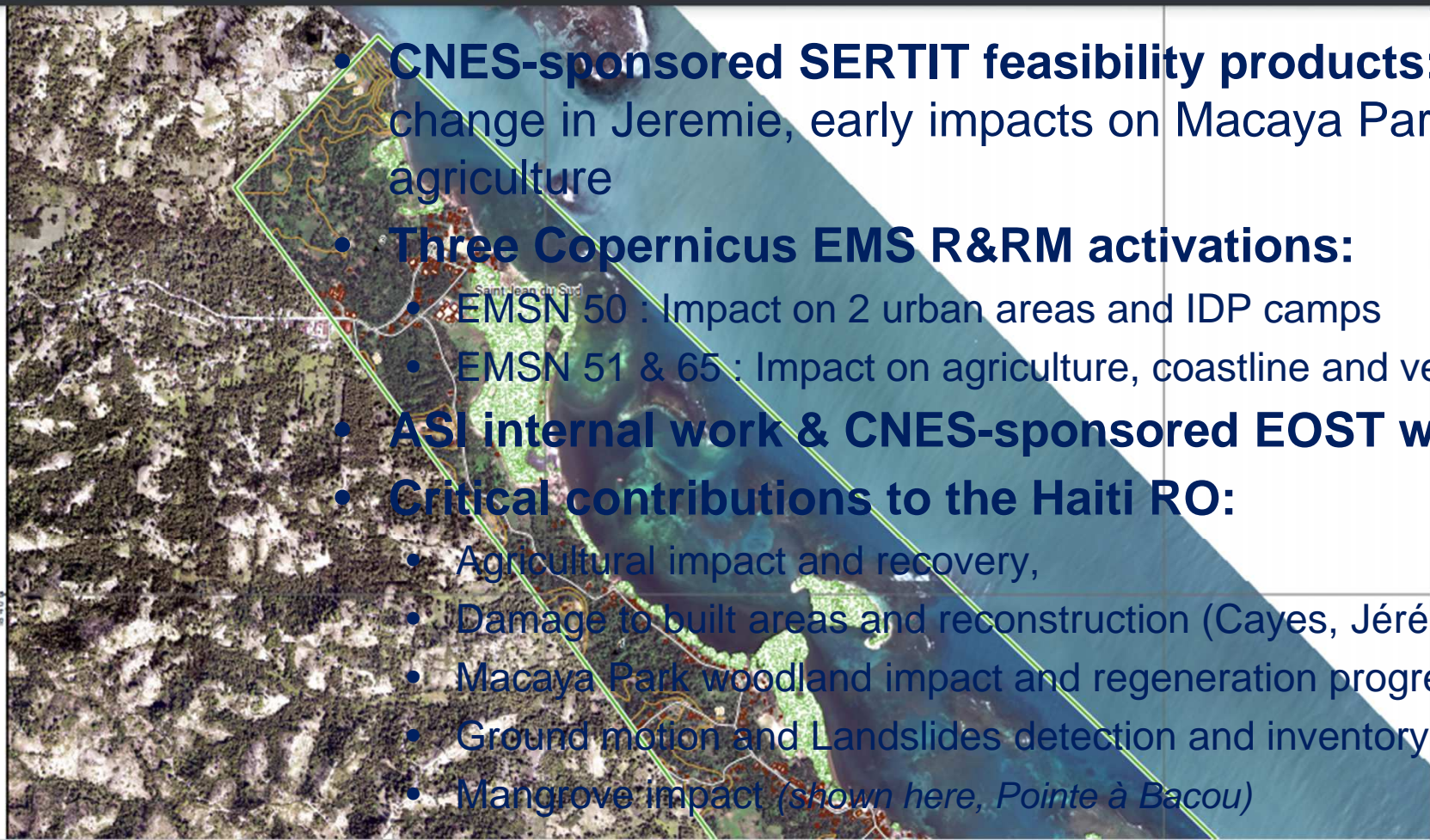
# Satellite-derived products

CEOS



EMSN051\_06POINTEABACOU\_01MANGROVEPREEVENTSITUATION\_OVERVIEW\_v2\_300dpi.pdf 1 / 1

- **CNES-sponsored SERTIT feasibility products:** damages and change in Jeremie, early impacts on Macaya Park, early impact on agriculture
- **Three Copernicus EMS R&RM activations:**
  - EMSN 50 : Impact on 2 urban areas and IDP camps
  - EMSN 51 & 65 : Impact on agriculture, coastline and vegetation (Macaya)
- **ASI internal work & CNES-sponsored EOST work on ground motion**
- **Critical contributions to the Haiti RO:**
  - Agricultural impact and recovery,
  - Damage to built areas and reconstruction (Cayes, Jérémie),
  - Macaya Park woodland impact and regeneration progress,
  - Ground motion and Landslides detection and inventory
  - Mangrove impact (*shown here, Pointe à Bacou*)



