

SPOT contribution to REDD

SPOT IMAGE – INFOTERRA France

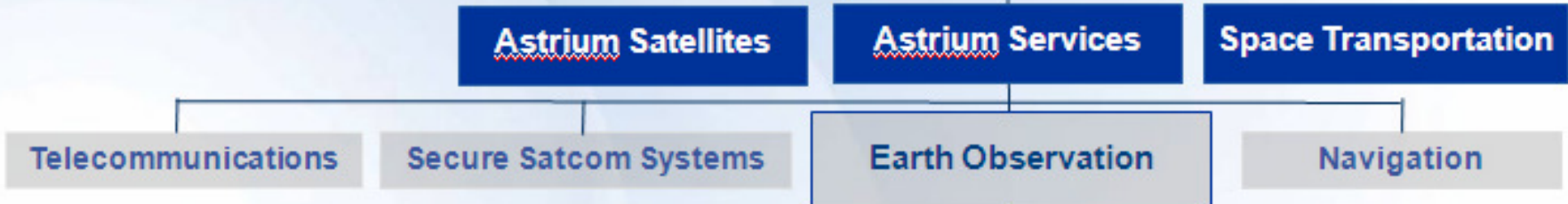
Didier RIGAL



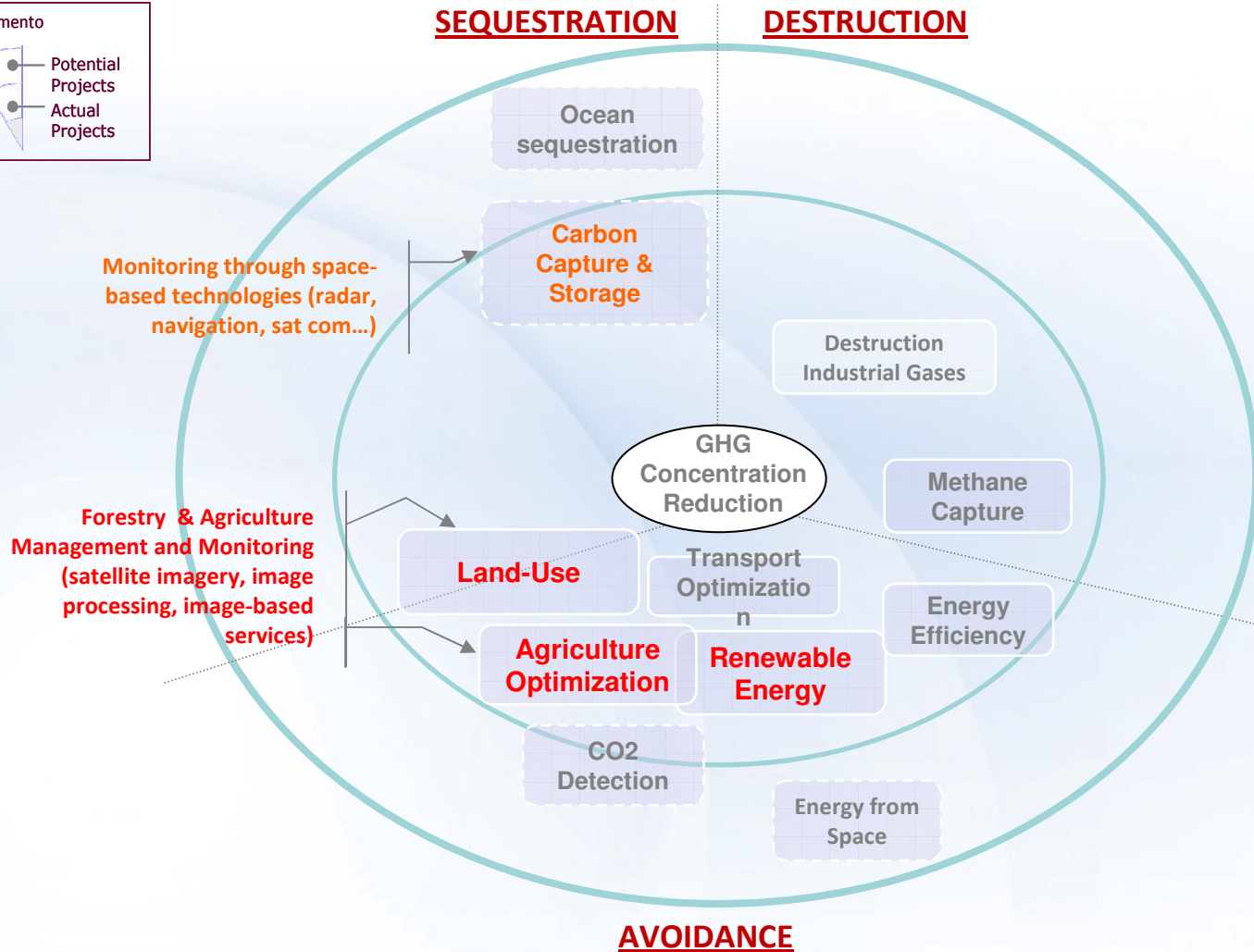
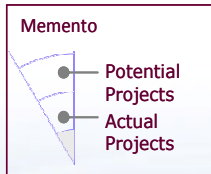
SPOT IMAGE within EADS ASTRIUM



Astrium
 Turnover 2009: € 4.8 billion
 Staff 2009: 15,000*



Project based activities of interest for EO for avoiding GHG emissions



Main topics of interest for EO

- Land-Use** is a short-term priority : Avoiding carbon emissions + increasing carbon storage (REDD , A/R, Agriculture, Green Energy)

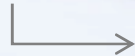
- Carbon Capture and Storage** is a mid-term priority : Capturing, transporting and storing carbon emissions (from coal electricity power plants, industries, cemeteries...).

Addressable Land-Use mitigation activities with EO

Changes in Land-Use account for more than 20% of anthropogenic GHG emissions

Land-Use

A/R & REDD



FORESTRY

ENVIRONMENT

AGRICULTURE

Opportunities

Scientific community agrees that tackling climate change without forest protection would be absurd. Benefits of attaching value to standing forests are widely acknowledged by NGOs, states, local communities, scientists and have gained sufficient visibility to create political momentum:

Agreement to protect forests is close to be reached in the context of an international accord

US climate-policy contains unanimous provisions to finance forest protection under future climate law.



International Funds will very likely be made available to promote protection of Forest carbon stocks :

Reducing Emissions from Deforestation and Degradation (REDD)

International funds

Now

Mixed approach

Now & Tomorrow

Carbon market credits

credits

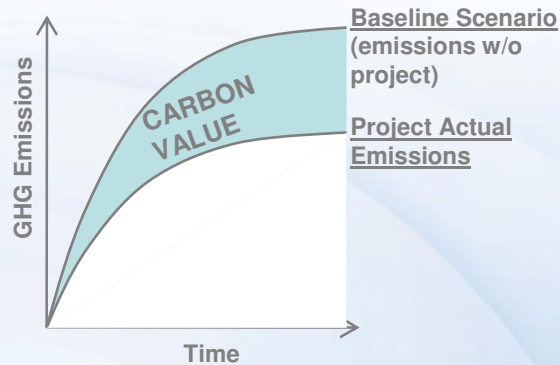
Future



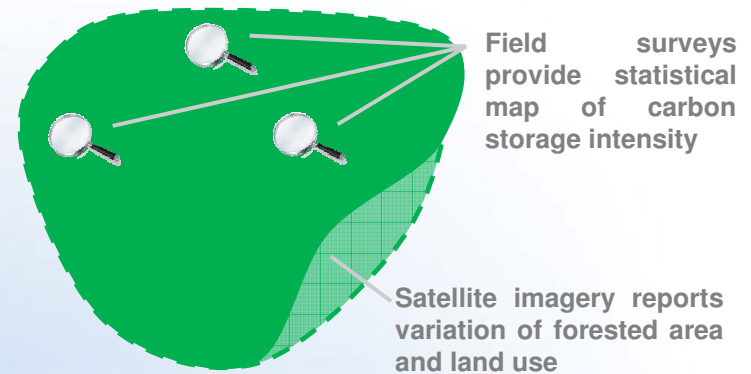
Why do REDD Forest projects require Satellite Imagery ?

Satellite Imagery is a helpful tool at various steps of project activity that are key to validating project carbon value

How is set project carbon value?



How to assess carbon storage variations in a forested area?



Satellite imagery is relevant to **build baseline scenario**

Satellite imagery is helpful to REDD projects to assess the rate at which deforestation occurs in the area.

Archives are valuable to make relevant forecasts.

Satellite imagery is relevant to

Map & Monitor Forest emissions

Satellite imagery is a relevant tool for REDD projects to monitor actual evolution of carbon stocks in the forest.

