ANALYSIS OF THE DYNAMICS OF URBANIZED SPACES BY SATELLITE APPLICATION TO FRENCH GUIANA (ADEUSA)

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Y. Fouzai, H. Alburquerque, N. Almeida, L. Demagistri, C. Bernard, T. Catry, C. Teillet, , B Pillot, C. Charron

PROGYSAT, 2nd Seminar – Paramaribo 27-30 September 2022

PROGYSAT

URBAN AXIS CHALLENGE : address one of the Progysat challenges which is to better understand the evolution of urbanized spaces in 11 cities on this region

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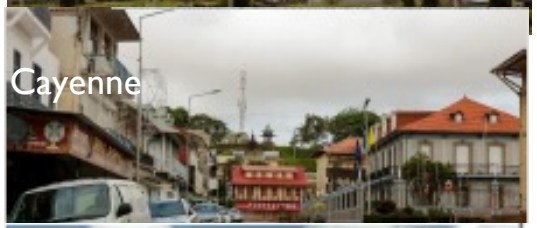
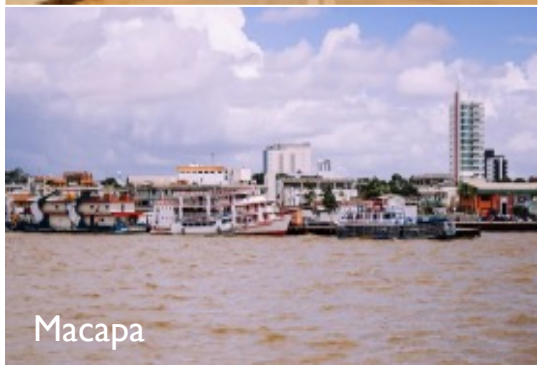
URBAN AXIS CHALLENGE : address one of the challenges of the Progysat project to better understand the evolution of urbanized spaces in 11 cities on the Guiana plateau

Context of these urbanized spaces

- ✓ Low demographic density but ever-increasing urbanization
- ✓ Complex geographic entity

PAYSAGES URBAINS du PLATEAU GUYANAIS
(Photos G. de Vilhena Silva)





OBJECTIVE

Study the spatial-temporal dynamics of urbanized spaces

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Study the spatio-temporal dynamics of urbanized spaces

- ✓ Quantify over time the growth in the ground area of cities
- ✓ Analyse intra-urban heterogeneity

NEED to Develop simple and generic TOOLS based on remote sensing data for monitoring urban areas at 2 scales

OBJECTIVE: Study the spatio-temporal dynamics of urbanized spaces

MACRO (Urban footprint - high resolution images)

11 cities selected [1984 - 2022]

Automatically delineate the urban footprint

5 years time step, + census year

GeorgeTown (Guyana capital city)

OBJECTIVE: Study the spatio-temporal dynamics of urbanized spaces

MACRO (Urban footprint - high resolution images)

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5 years time step, + census year

MESO (Urban fabric - very high resolution)

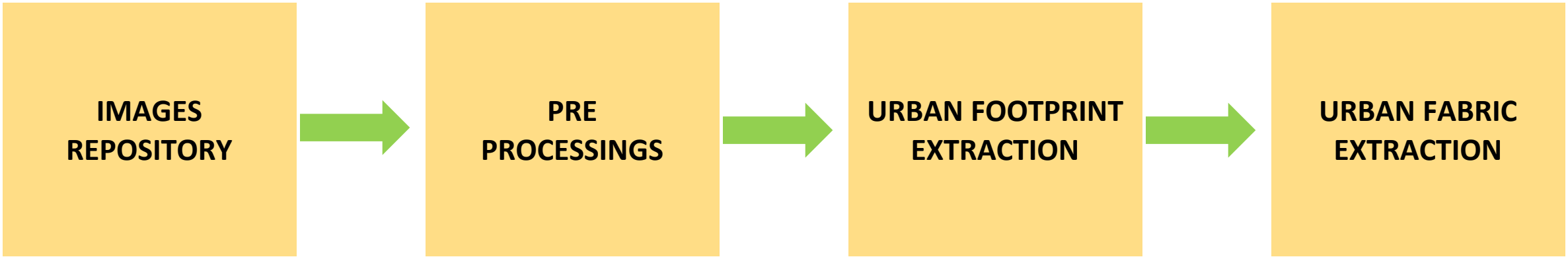
Limited number of cities (under discussion)

Study and follow 6 intra-urban classes:
dense, informal, discontinuous habitats,
vegetation, water, roads (under discussion)

GeorgeTown (Guyana capital city)

Work completed and in progress

Development of a processing workflow : URBATEX



Work completed

MACRO SCALE

STEP 1 : IMAGES REPOSITORY

Dry season (JJASO)			
Satellite Sensors	**Dates**	**Nb available images**	**Clouds < 20%**
Landsat 4,5,7,8	1987-2022	1896	327
Sentinel 2	2015-2022	2822	688