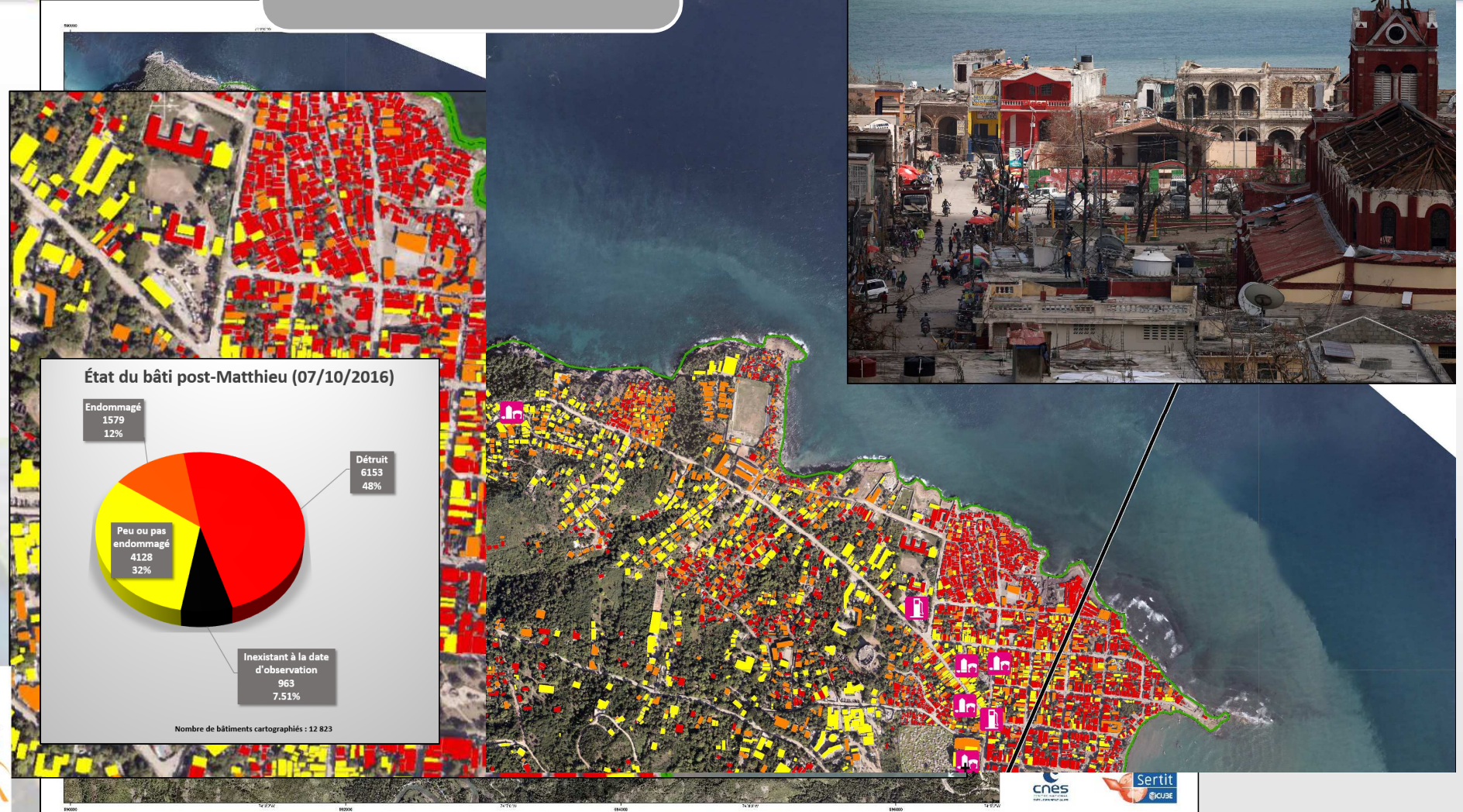
18/04/2010





# Buildings status, communication infrastructure

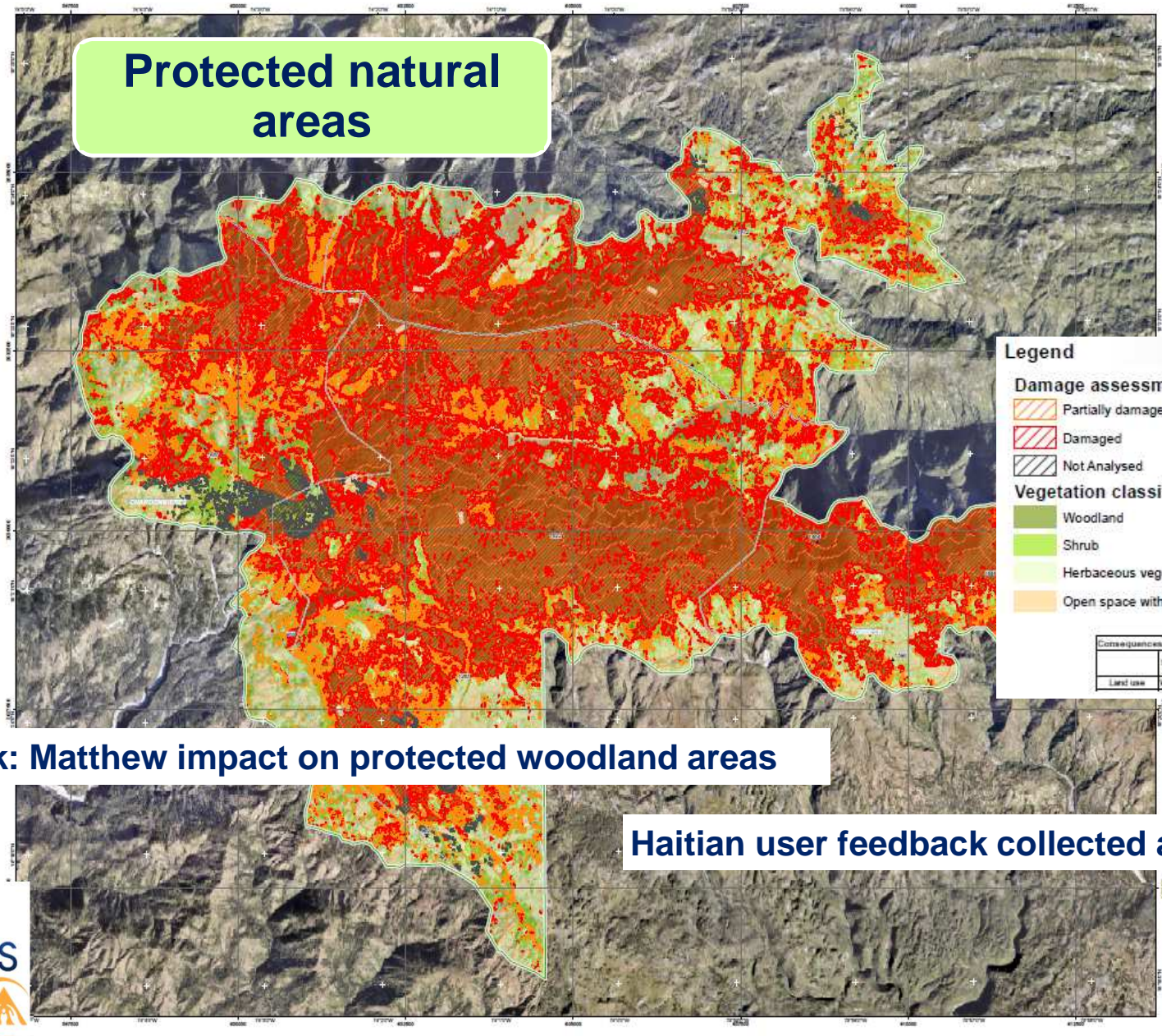
# Jérémie







Protected natural areas



Globe Number: (N/A)      Activation ID: DMSU-051  
 Product N.: DMSAAKAST\_V2\_English

**Makaya Park (East) - HAITI**  
**Vegetation - 23/12/2016**  
**Damage Assessment Map - Overview**

Cartographic Information  
 1:25 000      Full color A1, high resolution (300dpi)  
 Full color A1, high resolution (300dpi)

**Legend**

**Damage assessment of forest stands**

- Partially damaged
- Damaged
- Not Analysed

**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

Consequences within the AOI

Land use	Unit of measurement	Damaged	Partially damaged	Not analysed	Total affected	Total in AOI
Woodland	ha	3325.5	654.3	94.5	4074.3	4704.5