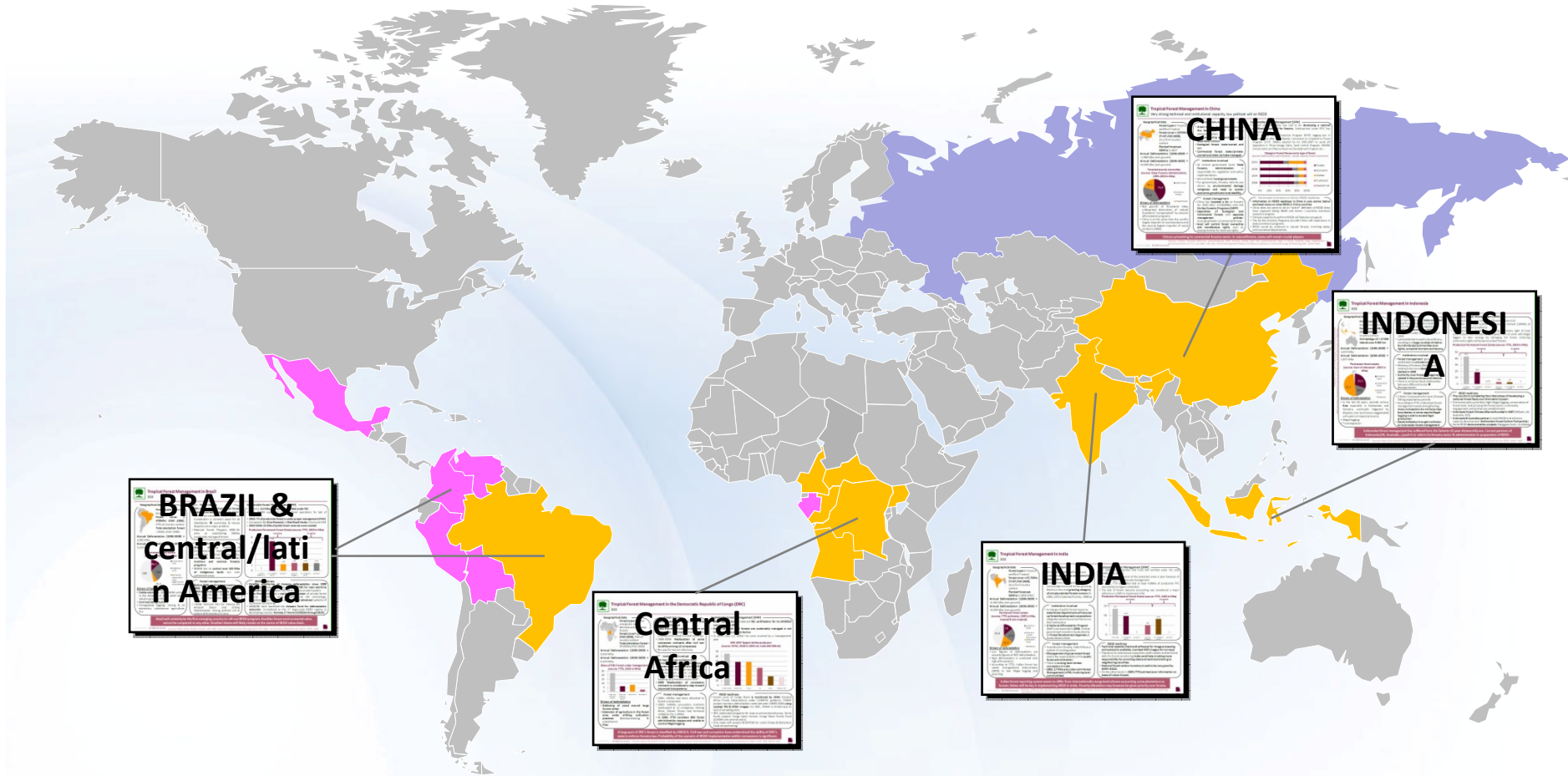
Satellite imagery is also relevant for REDD projects to prove that project activities did not just displace deforestation (no leakage)

Satellite imagery has the advantage of being fact-based and transparent which makes it legitimate as an evidence provider.



Major countries having forests candidates for REDD schemes & policies

Below is listed forest-holders major countries (forest asset and political readiness)



- Countries for which analysis has already been done (except China, all ITTO* members, selected for tropical forest resource and political influence)
- ITTO countries for which Forest information is partly available.
- Even though Russia is an Annex-I country, Russian forest (800Mha) is so large that its protection may be envisaged. Later analysis could be relevant.

* ITTO = International Tropical Timber Organization, promoting appropriate management of tropical forest resource, 59 member countries)

CO²

- 1. Forest application: the AMAZONIA Baseline project**
- 2. the French Aid REDD program on Congo basin**
- 3. SPOTIMAGE major contributions to the REDD**

SPOT Satellite image (SWIR composite)

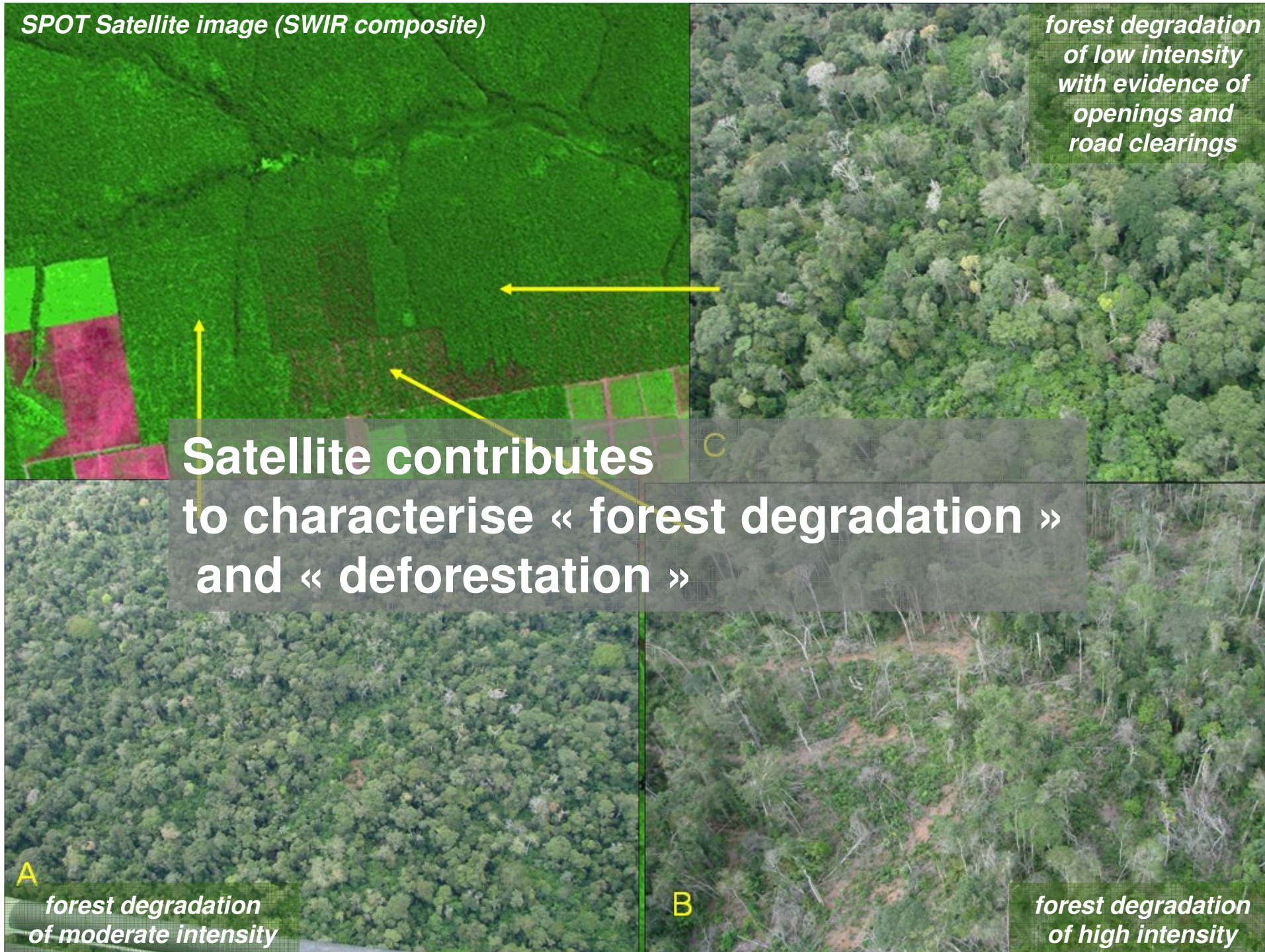
forest degradation of low intensity with evidence of openings and road clearings

Satellite contributes to characterise « forest degradation » and « deforestation »

A
forest degradation of moderate intensity

B

forest degradation of high intensity



- **Task 1 – to demonstrate the use of satellite images to establish the reference situation of Forest in a given country**
 - Use of Landsat old archive and New SPOT collections over the Amazon basin (25 years)
 - Demonstration on Mato Grosso state in Brazil : production of the historical situation (mid 80's) and trend since this date
 - Focus on the comprehensive mapping of deforested / degraded areas, and of their further evolution

- **Task 2 : develop operational concepts for *Monitoring and Verification* based on the group assets**
 - Combined use of satellite data with various characteristics (resolution, spectral bands, ...) to perform routine monitoring at different scales (from global to local)
 - Use of VHR to perform routine quality control and to perform *Verification* (control of the actual implementation of actions to reduce carbon emissions)