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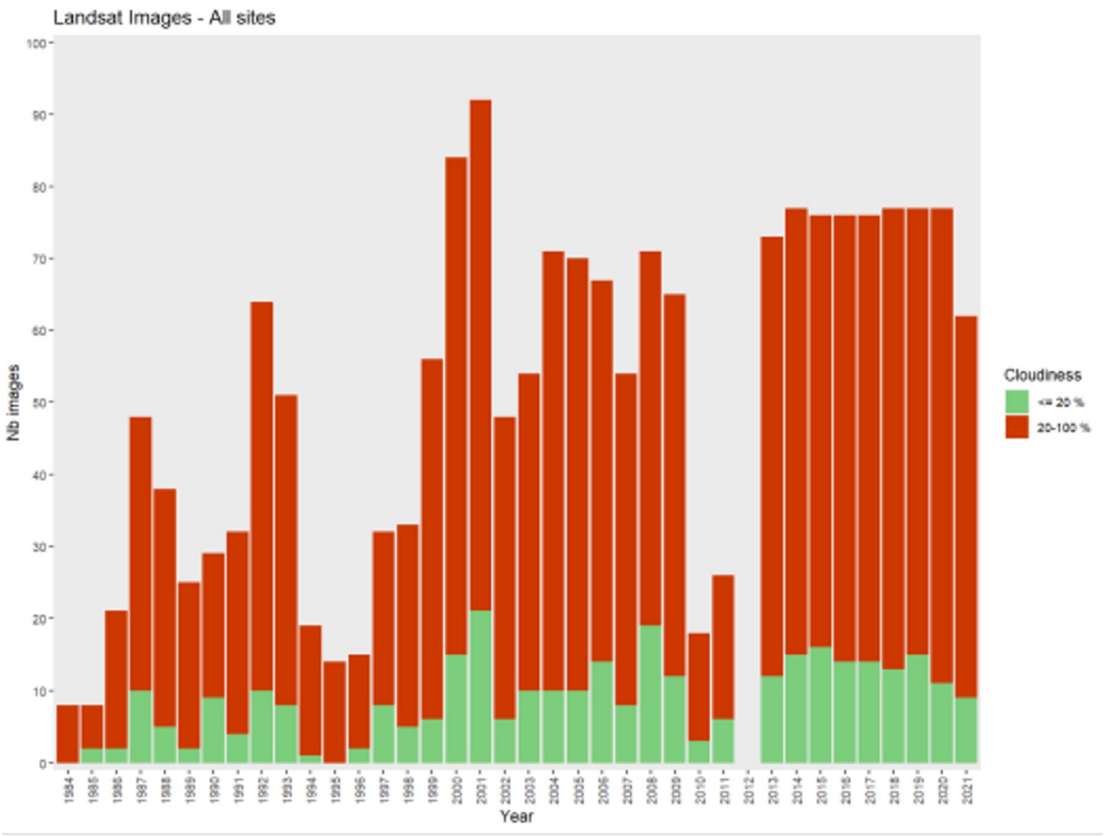

Work completed

MACRO SCALE

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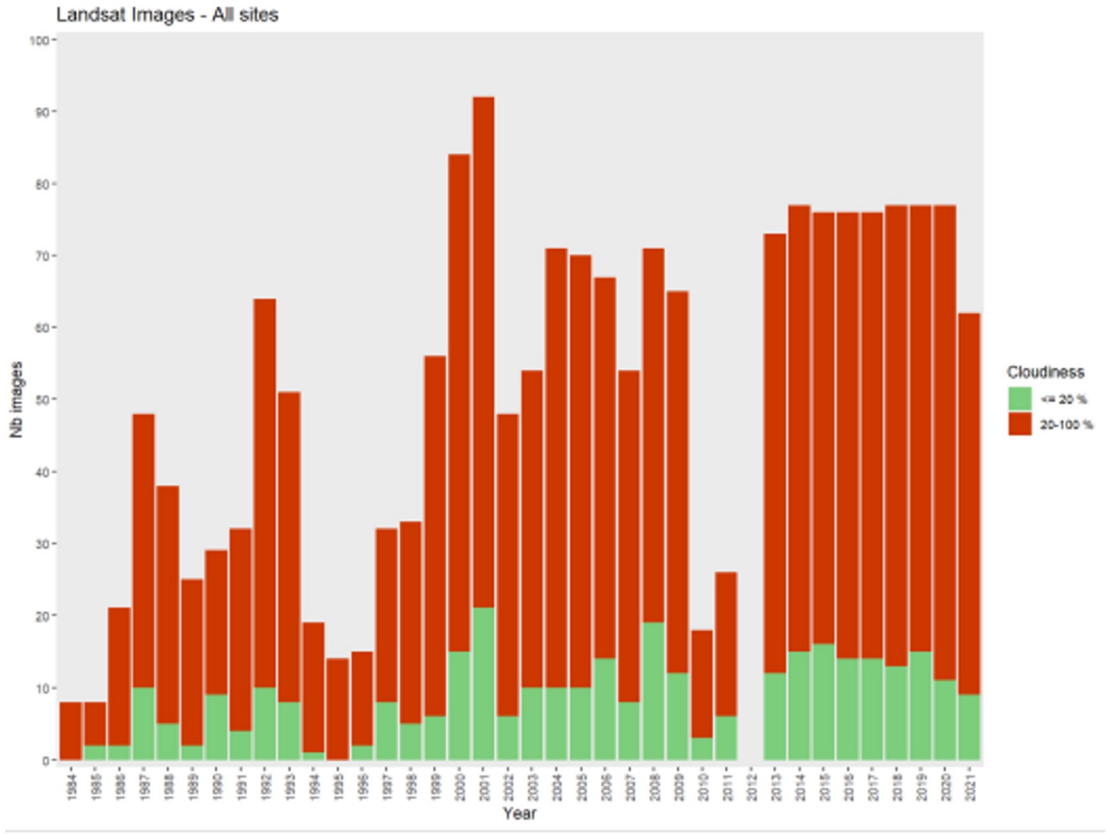
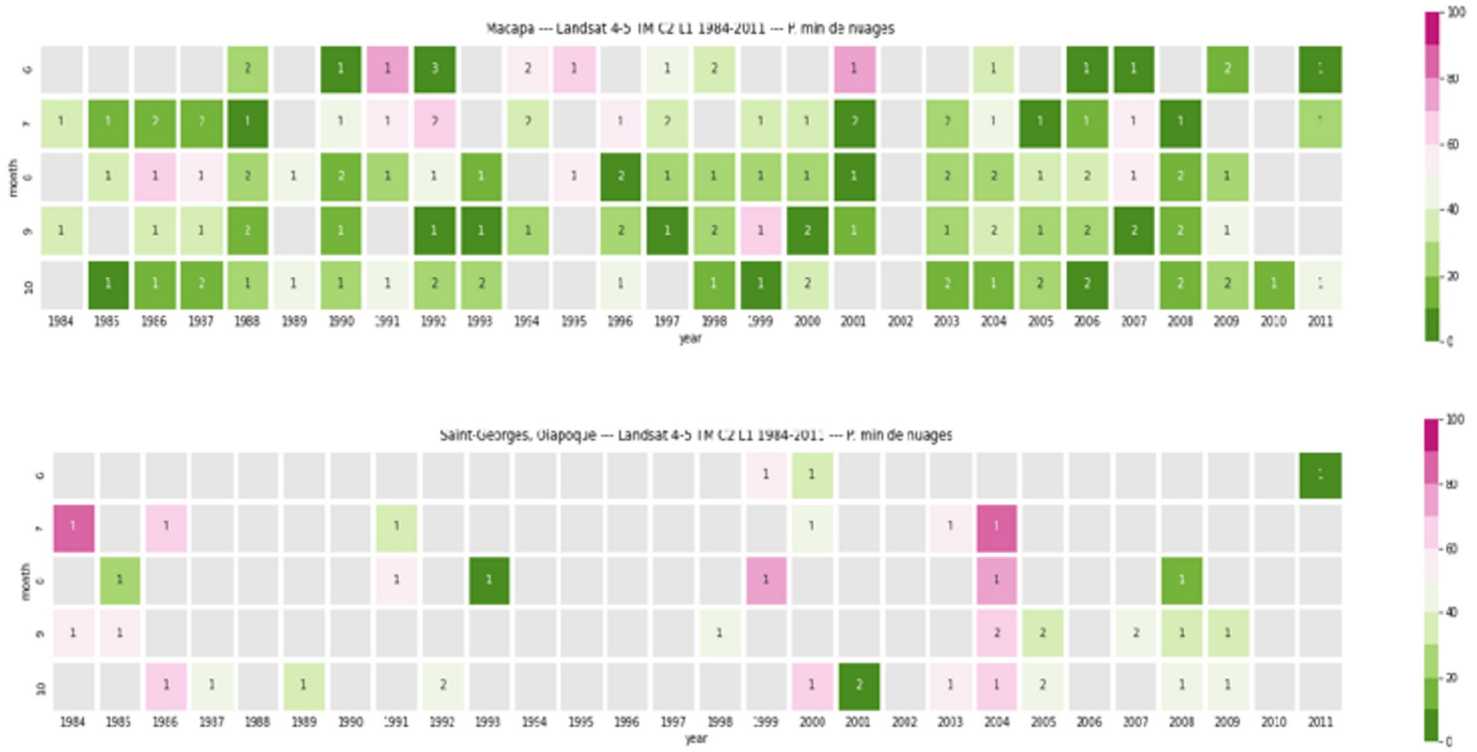