Macaya park: Matthew impact on protected woodland areas

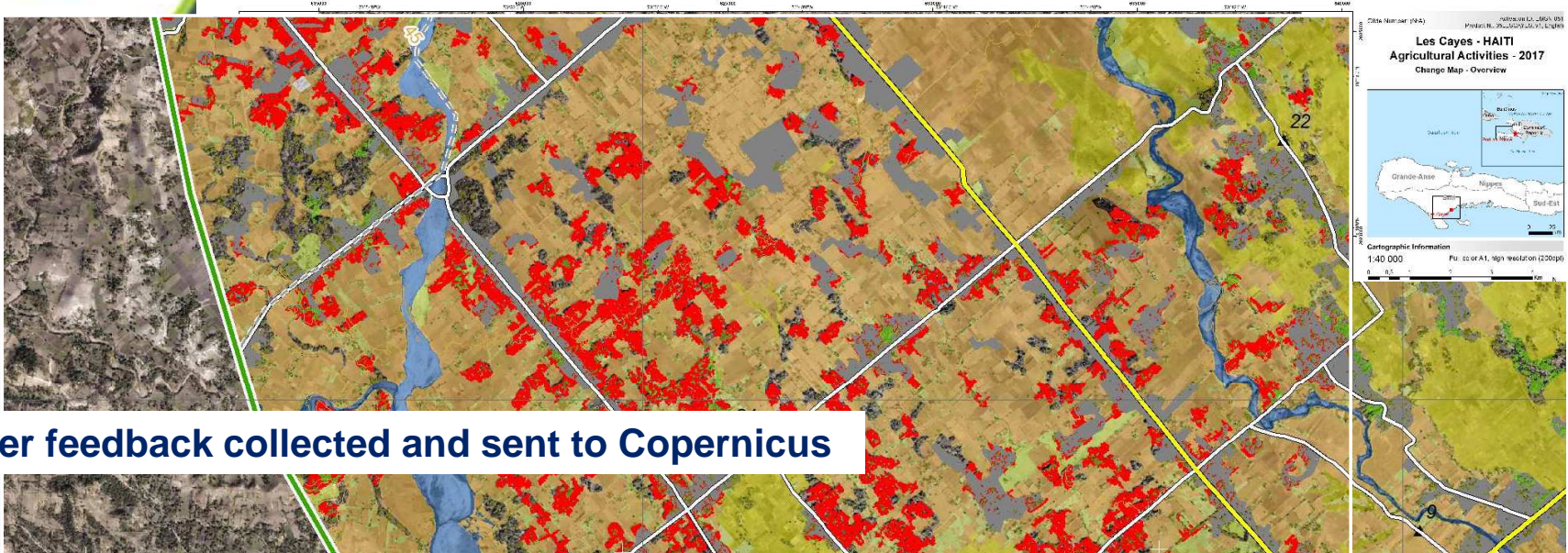
Haitian user feedback collected and sent to Copernicus





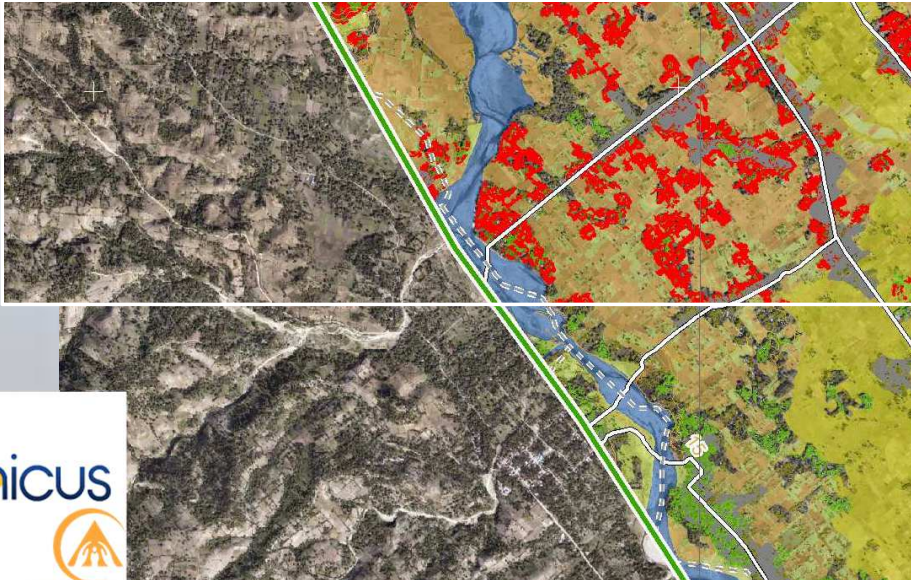
# Agriculture

# Agricultural map Plaines des cayes



Title Number (444)  
 Product No. 39...  
**Les Cayes - HAITI**  
**Agricultural Activities - 2017**  
 Change Map - Overview  
 Cartographic Information  
 1:40 000  
 Pu. co. of A1, high resolution (230pp)

Haitian user feedback collected and sent to Copernicus



**Legend**

<p><b>Visible changes</b></p> <ul style="list-style-type: none"> <li>Damaged woodland</li> </ul> <p><b>Land-use</b></p> <ul style="list-style-type: none"> <li>Rice fields</li> <li>Persistent low-lying vegetation</li> <li>Cropland</li> <li>Woodland</li> <li>Mangrove</li> <li>Copse</li> <li>Isolated trees</li> <li>Shrub</li> <li>Beaches, dunes, sands</li> <li>Bare soil</li> <li>Inland marshes</li> <li>Water courses</li> </ul>	<p><b>Area of interest</b></p> <ul style="list-style-type: none"> <li>Area of interest</li> </ul> <p><b>Administrative boundary</b></p> <ul style="list-style-type: none"> <li>Region</li> <li>Province</li> </ul> <p><b>Settlement</b></p> <ul style="list-style-type: none"> <li>Placenames</li> <li>Built up area</li> <li>Other</li> <li>Buildings footprint</li> </ul>	<p><b>Physiography</b></p> <ul style="list-style-type: none"> <li>Spot heights</li> <li>Elevation Contour (m)</li> </ul> <p><b>Transport network</b></p> <ul style="list-style-type: none"> <li>Departmental road</li> <li>Municipal road</li> <li>Local road</li> </ul>
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**Terrain motion**

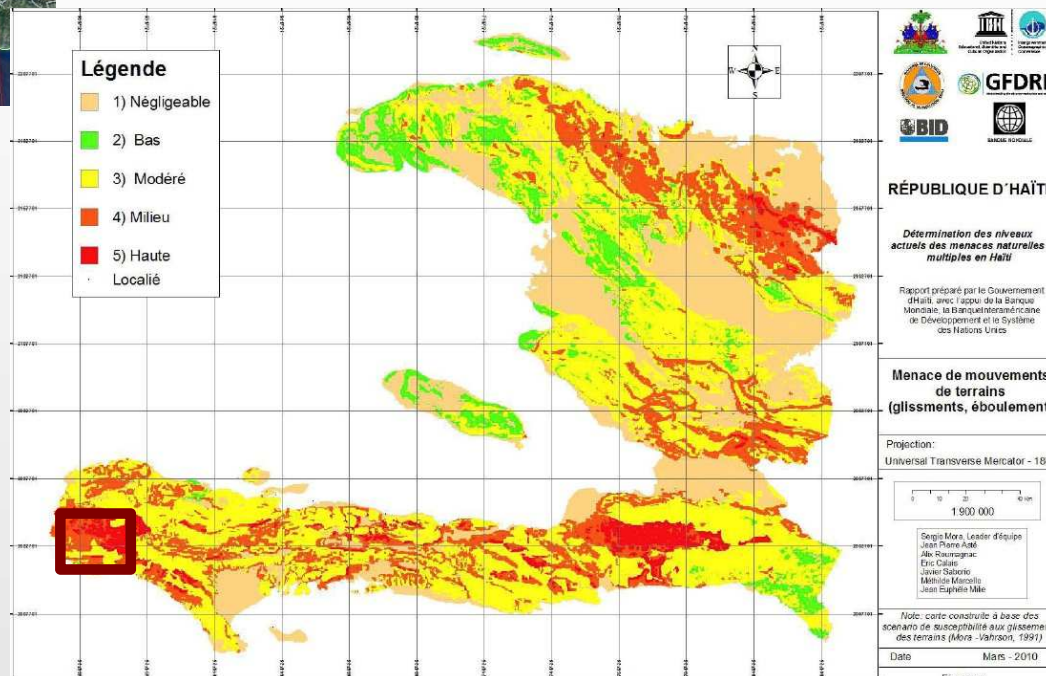
# Post-Matthew landslide detection and mapping