■ Focus on primary forest and its evolution through time

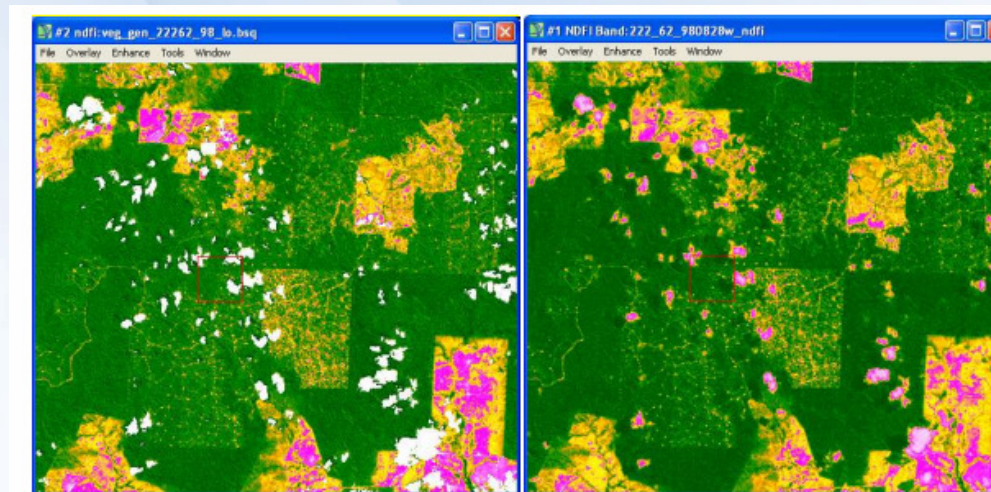
-  Water
-  Cloud/Shade Mask
-  Non-Forest (*Savannah, Rock, Flooded Plain*)
-  Forest (*Dense Forest, Transitional Forest, Open Forest w/ Palms/Bamboo*)
-  Deforestation (*Forest converted to Pasture, Crops, Bare Soil, Reforestation, Urban, Mining*)
-  Degradation (*Logged and Burned Forests*)
-  Forest Regeneration (*Old Degradation*)
-  Secondary Growth (*Abandoned Deforested Areas*)

classes to describe the forest dynamics

Methodology - *use of NDFI and other indicators*

- **Indicator selected : the NDFI (*indicator developed by IMAZON*) as main criteria for degradation / deforestation**
 - the OVERLAND processor allows to automatically generate NDFI from the biophysical layers, in a robust way (*haze correction, cloud masking ...*)
- **other biophysical layers from OVERLAND are used as well as complementary criteria**
 - *e.g improve discrimination with other dense vegetation - crops , secondary growth*

*demonstration of
OVERLAND performance
on test images*



*Automated NDFI from
OVERLAND*

*Hand adjusted NDFI from
IMAZON*

Methodology - yearly update and incremental classification

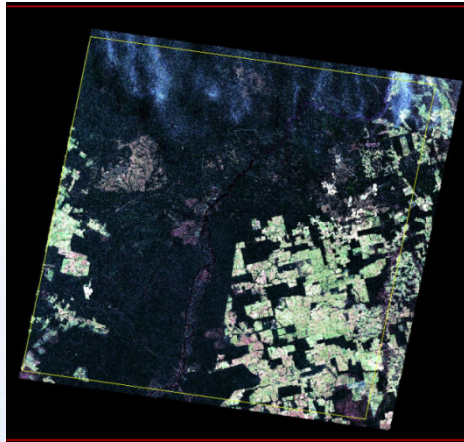
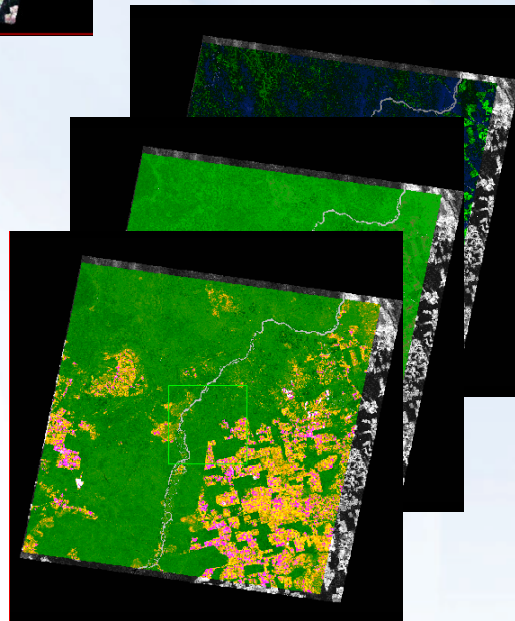


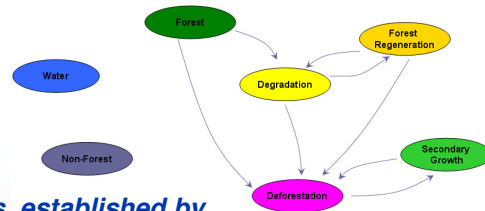
image of year N



processing with OVERLAND

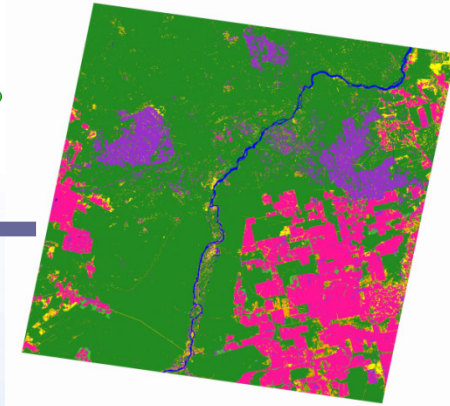


set of maps to characterize the physical state of the forest

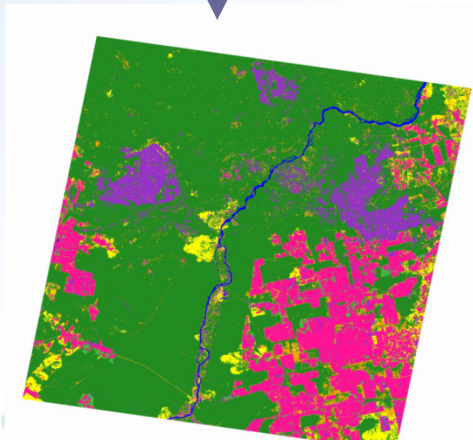


Transitions rules established by experts on Forest LC classes

Forest LC map from year N-1

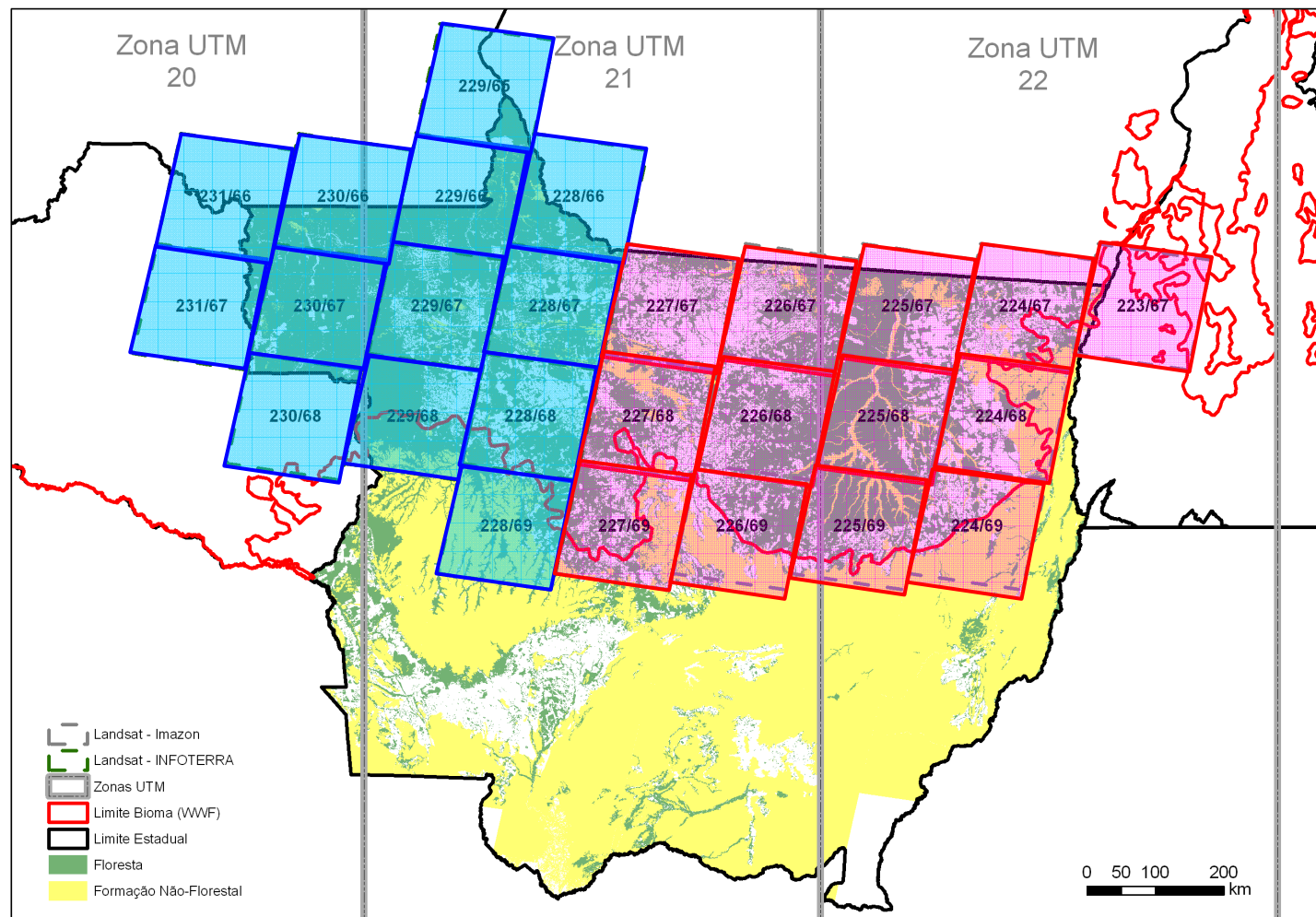


OVERLAND classification tool using decision tree to detect classes transitions

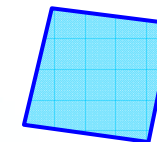


Updated Forest LC map (year N)

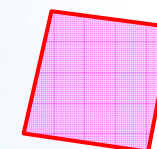
Production Shared between IMAZON and Infoterra-Spotimage