Image S2 Cayenne

Cloud cover percentage: 2.90

STEP 1 : IMAGES REPOSITORY

Development of tools to guide and help satellite images selection (C. Bernard)



Work completed

MACRO SCALE

STEP 1 : IMAGES REPOSITORY

Access to very high spatial resolution images (PLEIADES)

Image acquisition tasks have been planified to cover each sites

	A	B	C	D	E	F	G	H	I	J
1	DATE ACQ		Id. ICR	Référence Client	Nom du programme	Service commercial	Méthode d'acquisitio	Id. segment acquis	Id. segment catalogue	Statut segment acquis
2	16/11/2021	Macapa	ICR_FC_352524	Dinamis-2021-223-SCI-P2aP8		OnePlan	Monoscopique	AS_FC_352524_1_2	DS_PHR1B_202111161353044_FR1_PX_W052N00_1102_02	Validé
3	16/11/2021	Macapa	ICR_FC_352524	Dinamis-2021-223-SCI-P2aP8		OnePlan	Monoscopic	AS_FC_352524_1_1	DS_PHR1B_202111161353044_FR1_PX_W052N00_1102_02	Validé
4	16/11/2021	Macapa	ICR_FC_352524	Dinamis-2021-223-SCI-P2aP8		OnePlan	Monoscopique	AS_FC_352524_1_1	DS_PHR1B_202111161353044_FR1_PX_W052N00_1102_02	Rejeté
5	24/11/2021	Corriverton Nnickerie	ICR_FC_352519	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352519_2_3	DS_PHR1B_202111241428448_FR1_PX_W058N06_1001_00	Rejeté
6	27/11/2021	Kourou	ICR_FC_352522	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352522_1_2	DS_PHR1A_202111271406399_FR1_PX_W053N05_0504_01	Rejeté
7	27/11/2021	Kourou	ICR_FC_352522	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352522_1_1	DS_PHR1A_202111271406316_FR1_PX_W053N05_0504_00	Rejeté
8	03/12/2021	Paramaribo	ICR_FC_352520	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352520_2_7	DS_PHR1B_202112031410131_FR1_PX_W056N05_0818_02	Rejeté
9	03/12/2021	Paramaribo	ICR_FC_352520	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352520_2_3	DS_PHR1B_202112031410005_FR1_PX_W056N05_1019_03	Validé
10	17/12/2021	Kourou	ICR_FC_352522	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352522_1_3	DS_PHR1B_202112171402078_FR1_PX_W053N05_0504_00	Validé
11	17/12/2021	Kourou	ICR_FC_352522	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352522_1_5	DS_PHR1B_202112171402239_FR1_PX_W053N05_0504_01	Validé
12	03/01/2022	Corriverton Nnickerie	ICR_FC_352519	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352519_3_5	DS_PHR1B_202201031421166_FR1_PX_W058N05_1123_02	Validé
13	03/01/2022	Georgetown	ICR_FC_352518	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352518_2_1	DS_PHR1B_202201031421306_FR1_PX_W059N06_1219_01	Validé
14	08/01/2022	Georgetown	ICR_FC_352518	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352518_2_2	DS_PHR1B_202201081432520_FR1_PX_W059N06_1018_02	Rejeté
15	17/01/2022	Paramaribo	ICR_FC_352520	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352520_2_2	DS_PHR1B_202201171414149_FR1_PX_W056N05_1018_02	Rejeté
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19	17/02/2022	Georgetown	ICR_FC_352518	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352518_2_2	DS_PHR1B_202202171425015_FR1_PX_W059N06_1019_01	Validé
20	28/05/2022	Cayenne	ICR_FC_352517	DINAMIS-2021-223-SCI-P1-Cayenn	ISIS_2021	OnePlan	Monoscopique	AS_FC_352517_1_3	DS_PHR1A_202205281405494_FR1_PX_W053N04_0921_02	Rejeté
21	28/05/2022	Cayenne	ICR_FC_352517	DINAMIS-2021-223-SCI-P1-Cayenn	ISIS_2021	OnePlan	Monoscopique	AS_FC_352517_1_4	DS_PHR1A_202205281406001_FR1_PX_W053N04_0921_02	Rejeté
22	14/06/2022	Corriverton Nnickerie	ICR_FC_352519	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352519_3_2	DS_PHR1A_202206141425178_FR1_PX_W058N05_1121_00	Validé
23	15/06/2022	Paramaribo	ICR_FC_352520	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352520_2_8	DS_PHR1B_202206151417410_FR1_PX_W056N05_0818_02	Rejeté
24	17/06/2022	Oiapoque StGeorges	ICR_FC_352523	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352523_1_7	DS_PHR1B_202206171402220_FR1_PX_W052N03_0322_02	Validé
25	22/06/2022	Paramaribo	ICR_FC_352520	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352520_2_8	DS_PHR1B_202206221412595_FR1_PX_W056N05_1018_02	Validé
26	22/06/2022	Paramaribo	ICR_FC_352520	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352520_2_8	DS_PHR1B_202206221412595_FR1_PX_W056N05_1018_02	Rejeté
27	22/06/2022	Paramaribo	ICR_FC_352520	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352520_2_8	DS_PHR1B_202206221413121_FR1_PX_W056N05_0818_02	Validé
28	22/06/2022	Paramaribo	ICR_FC_352520	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352520_2_8	DS_PHR1B_202206221413121_FR1_PX_W056N05_0818_02	Rejeté
29	30/06/2022	Kourou	ICR_FC_352522	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352522_1_1	DS_PHR1A_202206301402486_FR1_PX_W053N05_0405_01	Rejeté
30	03/07/2022	Corriverton Nnickerie	ICR_FC_352519	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352519_3_2	DS_PHR1A_202207031429039_FR1_PX_W057N05_0123_00	Validé
31	12/07/2022	Kourou	ICR_FC_352522	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352522_1_1	DS_PHR1A_202207121410148_FR1_PX_W053N05_0405_01	Validé
32	12/07/2022	Saint Laurent Albina	ICR_FC_352521	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352521_1_1	DS_PHR1A_202207121410010_FR1_PX_W054N05_0110_02	Validé
33	12/07/2022	Saint Laurent Albina	ICR_FC_352521	Dinamis-2021-223-SCI-P2aP8	ISIS_2021	OnePlan	Monoscopique	AS_FC_352521_1_2	DS_PHR1A_202207121410475_FR1_PX_W055N05_1211_02	Validé