Landscape after Matthews  
Major rain events



**First landslide susceptibility map in Haiti with optical images**  
Topography = first driver of landsliding



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





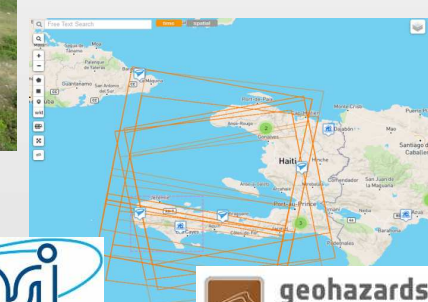
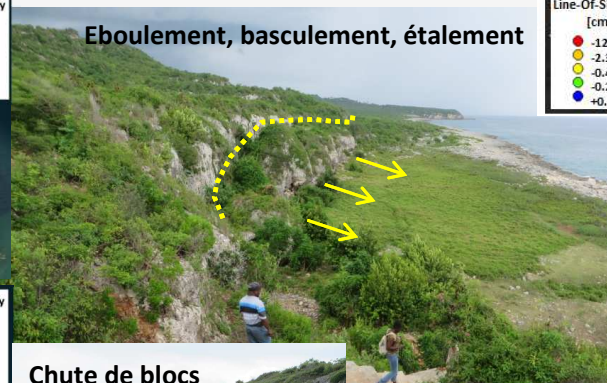
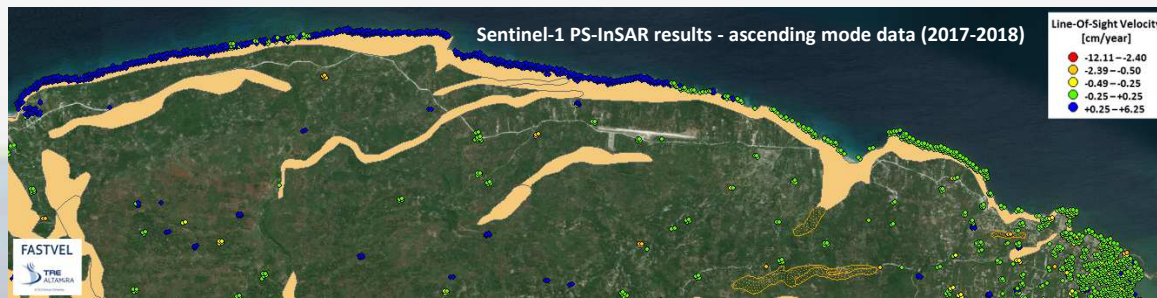
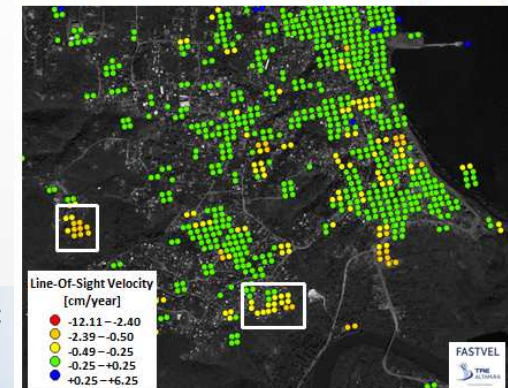
## Methodologies

- SAR interferometry (InSAR) and change detection methods
- Advanced multi-temporal InSAR and landslide motion time series
- Ground validation with CNIGS/BME on May 2019

## Coastal process and hazards / ground validation

## Post Matthew urban changes and induced risks on Jeremie

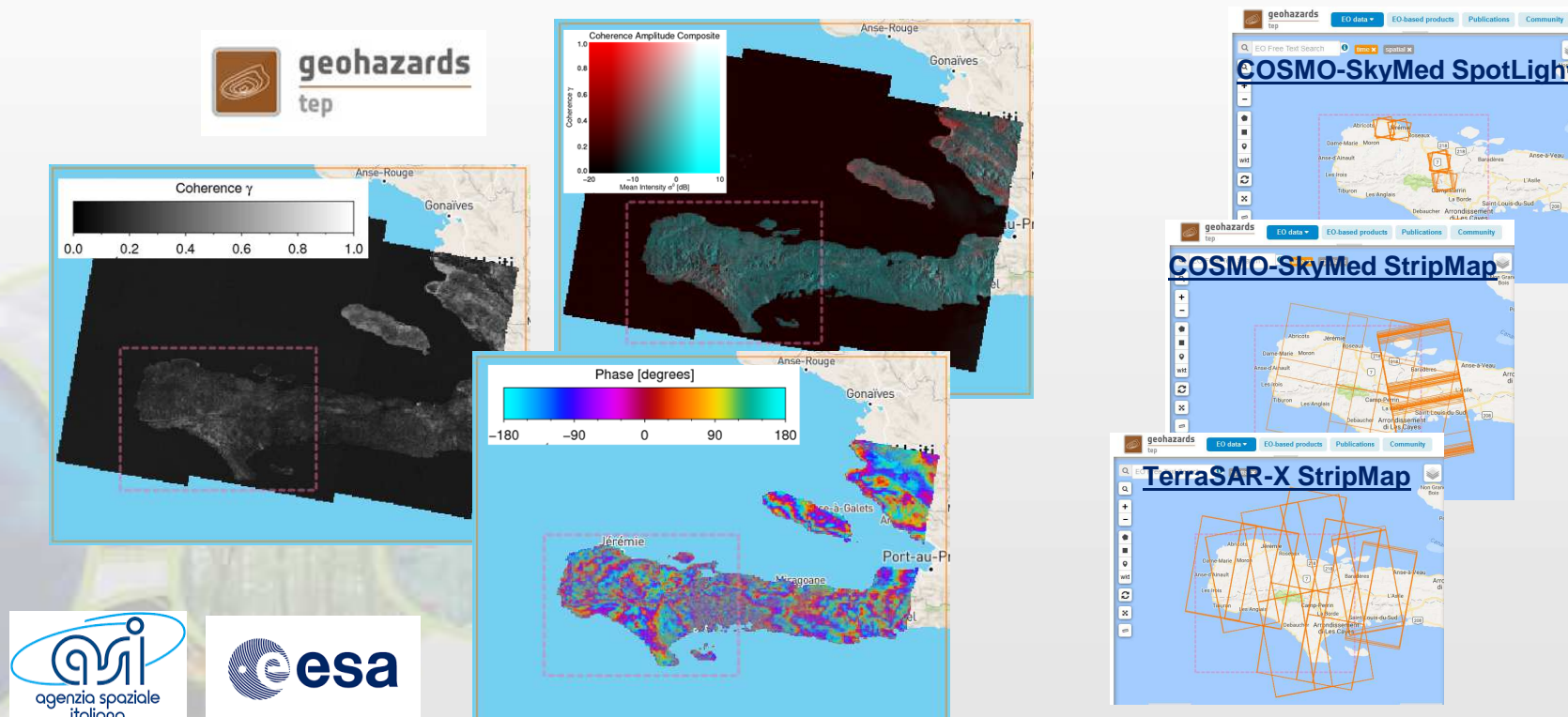
Sentinel-1 PS-InSAR results - ascending mode data (2017-2018)



