Mapping land cover changes and land deformation due to climatic hazards using high resolution time series space-born data : study applied to the Cayes plain in Haïti

MALLET F. (1), NGUYEN DUY – BARDAKJI B. (2), DUPAQUIER C. (2), ROSSELLO P. (3)

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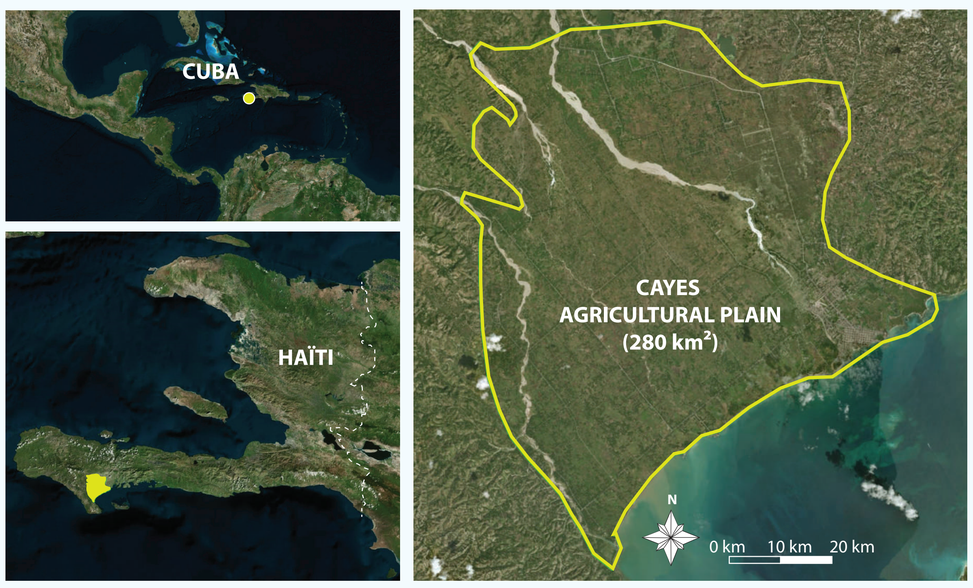
1. Introduction

The Cayes agricultural plain (280 km²) in Haïti has suffered two droughts periods in 2014 and 2015 and two hurricanes in 2016 (Matthew) and 2017 (Irma). In 2018, the World Bank has ordered a study to enhance the Cayes plain resiliency against natural disasters. This project aims at better understanding the hydrological functioning and the agricultural potentialities in order to optimize and adapt the agricultural activity regarding to climate change. This poster presents the main results from the remote sensing study.



Study area – The Cayes plain located in south-west of Haïti

2. Methods & Data

2.1 Land cover mapping in 2014 and 2018

Land cover maps have been performed using the Moringa processing chain which made it possible to produce a segmentation from very high spatial resolution images (ortho-image, 2014 ; Pléiades, 2018) and temporal analyzes from very high temporal resolution images (ASTER, 2014 ; Landsat 8, 2014 -2018 ; Sentinel 2, 2018). To generate classification, Moringa has performed machine learning (Random forest method) with ground truth data.

Objective	Method	Data
Land cover mapping	Moringa processing chain (THEIA – CES OSO ; developed by CIRAD)	- ortho-image (25 cm), 2014 - Pléiades (50 cm), Recovery Observatory of Haïti (2018) - Sentinel 2, L2APEPS – CNES - Landsat 8 (30m)