PHR1B_MS_202207201358559_ORT_6433234101-2.JPG

In green : validated acquisitions (july 2022)

STEP 2 : PRE-PROCESSINGS

Lots of experiments performed …

Images Calibration :

- Reflectances computation and atmospheric corrections :
  landsat (USGS, SCP); Sentinel (Sen2cor, MAJA), Sen2lasrc-NASA

Cloud masks evaluation and computation :

- Landsat 4 / 5 , 7 et 8 (USGS)
- Sentinel (MAJA - CESBIO),
- Sentinel (Sen2cor -ESA)
- Sen2lasrc (Fmask, S2cloudless)

According to cloudiness :

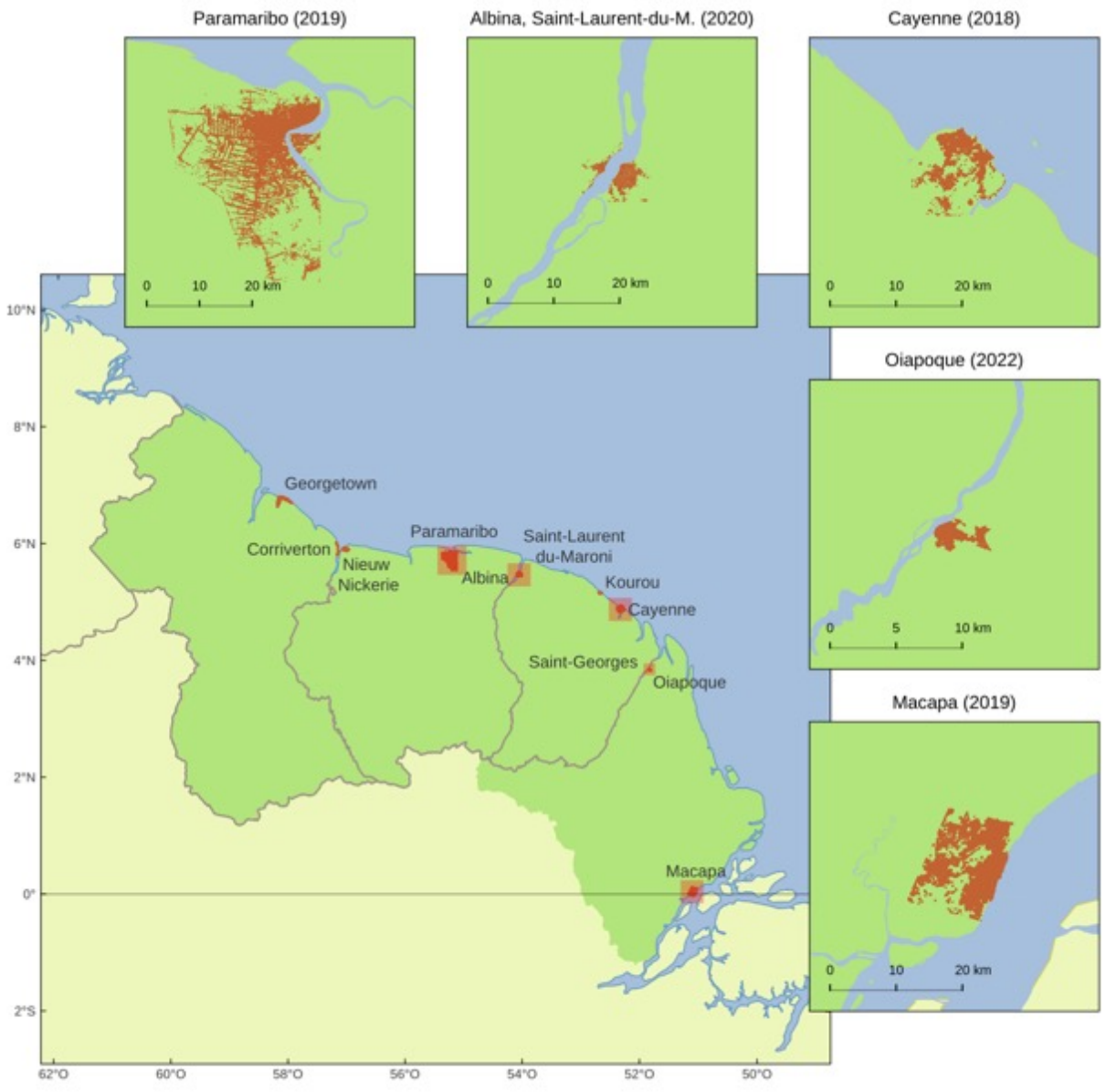
- IF ≈ 0 THEN GOTO next processing,
- ELSE images synthesis (gap filling, Composite, WASP)
- ELSE try Radar data (S1)