# Terrain motion products based on satellite SAR










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

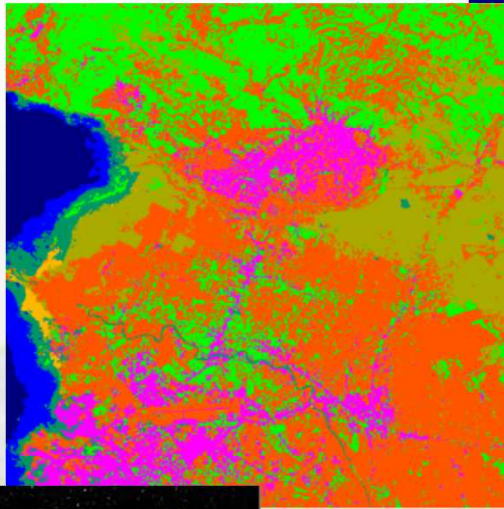
- Service allowing **detection of deformation and surface change** with Sentinel-1
- RO team developing **specific Haiti approach** for ease of technology transfer
- Cloud-based approach will be **implemented for Haitian users** even after RO





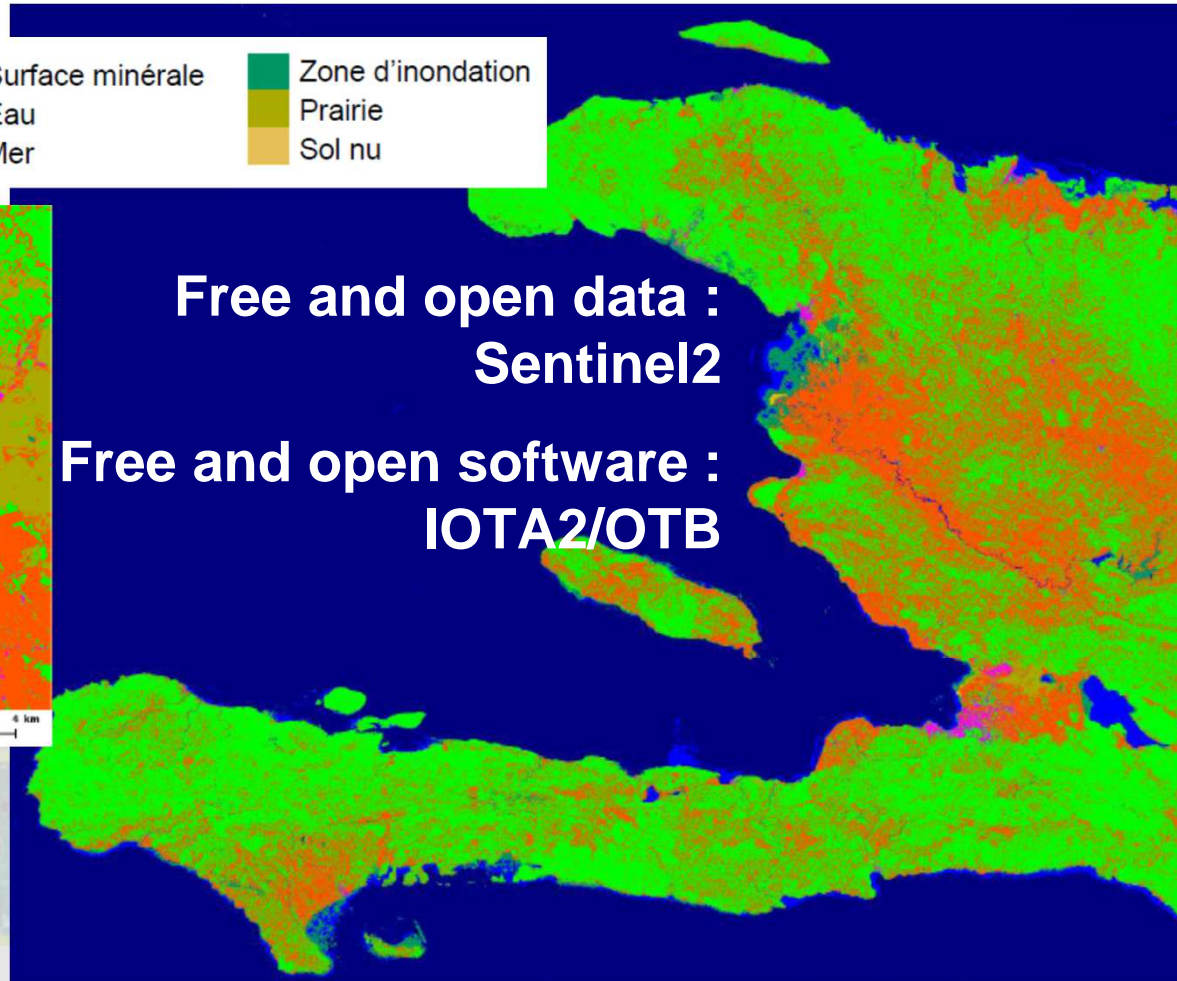


- |   |  |   |
|---|--|---|
|  Culture           |  Surface minérale |  Zone d'inondation |
|  Végétation boisée |  Eau              |  Prairie           |
|  Bâti              |  Mer              |  Sol nu            |