Infoterra production



IMAZON production

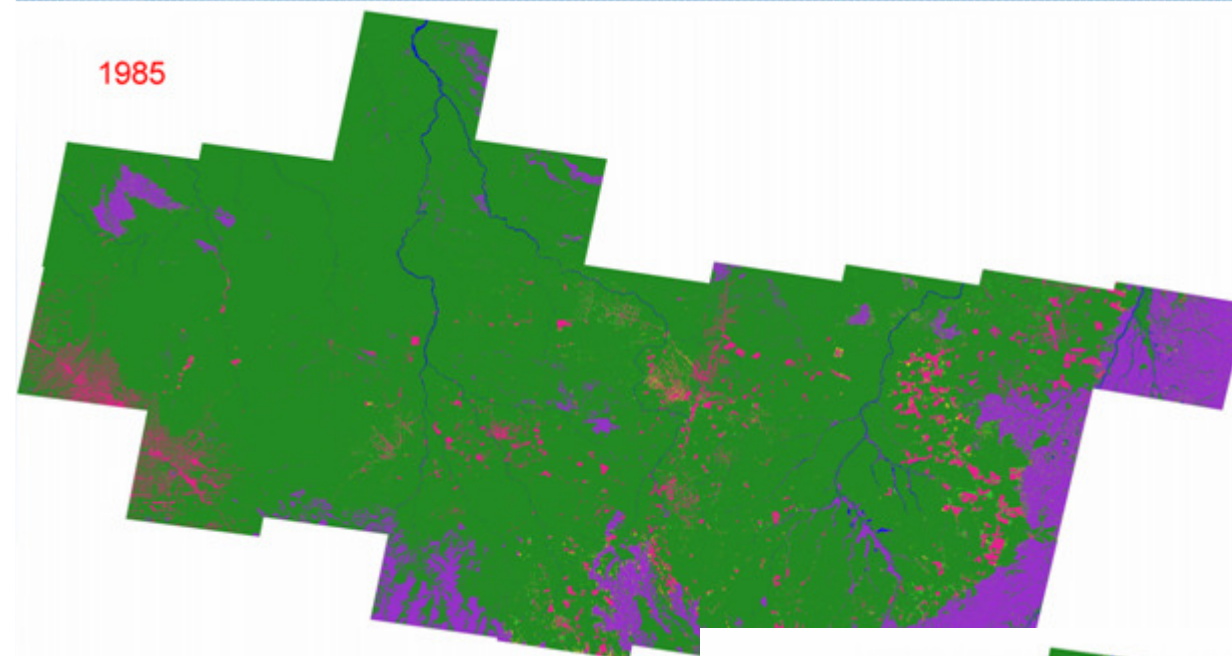


Total : 650 Landsat images processed
(26 scenes x 25 years)

production scheme

Mato Grosso baselines – forest change area over last 25 years

1985



Joint project between Spot Image and Imazon, results presented during COP-15

2007

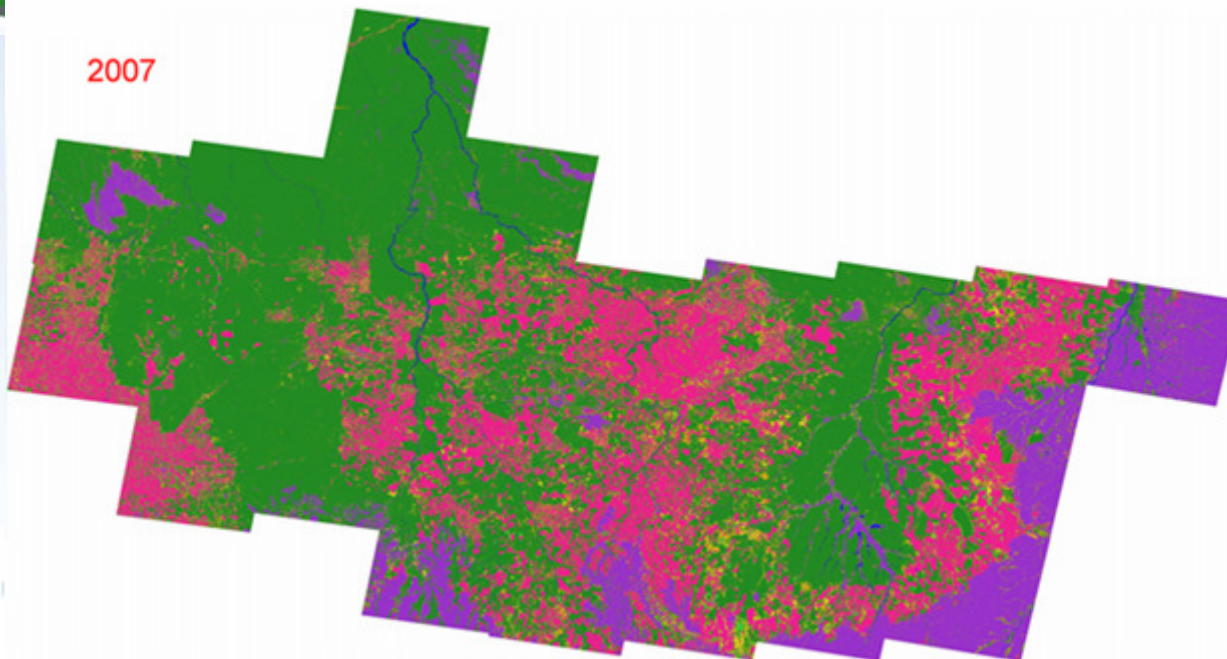
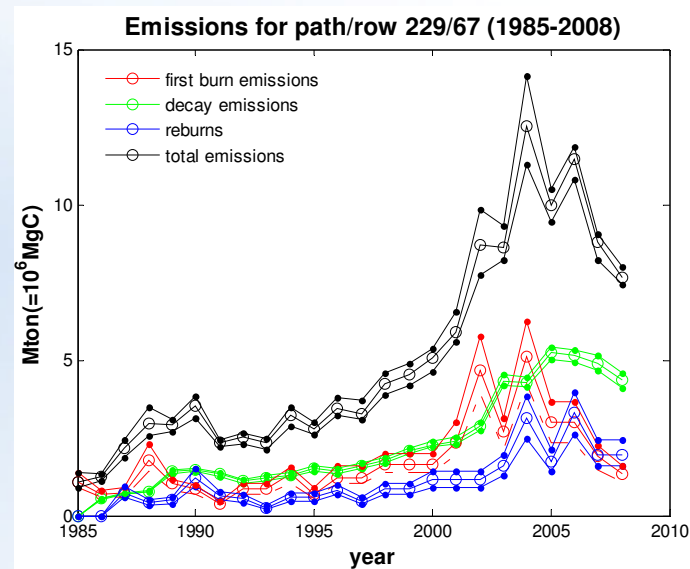
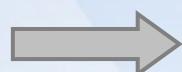
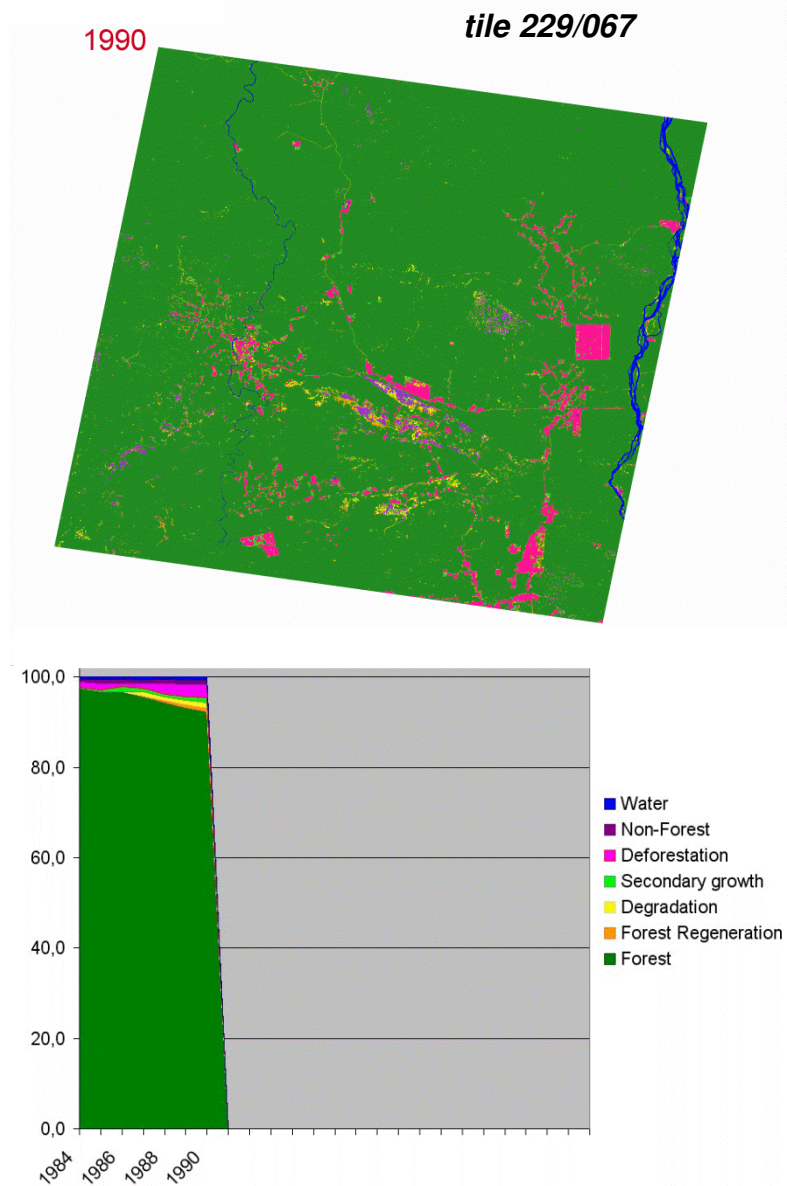