some tests performed on Macapa for 2 dates : data synthesis over 1 year needed in order to filter speckle.

… and meetings and workshops with experts

R. Gaetano,
J.B. Feret
F.de Boissieu,
A. Defossez,
J. Fozzani
C. Charron,
O. Hagolle …

STEP 3 : PROCESSINGS



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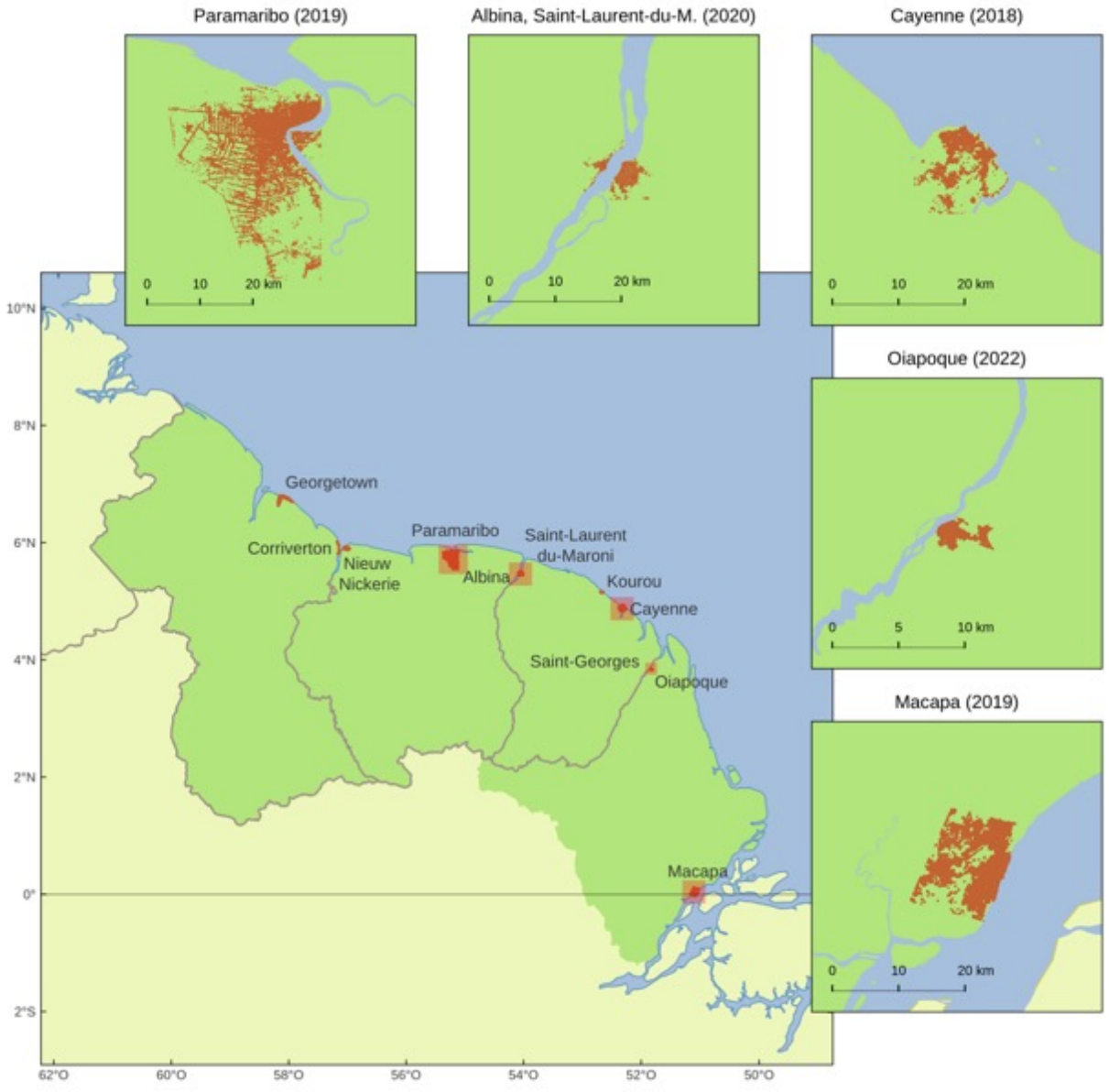