Free and open data :  
Sentinel2

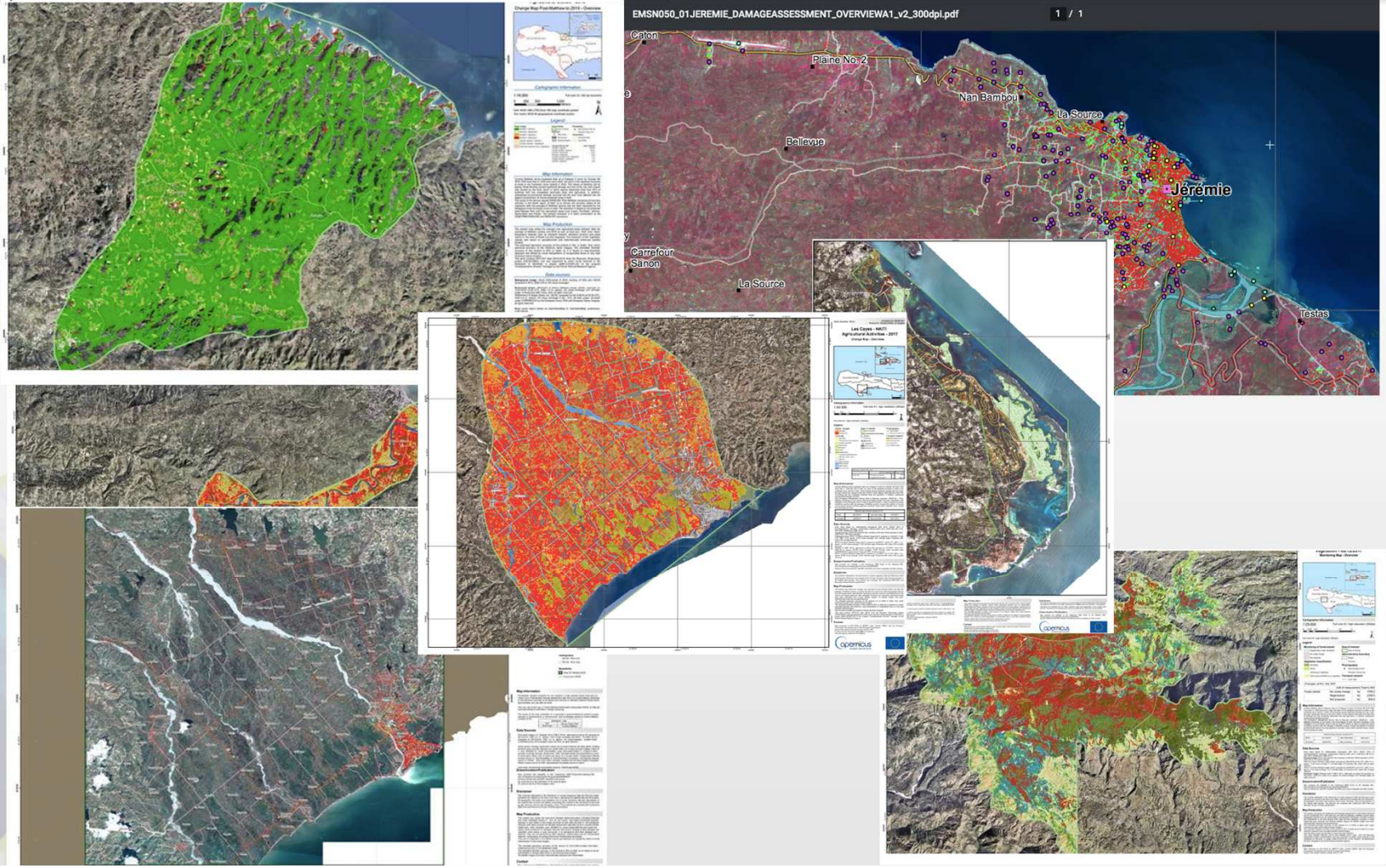
Free and open software :  
IOTA2/OTB







# RO hotspot zooms: Macaya park, urban and agricultural areas at Les Cayes and Jérémie, Pestel et Dame-Marie, Mangrove at Pointe-à-Bacou





The Capacity Development RO plan targeted **two distinct communities**:

- **Remote sensing and GIS professionals**, capable of producing products derived from satellite earth observation images
- **Professionals** who carry out **thematic monitoring** of the territory, using EO derived products in their organizations, having the basic knowledge to understand how they were made and their limits of representativeness.

Details of the objectives in the "RO Capacity Development Plan"

In parallel, several specific actions have been carried out towards **academic community**





## Producer training (CNIGS):

Technical seminars on RO thematic products  
Land Use IOTA-2 training for Sentinel-2

## User training (ONEV, CIAT, BME)

## Academic training (UEH/URGEC)

Introduction to space technologies  
Introduction to optical spatial imagery  
Earth observation for risk management  
Land use classification with free software IOAT  
Examples of applications with SAR imagery



## Activities postponed to 2021 (Covid)

Basic GIS training by the CNIGS in the region - "outreach caravan"

Basic radar data processing training by ASI (two CNIGS executives in Italy for 3 months)

RASOR and WASDI training by CIMA on WB financing (two CNIGS executives for 3 weeks in Italy)



**2017 May : World Reconstruction Conference (WRC#3), Brussels**

**2018 May : Understanding Risk (UR) 2018, Mexico**

- WGD event : “Satellite Earth Observation in Support of DRM”
- RO event : “Satellite Support for Risk management in Haiti – an innovative example”
- WB event : “Earth observation for Disaster Risk Financing”

**2018 Dec : World Bank BBL, Washington**

**2019 May : WRC#4, Geneva - “ Facilitating Recovery and Inclusion through Satellite EO”**

**2019 May : Living Planet Symposium, Milano- ASI paper +CNIGS, CNES, EOST, SERTIT, TeleScop**

**2019 May : Workshop Copernicus EMS, Stresa**

**2020 Dec : UR 2020 / WGD session (remote) - “Harnessing the Evolution of Earth Observations and Risk”**

**2021 Feb : UN GAR, “EO into Action: Systemic integration of EO applications into national risk reduction decision structures leveraging geospatial data infrastructures”**





### RO-related World Bank interventions for the agriculture in Haiti

- RESEPAG II : « Study on improving climate resilience and productivity in the Plaine des Cayes »
- TPR Nippes : « Resilient Productive Territories Project »



### RO-related IDB interventions

- UGP Macaya : « Program for the Sustainable Protection of the High Watershed Lands of the Macaya Park Zone »
- Mangroves : « Elaboration and Execution of the mangrove restoration plan »



### RO-related UE Haiti projects :

- Urbayiti : « Resilient cities & urban governance – Les Cayes, Jeremie »

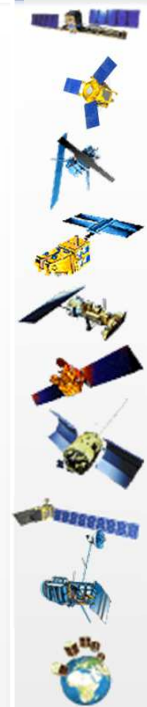




Application of DGPC Haiti to Charter Universal Access on 19/03/2019



- ESA
- CNES
- CSA
- NOAA
- ISRO
- CONAE
- JAXA
- USGS
- UKSA/DMCi
- CNSA
- DLR
- KARI
- INPE
- EUMETSAT
- ROSCOSMOS
- ABAE



Since 27/08/2019, DPC is " Authorized User " registered in the « User Registration Document »



**External evaluation process of the post Mathew RO Pilot - Criteria :**

- **Relevance:** extent to which project activities were appropriate to the priorities of the target group.
- **Efficiency:** the product achieved the expected results.
- **Effectiveness:** measures whether the project achieved its objectives.
- **Impact:** refers to the positive and negative changes produced by the use of RO products, or by a capacity development intervention;
- **Sustainability:** refers to whether the benefits are likely to continue after the project ends.