2.2 Ground deformation mapping from 2014 to 2018

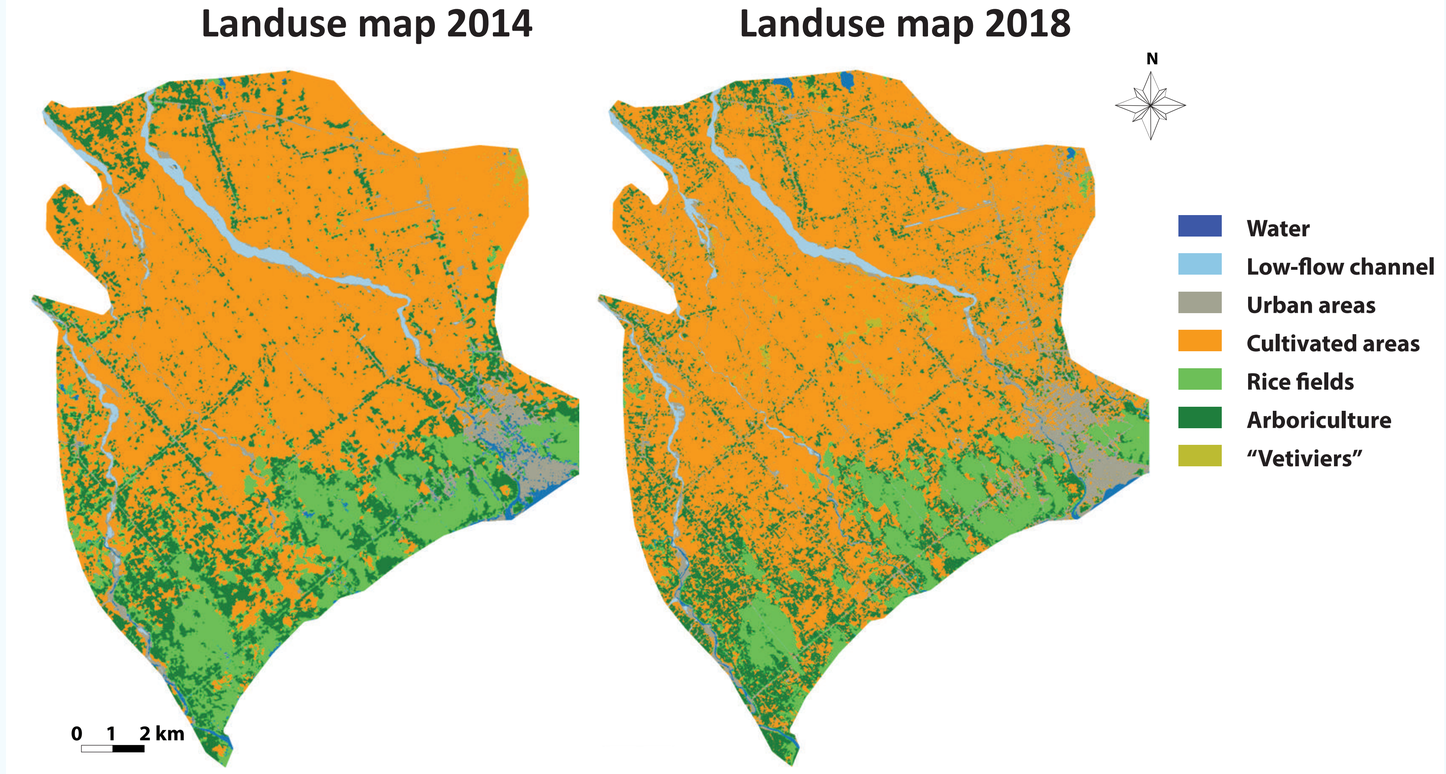
Ground deformations have been mapped using radar interferometry which made it possible to calculate the topography and reveal the ground deformations with millimetric accuracies between two images acquired at different dates. Interferometry consists in comparing the C-band phase between two radar images previously geometrically superimposed. This difference is called "interferogram".

Objective	Method	Data
Ground deformation mapping	Radar interferometry (RUS Copernicus)	- Sentinel 1A, ESA, 2014 - Sentinel 1A, ESA, 2015 - Sentinel 1A, ESA, 2016 - Sentinel 1A, ESA, 2017 - Sentinel 1A, ESA, 2018

(1) ASTERRE, France – **florian.mallet.asterre@gmail.com**
(2) La TeleScop, France
(3) GeographR, France

3. Results

3.1. Land Cover mapping in 2014 and 2018



Matrice de confusion en surface (m²) pour l'occupation du sol 2014		Polygones de la classification						
		Water	Low-flow channel	Urban areas	Cultivated areas	Rice fields	Arboriculture	"Vétiviers"
Polygones de référence (terrain et photo-interprétation)	Water	50999.79	0	182.65	487.00	591.18	0	0
	Low-flow channel	0	120785.18	2.64	0	0	0	0
	Urban areas	0	620.02	28529.46	395.57	249.45	140.03	0
	Cultivated areas	0	0	0	155387.62	0	0	0
	Rice fields	0	0	0	0	9874.65	10.09	0
	Arboriculture	0	0	0.15	2087.35	100.76	21148.58	0
	"Vétiviers"	0	0	0	13445.13	0	0	0