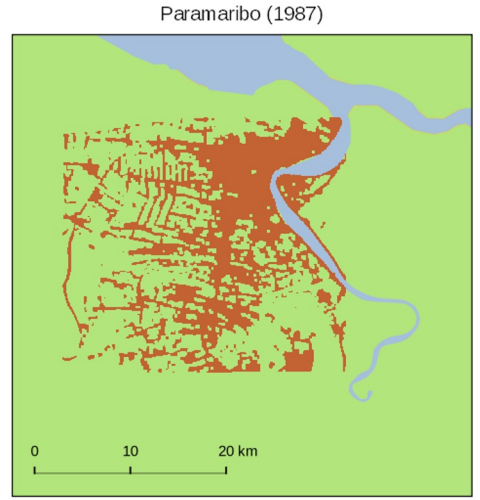

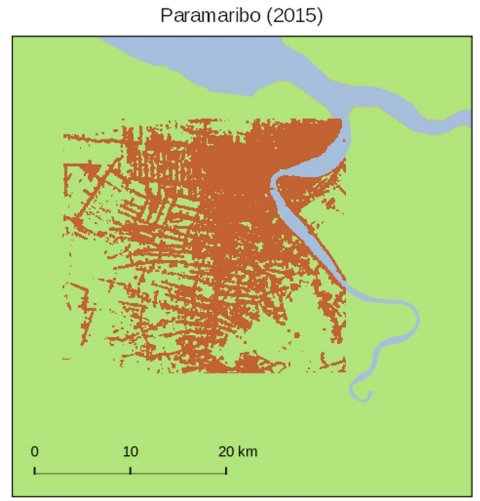

STEP 3 : PROCESSINGS

Lizmap web portal for data / results visualization https://portails-espacedev.teledetection.fr/

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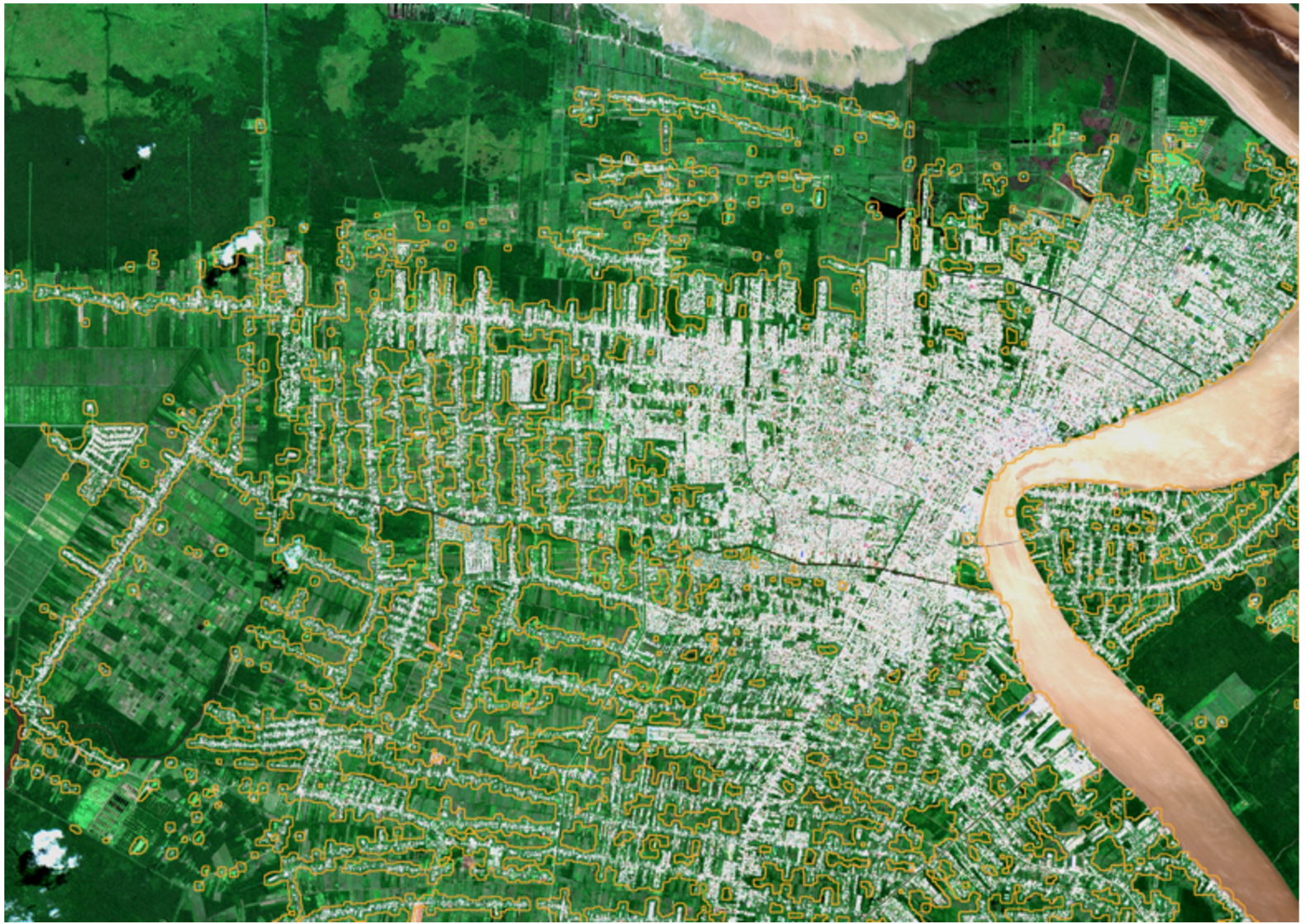
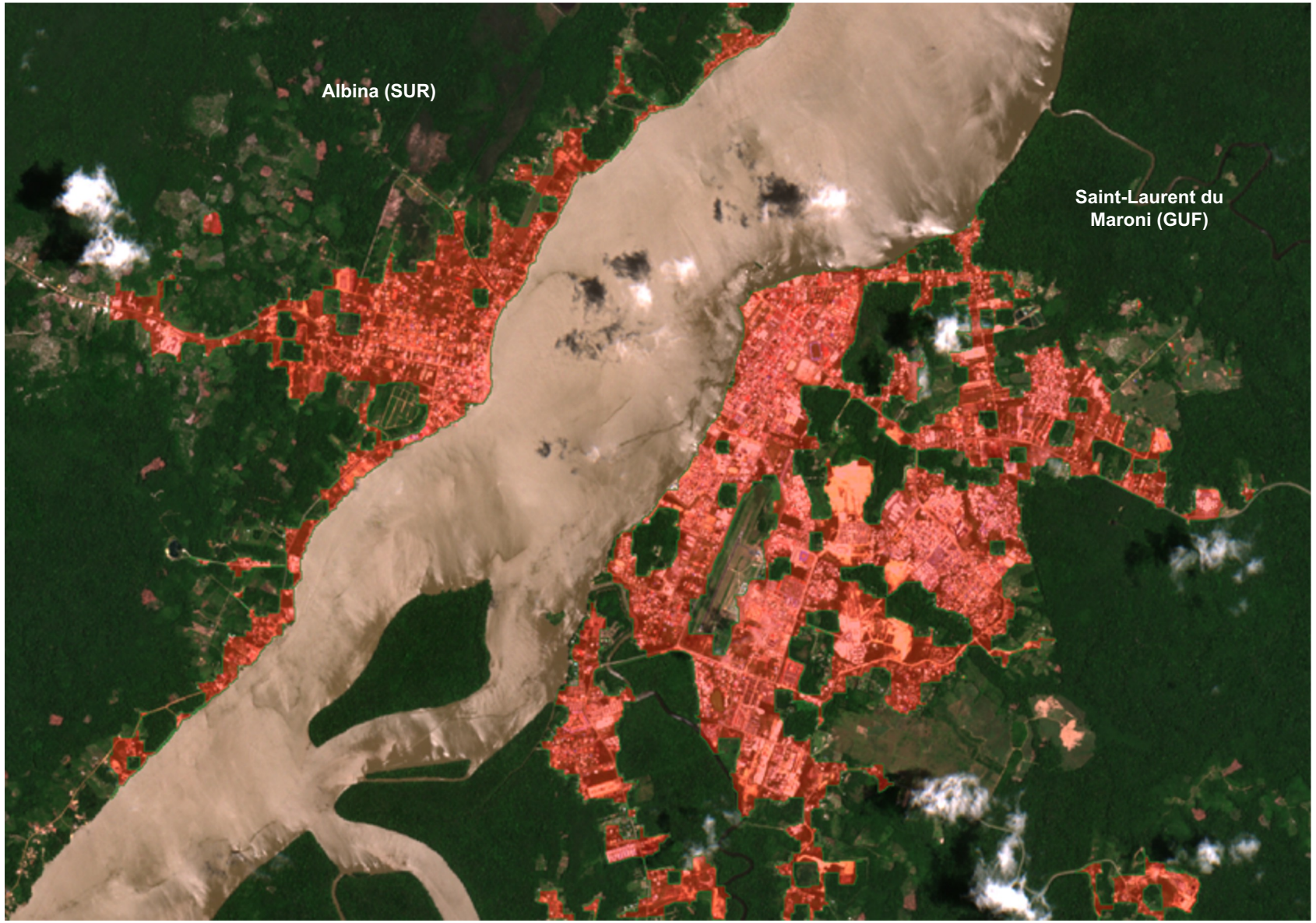