**Level of achievement :**

Taux de réussite	Code couleur
Entièrement réussi (100% de l'objectif de référence)	Vert
Plus que partiellement réussi (51%-99% de l'objectif de référence)	Bleu
Partiellement réussi (50% de l'objectif de référence)	Jaune
Moins que partiellement réussi (1-49% de l'objectif de référence)	Brique
Non réussi (0% de l'objectif de référence)	Rouge

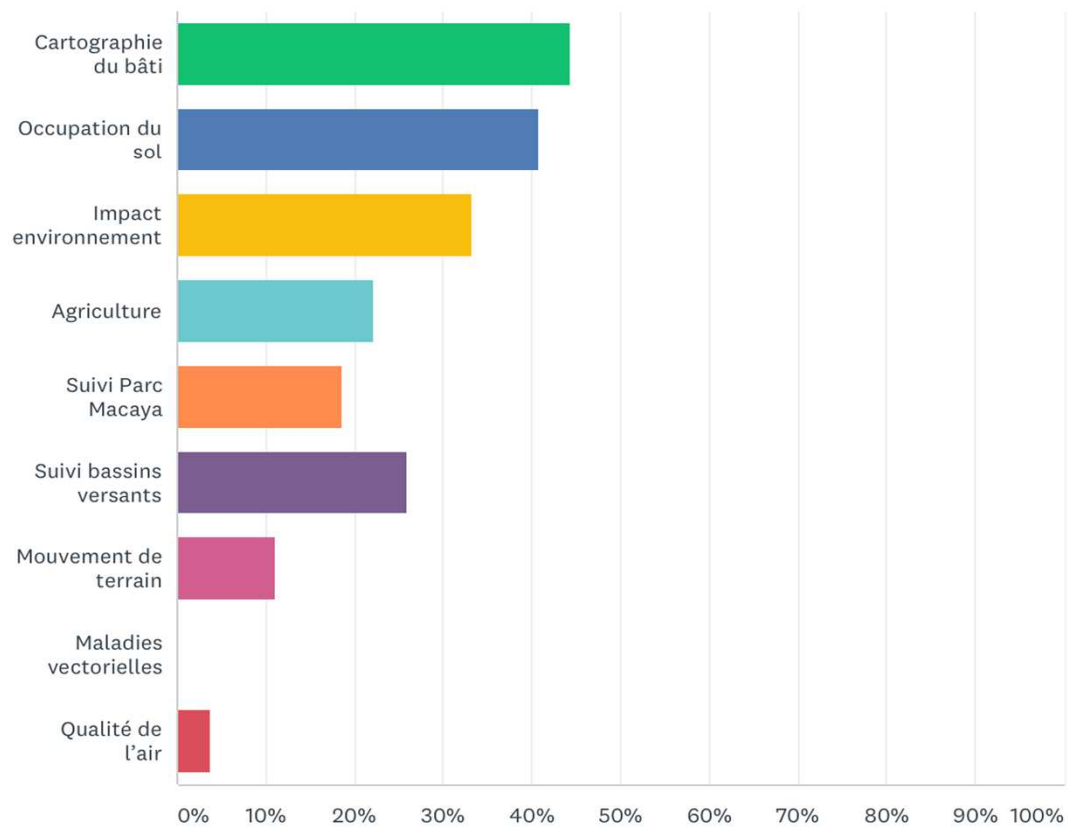


# Initial objectives of RO Haiti and summary evaluation

- **Démontrer la valeur des observations de la Terre** par satellite pour soutenir le relèvement post-catastrophe majeure ;
- **Travailler avec la communauté du relèvement post-catastrophe afin de définir une vision durable** en vue du renfort de l'utilisation des données d'observation de la terre ;
- **Établir des relations** entre les agences du CEOS et les parties prenantes internationales du relèvement ;
- **Favoriser l'innovation** autour des applications de haute technologie pour soutenir le relèvement post-catastrophe ;
- **Soutenir le développement de capacités** en Haïti :
  - Les acteurs gouvernementaux et non - gouvernementaux ont accès à des connaissances détaillées sur l'apport des donnée OT pour répondre à des problématiques post-catastrophe ;
  - Des groupes cibles augmentent leurs capacités à mettre en œuvre des initiatives de relèvement post-catastrophe et de mitigation des risques afin de réduire la vulnérabilité ;
  - Les capacités techniques des organismes en charge de la gestion et production des données géo-spatiales sont renforcées.

A mon avis, la catégorie de produits la plus utile dans les produits RO c'est (choisir deux)

Answered: 27 Skipped: 2

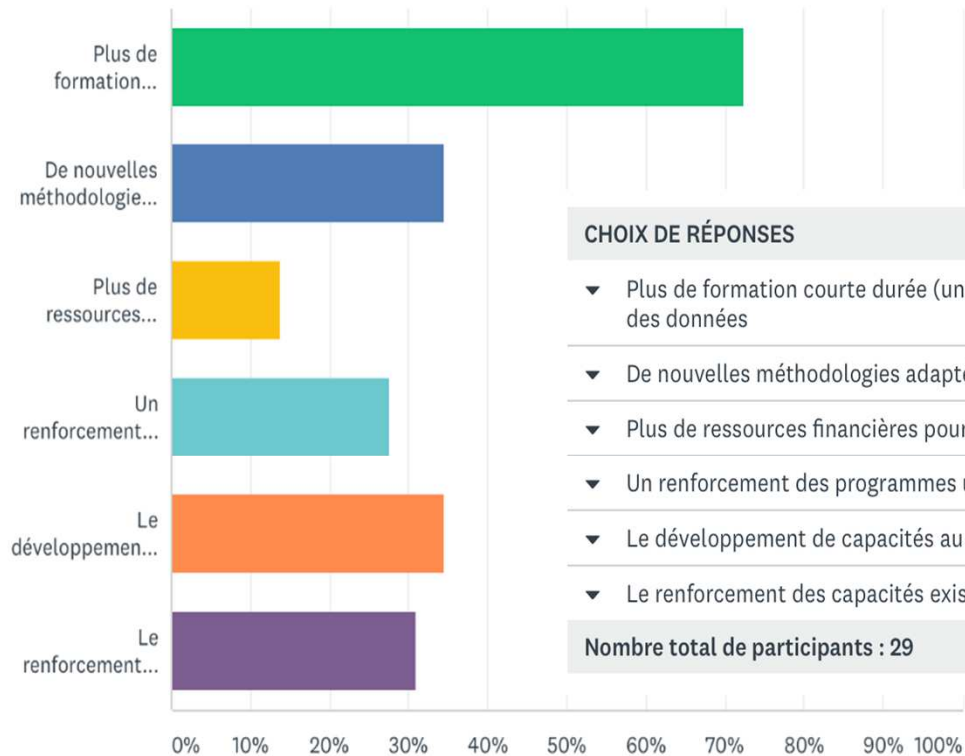






Afin de continuer à renforcer la capacité en Haïti, nous avons besoins en priorité de (choisir deux réponses)...