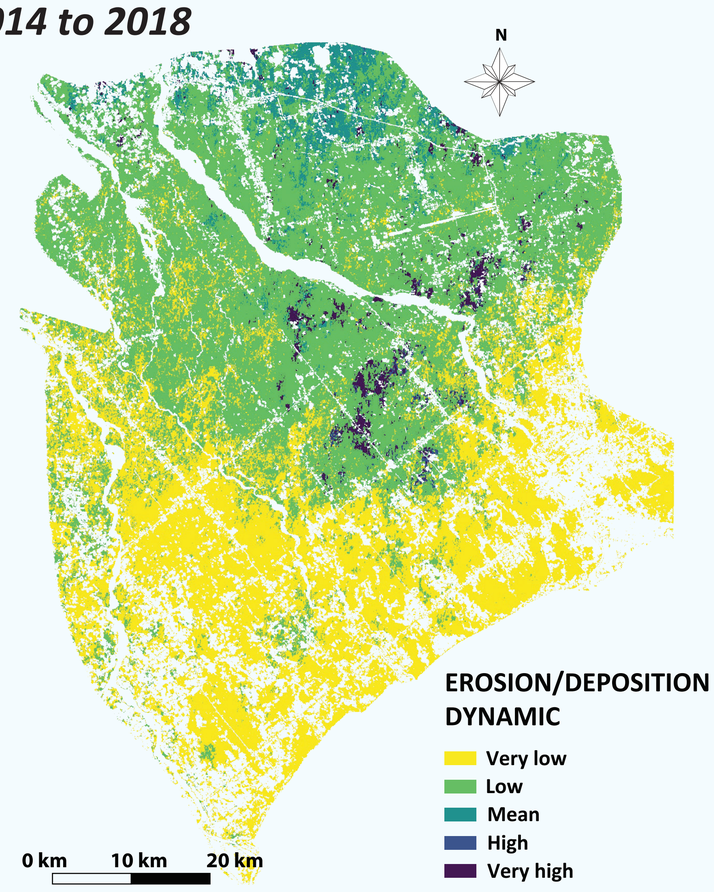
Overall accuracy index = 0.9548

Matrice de confusion en surface (m²) pour l'occupation du sol 2014		Polygones de la classification						
		Water	Low-flow channel	Urban areas	Cultivated areas	Rice fields	Arboriculture	"Vétiviers"
Polygones de référence (terrain et photo-interprétation)	Water	494038	36	836	0	0	0	0
	Low-flow channel	0	443910	0	0	0	0	0
	Urban areas	0	1380	29439	63	0	0	0
	Cultivated areas	0	0	2	411179	0	0	4090
	Rice fields	0	0	0	0	39833	0	0
	Arboriculture	0	0	212	2061	951	140480	0
	"Vétiviers"	0	0	0	9928	0	0	4436

Overall accuracy index = 0.9876

3.2 Ground deformation mapping from 2014 to 2018

We assumed that ground deformations between 2014 and 2018 were mainly caused by erosion processes which are associated to topography, vegetation, soil surface roughness and the hydrographic network density. Erosion/deposition dynamic was strong (dark purple) : 1/ on inhabited and bare hillslopes ; 2/ on floodplain where a dense shallow talweg network (with intermittnent water flows) caused a significant hydro-sedimentary activity during rainfall. Eventually, erosion dynamic was quite low in the irrigated areas (yellow).



4 . Conclusions & perspectives :

In 2018, rice fields surfaces were smaller probably due to 2 years of drought. Tree cultivation (arboriculture) areas also decreased because of Matthew Hurricane in 2016. Urban areas and flood zone were difficult to distinguish (rocks, stones). Eventually, land cover mapping in 2018 could be enhanced with more ground truth (especially about Vetivers culture, but also tiered crops). A future study focused on the headwater catchments (upstream of the plain) hydro-sedimentary processes could help to better understand erosion/deposition dynamic in the Cayes Plain.

5. References & aknowledgments

Dupuy Stéphane, Defrise Laurence, Lebourgeois Valentine, Le Mézo Lionel, Gaetano Raffaele. 2019. Moringa pour cartographier l'occupation du sol à la Reunion et Antananarivo. . Saint-Pierre : s.n., Résumé, 2 p. Rencontres Géomatique de La Réunion (RGR 2019), Saint-Pierre, Réunion, 19 Février 2019/19 Février 2019

Raucoules, D., 2011. Mesure des déformations sur la surface de la Terre à partir de techniques de télédétection spatiales (thesis), Université d'Orléans.

Pléiades image was be delivered by CNES program Recovery Observatory of Haïti. Sentinel 2 images were be downloaded on CNES-PEPS Platform (L2A MAJA Processing). ASTER and LANDSAT were be downloaded USGS EarthExplorer platform.