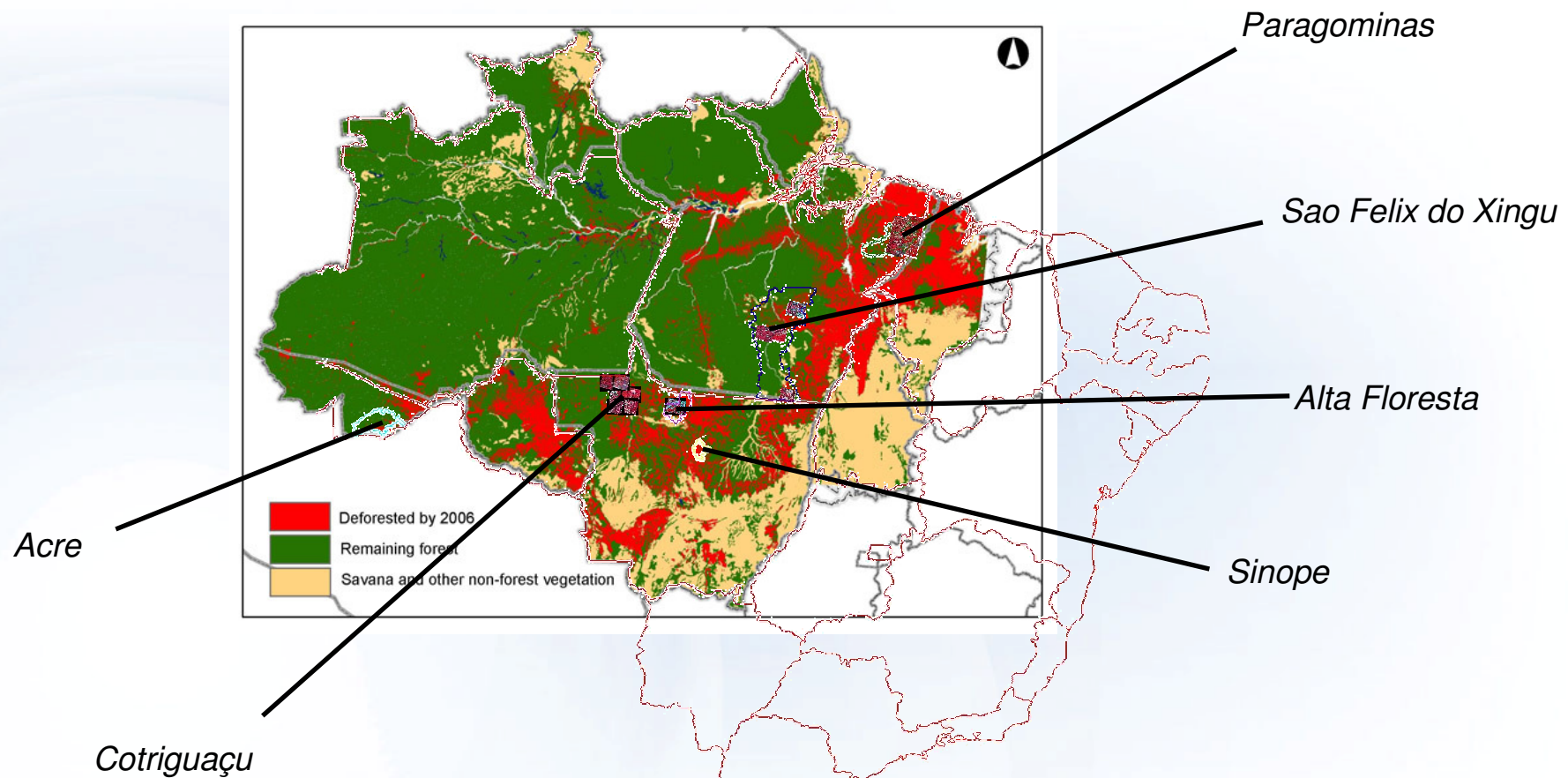
Illustration of project outputs - *time series of Forest LC maps for 1 tile*



derived profile of carbon emissions over this period

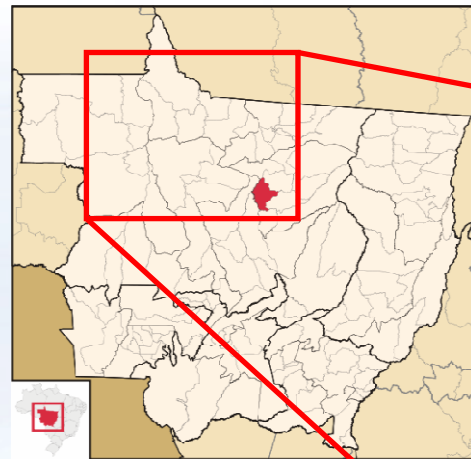
Task 2 - Monitoring and Verification

- 6 sites selected to develop /illustrate operational concepts for *Monitoring and Verification*



MRV: Sinope region case

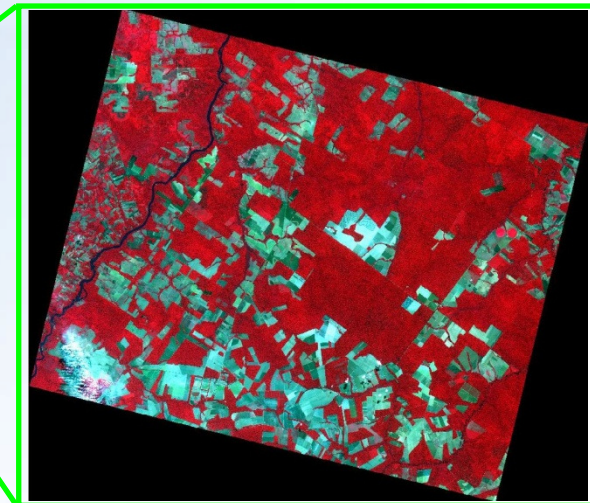
■ Sinope is a region within the arc of deforestation in Mato Grosso state



Sinope



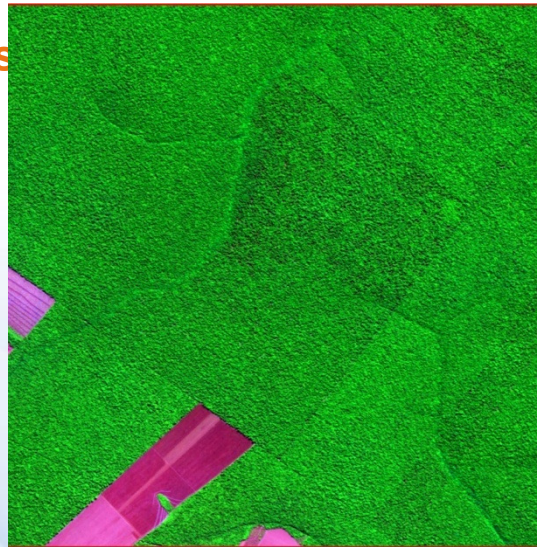
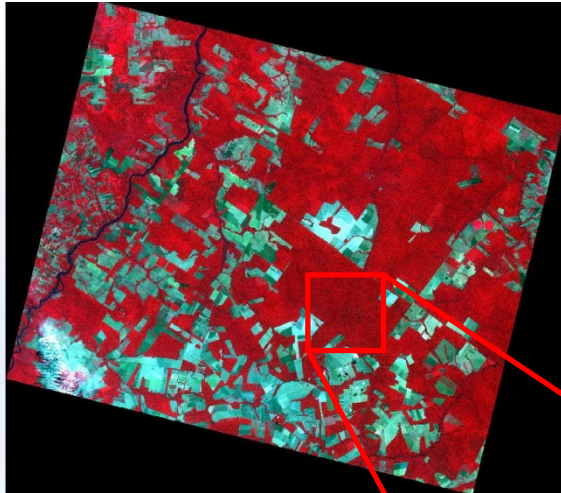
SPOT 5 imagery selected on the Sinope region