Answered: 29 Skipped: 0

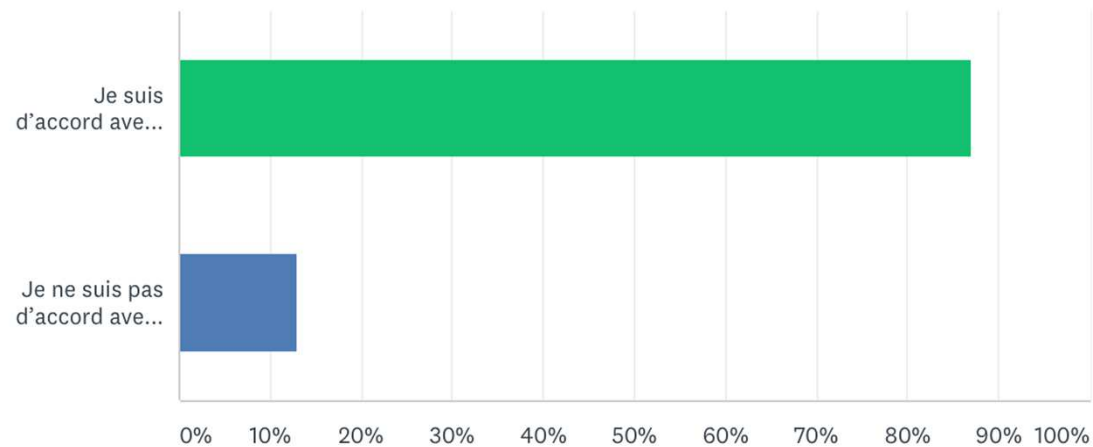


CHOIX DE RÉPONSES	RÉPONSES
Plus de formation courte durée (une semaine ou deux) sur les techniques d'Observation de la terre et du traitement des données	72,41% 21
De nouvelles méthodologies adaptées au contexte haïtien	34,48% 10
Plus de ressources financières pour acheter des équipements	13,79% 4
Un renforcement des programmes universitaires	27,59% 8
Le développement de capacités au sein des ministères	34,48% 10
Le renforcement des capacités existantes afin de consolider et empêcher la fuite des cerveaux	31,03% 9

Nombre total de participants : 29

Dans l'ensemble, j'estime que les produits générés dans le RO et la capacité développée a mené à un legs durable du projet

Answered: 23 Skipped: 6

**CHOIX DE RÉPONSES**

- ▼ Je suis d'accord avec cette affirmation
- ▼ Je ne suis pas d'accord avec cette affirmation

**RÉPONSES**

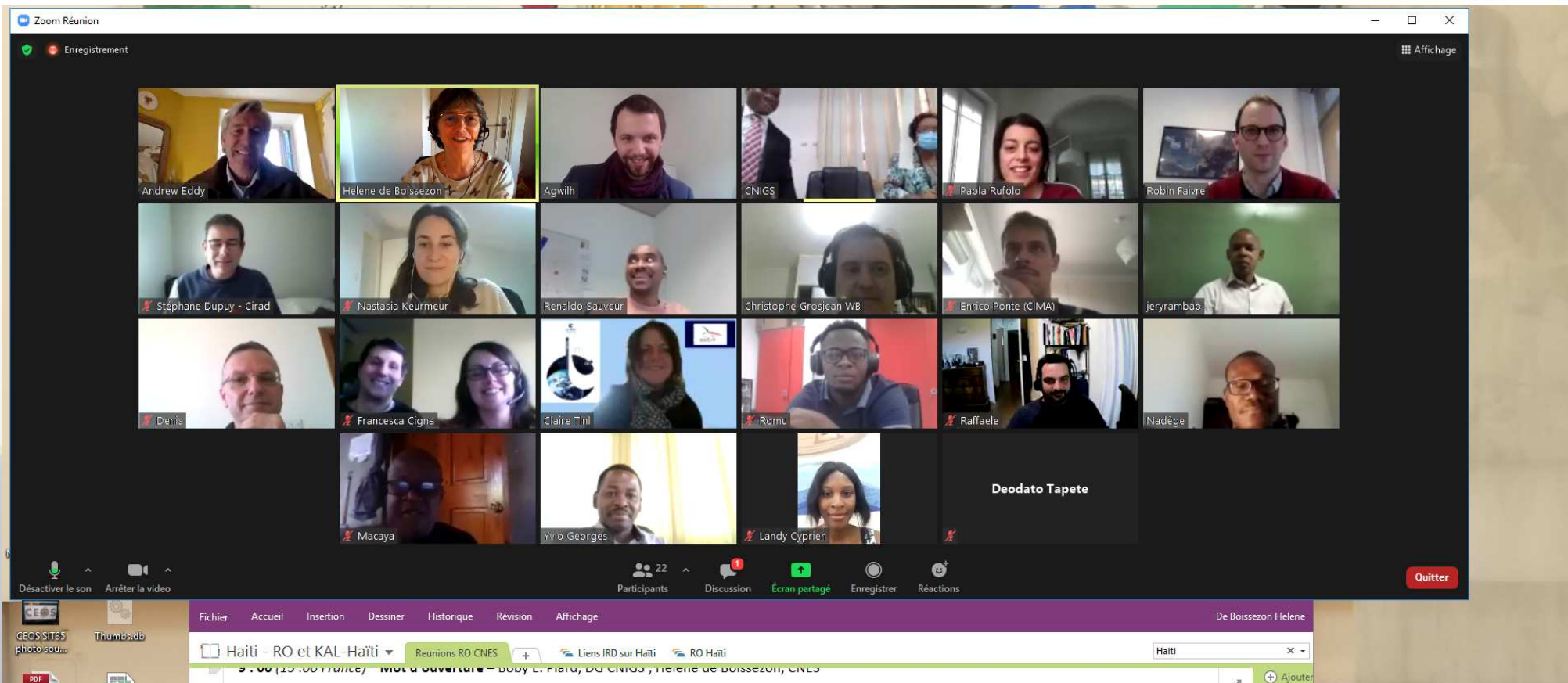
86,96% 20

13,04% 3

**TOTAL****23**



# « Haiti RO Final Workshop » – Zoom 19 January 2021 « Space for Decision-making » National Symposium – @CNIGS and Zoom 20 January, 2021



**Each event had over 30 attendees – four-hour sessions showcasing technical achievements and policy advantages to use of satellite EO**

## In Haiti:

- RO post Matthew database transferred to CNIGS : a **concrete and perennial resource**
- Capacity of **Haitian organizations to respond themselves to future events** : a capacity that is developing, based on a long-term partnership with key organizations.
- Important **transfer of capacity**, notably on the development of operational land use products (annual LULC maps based on Sentinel-2 data).
- **Institutional relations strengthened** between space agencies and Haitian organizations, with on going training in 2021.
- Successful rapprochement with the **academic sector** (URGeo).

## Outside Haiti:

- Work with UNDP/WB/UE on G-RO through **entire response/recovery/development loop**
- **Lessons learnt** used for RO Demonstrators
- Links UNDP / SCO Vietnam and other



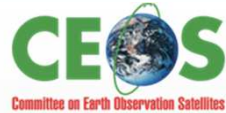
# Lessons Learned from Haiti RO Pilot



- Demonstrated the **value of satellite EO** to support major post disaster:
  - Satellites can be a very useful tool to **fill data gap** where **no other information are available** and to get **synoptic information** over large areas.
  - Satellite can provide information (together with other data set) in a wide **range of thematic products** relevant for recovery (short and long term)
- **First CEOS project focused on Recovery** phase with large participation and interest from space agencies
  - Demonstrated **need of coordination** between space agencies resources
- **Worthy model of collaboration** with Haitian partners that could be reproduced:
  - **Users** had **critical role** in the definition and in the management of the project
  - Methodologies based on **free and open data and software** to ensure sustainability
  - Consequent **capacity building** and **academic conferences** program
- Opened the challenge to establishing a **sustainable capacity to support major disaster recovery**

CEOS

Mesi ampil ! Merci ! Thank you !



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