STEP 3 : PROCESSINGS

Urban footprint extraction (UF)
Albina (Suriname) / Saint Laurent (Guyane Fr.)
Image Sentinel 2 :
N0209_R110_T21NZG_20200911T160222
date acquisition : 2020-09-11

UF digitized by an expert (photointerpretation)

STEP 3 : PROCESSINGS



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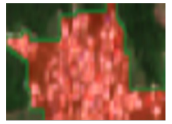

UF obtained with URBATEX

STEP 3 : PROCESSINGS

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Image Sentinel 2 :
N0209_R110_T21NZG_20200911T160222
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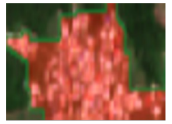
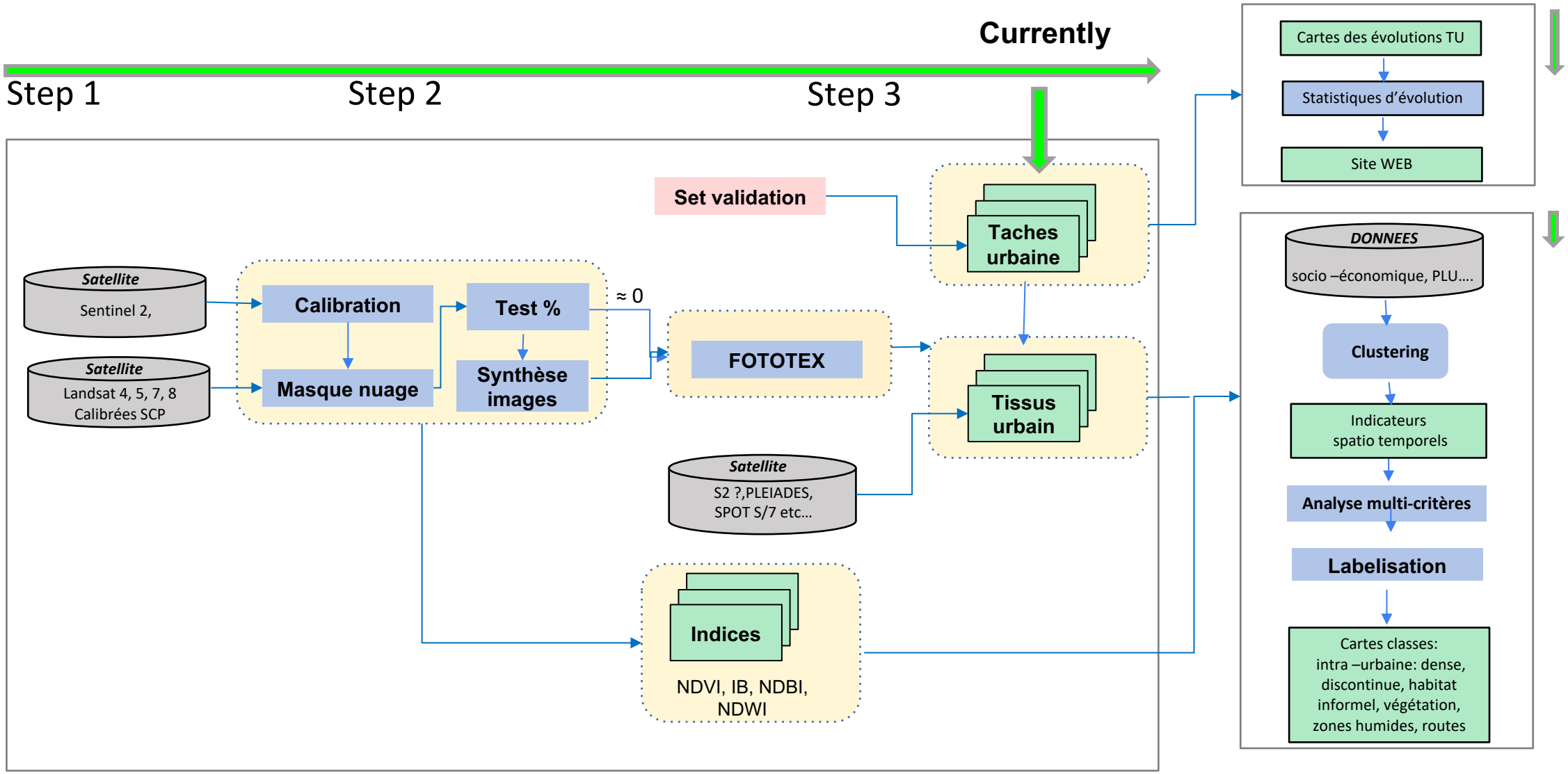