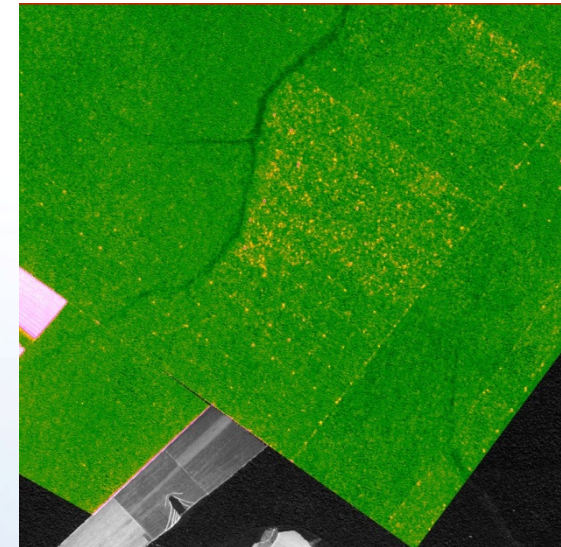
SPOT 5 image used for MRV

Illegal activities detected on a ARL

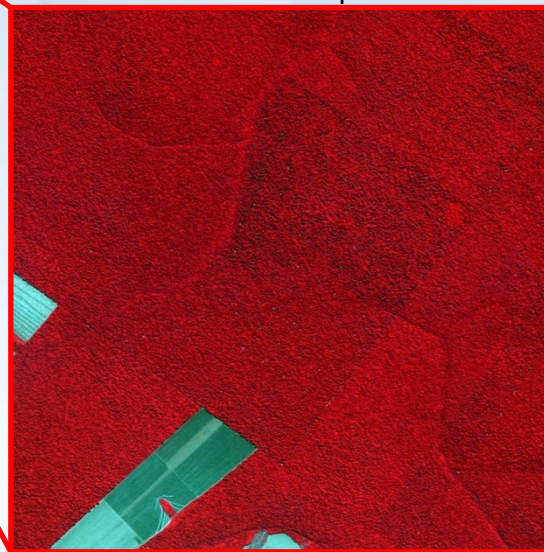
Focus on Protected Forests



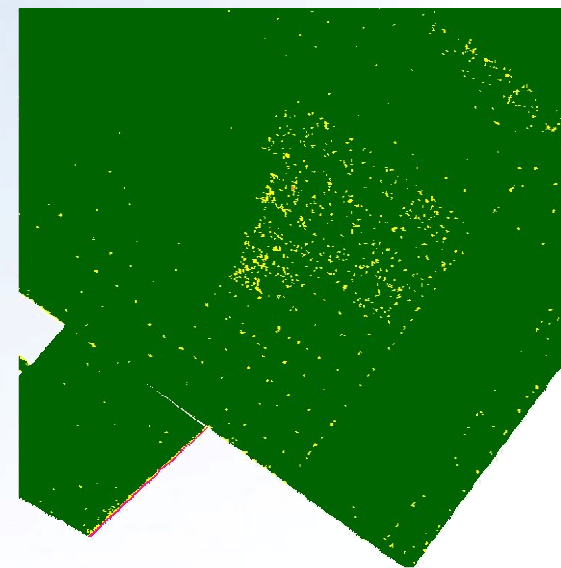
SWIR composite



NDFI

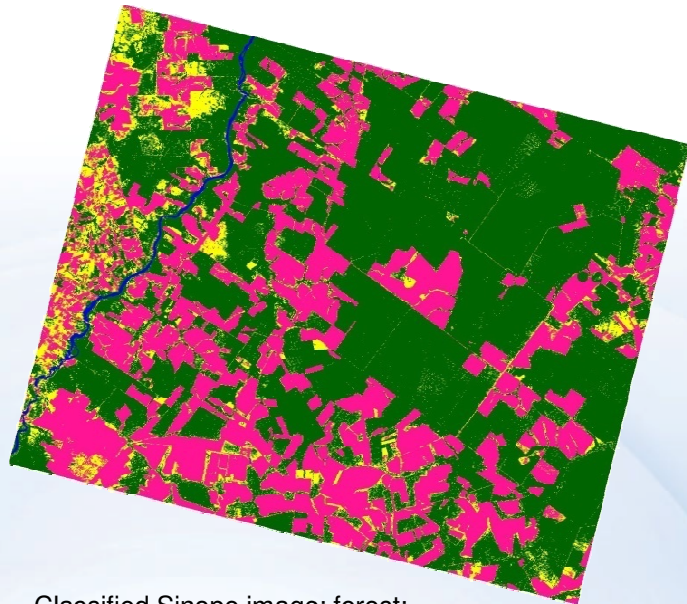


NIR composite

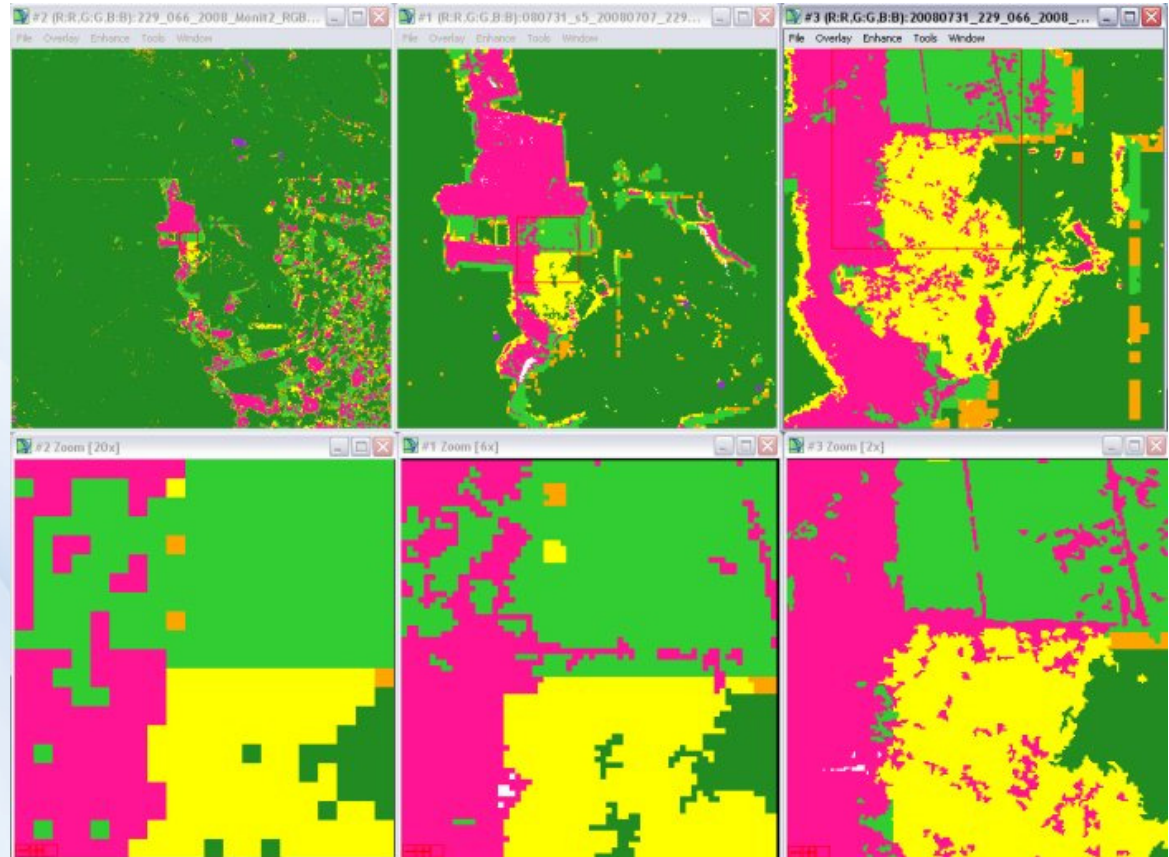


Binary classification

Improvement of Change detection with Resolution



Classified Sinope image: forest;
degraded; deforested



**Landsat
processed and
classified at
100m
(2007 image)**

**Landsat
processed and
classified at
30m
(2008 image)**

**SPOT5
processed and
classified at
10m
(2009 image)**

MRV process - Deforestation & Degradation hot-spot monitoring

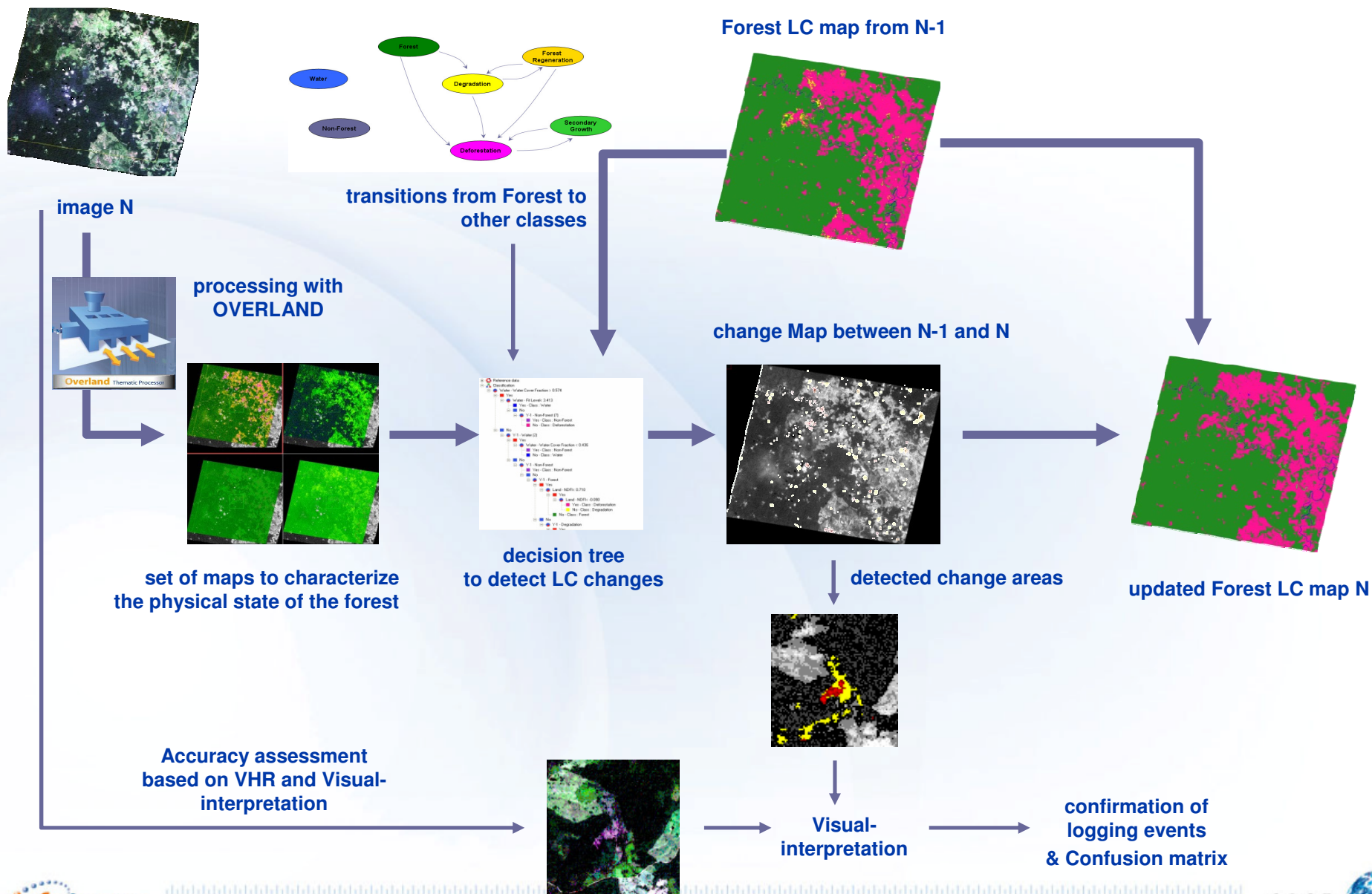
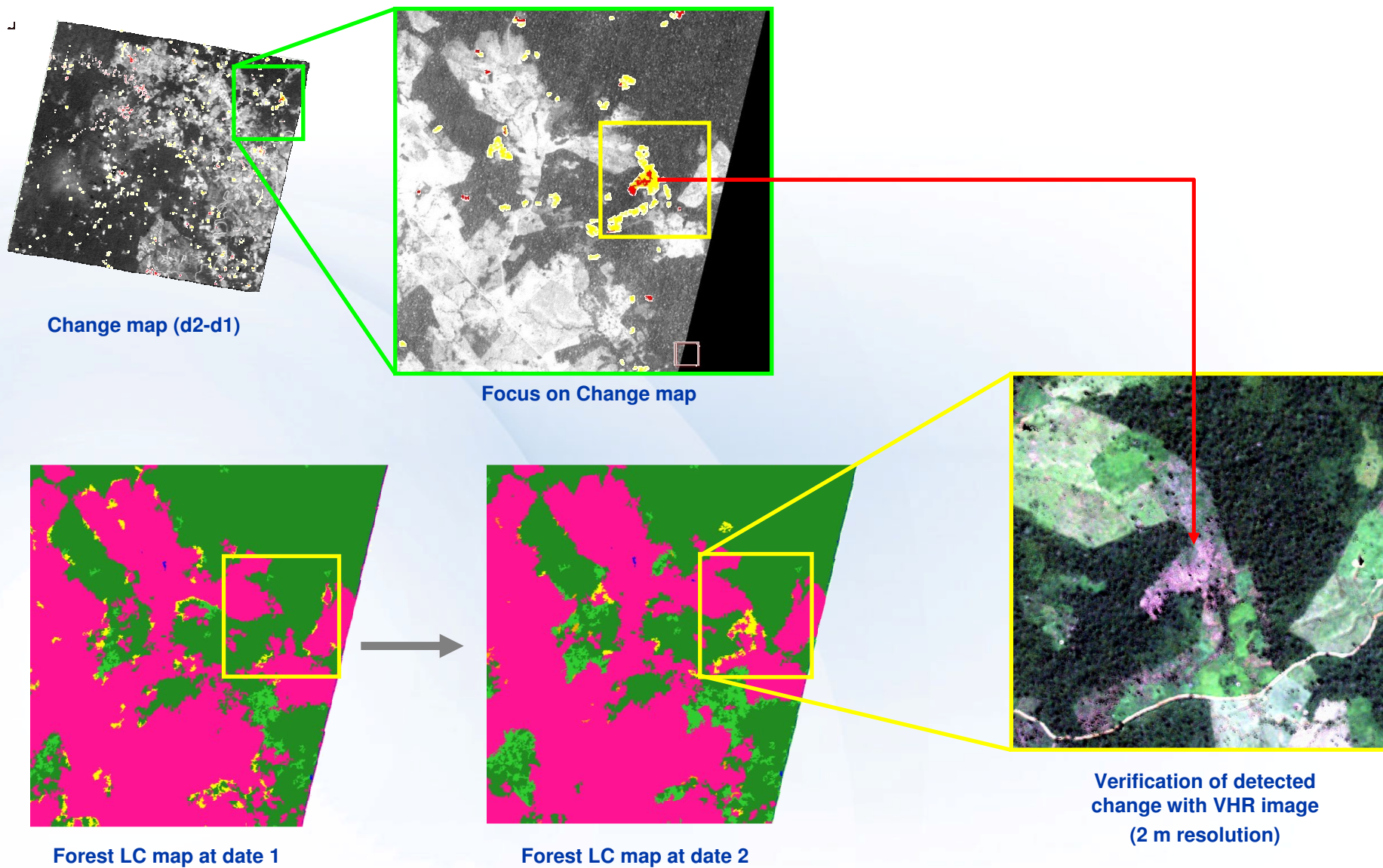


Illustration of MRV control with VHR imagery (2m color) on Xapuri site



CO²

- 1. Forest Offer: the AMAZONIA Baseline project**
- 2. the French Aid REDD program on Congo basin**
- 3. SPOTIMAGE major contributions to the REDD**

- **Objective of the Agreement is to allow developing countries from Congo Basin to enter into REDD+ with the provision of :**
 - Access to selected SPOT ARCHIVES
 - Establishment of BASELINES on Deforestation & Degradation
 - Collection of NEW SPOT COVERAGE
 - Ortho-processing based on Reference 3D (geolocalisation @ 5m RMS)
 - Implementation of specific REDD licensing allowing to share data within REDD community
 - Data sets accessible via Web Platform

- **AFD & EADS ASTRIUM funding the access to Data**
 - AFD Financing Archive, New collections & Baselines
 - EADS ASTRIUM providing access to ARCHIVE at non commercial cost to AFD

- **AFD & EADS ASTRIUM contract under preparation**
 - Agreement within the coming weeks
 - Official kick off scheduled in June-July 2010

Ex: 2,5m resolution data + 5/10/20m complements since 2006

PAYS	SURFACE (km ²)	SURFACE COUVERTE PAR THX	%	SURFACE RESTANTE	Surface compl. couverte	Surface restante apres complément SPOT	Surface Totale couverte	%	NB D'IMAGES 2,5m	NB D'IMAGES compl.
GABON	265 900	21 600	8%	244 300	15 300	229000	36 900	14%	8	8
RDC	2 338 000	1 565 000	67%	773 000	337 800	435200	1 902 800	81%	618	139
RCA	622 900	603 000	97%	19 900	4 340	15560	607 340	98%	308	4
CONGO	343 200	75 040	22%	268 160	46 860	221 300	121 900	36%	30	27
CAMEROUN	468 300	230 900	49%	237 400	79 300	158100	310 200	66%	100	39
BURUNDI	27 070	22 750	84%	4 320	4 320	0	27 070	100%	18	3
RWANDA	25 320	16 150	64%	9 170	7 938	1 232	24 088	95%	10	10
sud TCHAD	349 700	349 700	100%	0	0	0	349 700	100%	226	0
GUINEE EQ.	28 000	0	0%	28000	0	28000	0	0%	0	
SAO TOME	1 008	0	0%	1008	0	1008	0	0%	0	
TOTAL	4 469 398	2 884 140	65%	1 585 258	495 858	1 089 400	3 379 998	76%	1318	230

CAR:

Covered at 97%

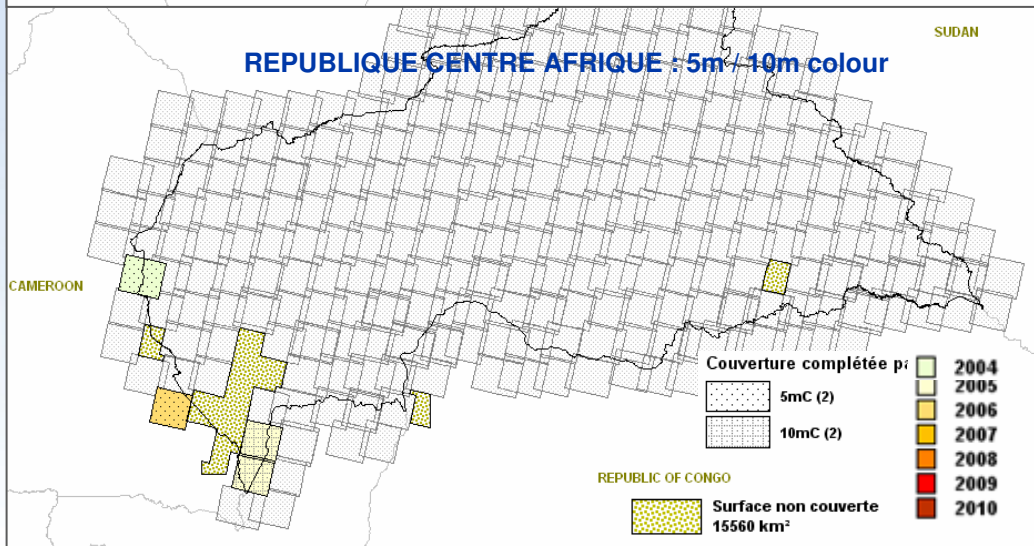
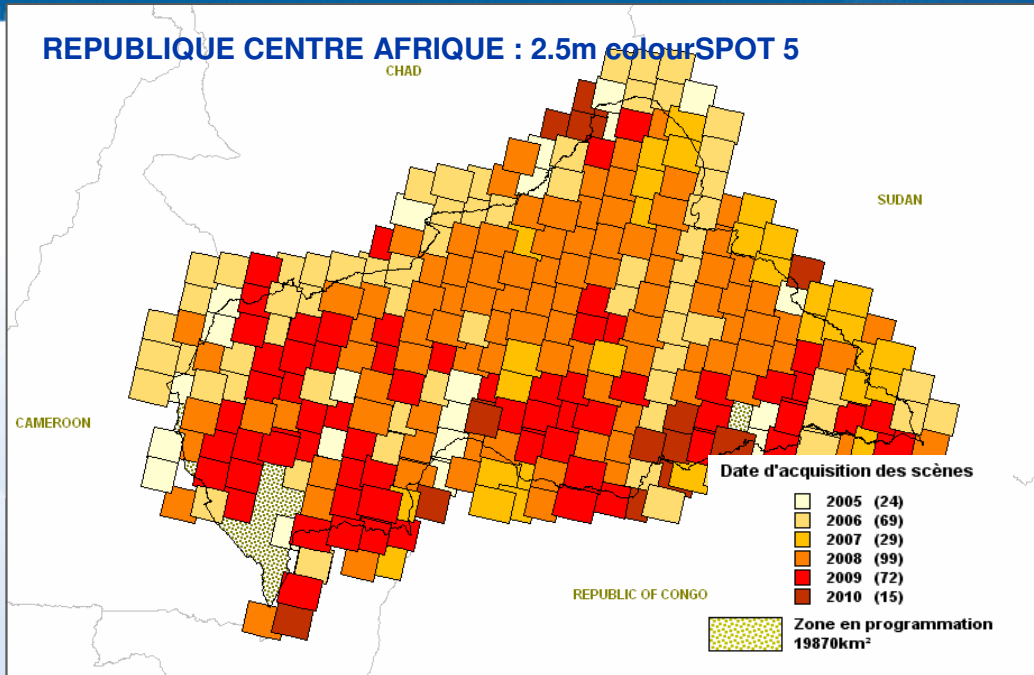
- 308 images selected
- Data since 2005
- 70% acquired since 2007