UF obtained with URBATEX

UF digitized by an expert (photointerpretation)

Work completed

Simplified workflow of the **URBATEX** processing tool



STEP 3 : PROCESSINGS

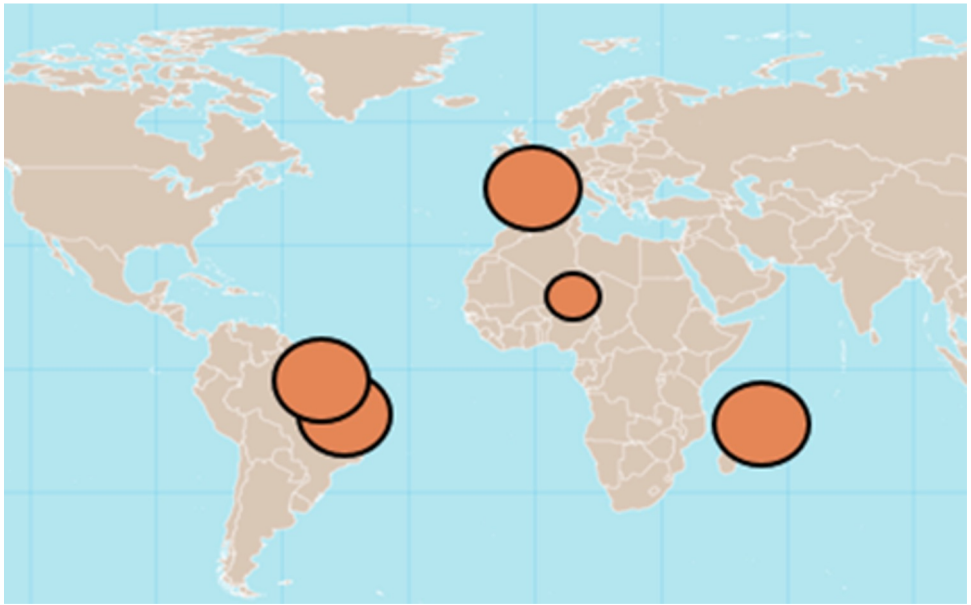
remote sensing

MDPI

Article

Fast Unsupervised Multi-Scale Characterization of Urban Landscapes Based on Earth Observation Data

Claire Teillet [1,*], Benjamin Pillot [1], Thibault Catry [1], Laurent Demagistri [1], Dominique Lyszczarz [2], Marc Lang [3], Pierre Couteron [4], Nicolas Barbier [4], Arsène Adou Kouassi [5,6], Quentin Gunther [7] and Nadine Dessay [1]



Fototex : https://framagit.org/espace-dev/fototex

Application to various research study sites
Results **evaluation** and **comparison** with available **global products**

Work completed

TRANSVERSAL ACTIVITIES

Creation of a data base for each country
- Administrative limits
- Urban plans
- Streets (11 cities)
- Roads
- Land use and land cover
- Rivers

…

Work completed

TRANSVERSAL ACTIVITIES

Bibliographic search in Brazilian public institutions documents on intra-urban typologies;

Systematization of GIS of the intra-urban typology produced by IBGE (main Brazilian institute producing socio-demographic data);

Bibliographic search on academic articles involving intra-urban typologies in the main academic search platforms;

Systematization of selected articles, extracting the main results found and analytic frameworks;

Planning the next steps of next steps

Partnership

CURRENT:

UNIFAP AMAPA : Grupo Potedes: G. Vilhena Silva, Nataliel

FIOCRUZ - Lab DP et Lab EDTA : P. Peiter, H. Alburquerque

Université de Brasilia (UnB) Lab LAGAS : H. Gurgel

IRD/Espace-DEV : N. Dessay, T. Catry, L. Demagistri, C. Charron, Y. Fouzai, C. Bernard, B. Pillot, C. Teillet

TO BE DEVELOPED:

Instituto de Pesquisas Científicas e Tecnológicas do Estado do Amapá (IEPA): Francinete Facundes

Agence Urabanisme et Développement de la Guyane (AUDeG) : G. Benito Perez

Collectivité Térritoriale de Guyane : *B. Ruelle*

SURINAME - GUYANA : Dan Mark (georgetown), Ruben Merovijo (Paramaribo)

Some Others ?

Interactions PROGYSAT Project : Axis 1 "Data and tools"

Thematic axis : **Health , Pollution**

WORKSHOP Thursday 29th

Next steps : discussions on results achieved until now and future actions

Urban footprint : which scientific elements in literature could explain the results regarding the urban footprints of each country ?

Intra urban classes :

- Which intra urban typology ?
- On which towns ?

Interactions with other axis ?

THANK YOU FOR YOUR ATTENTION