New Collection

- Missing parts under programming

Covered at 98%

- 2 images @ 5m
- 2 images @ 10 m



RDC: 2,5m colour

RDC:

Covered at 67%

- 618 images selected
- Data since 2002
- 90% acquired since 2007

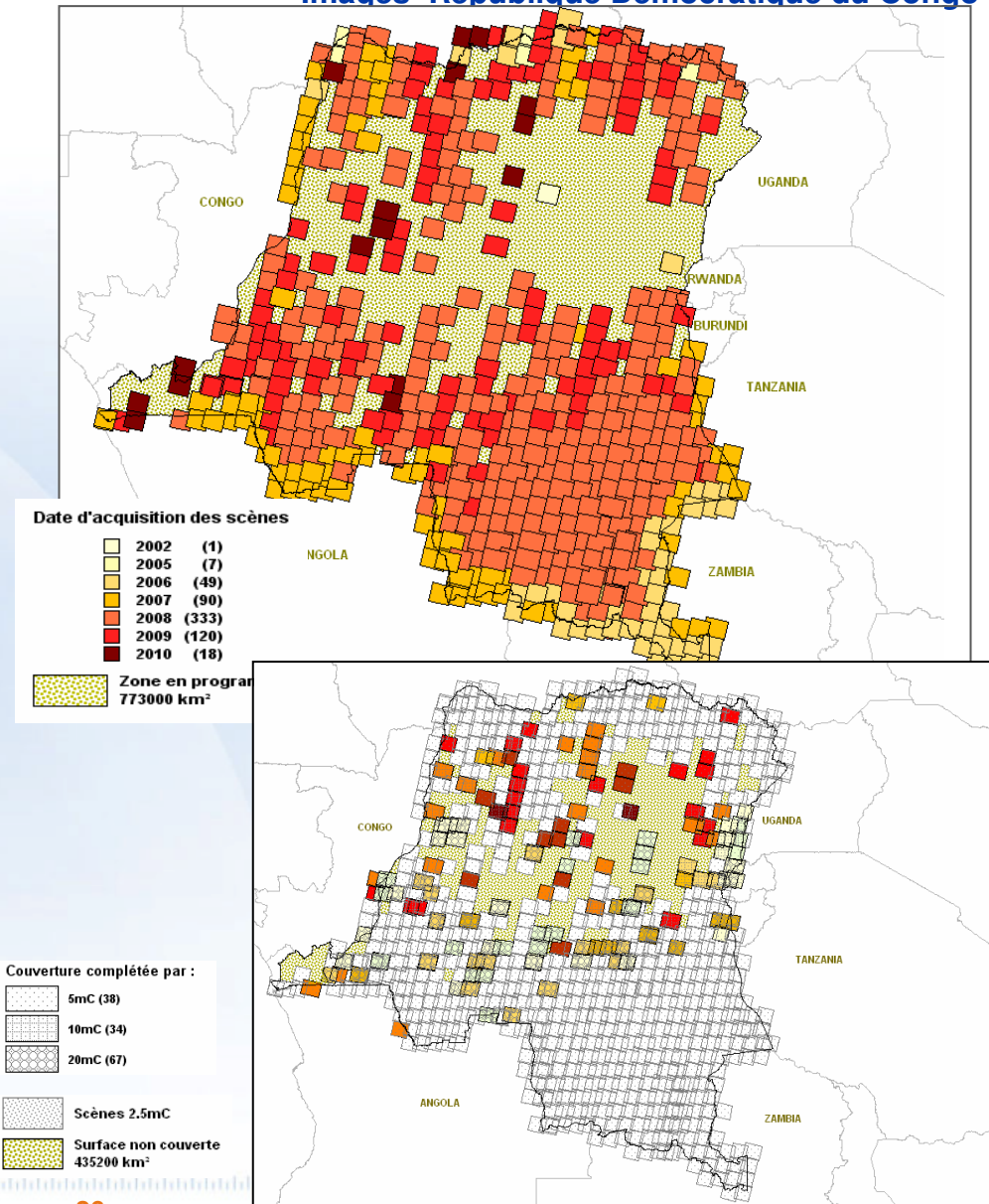
New Collection

- Missing parts under programming
- Climate constraint moderate, except North East

Covered at 81%

- 139 images selected
- 38 images @ 5 m
- 34 images @ 10 m
- 67 images @ 20 m

Images République Démocratique du Congo



Cameroun: 2,5m Colour

Cameroun

■ Covered at 49% ; huge contrast from North to South

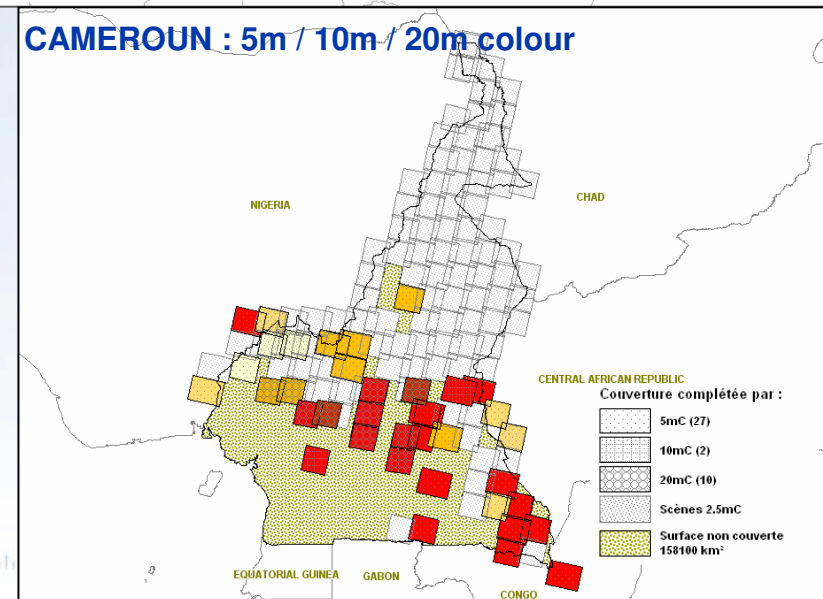
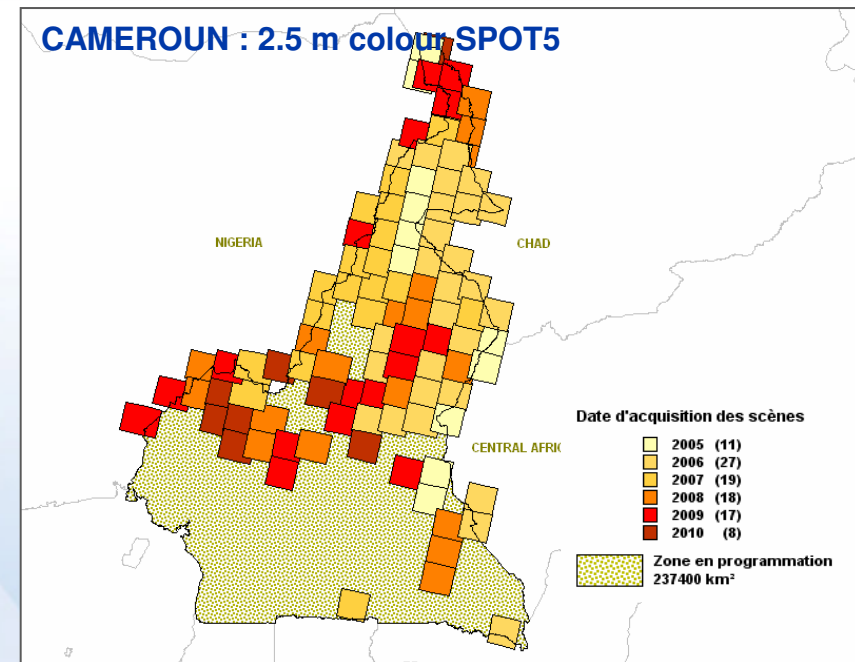
- 100 images selected
- Data since 2005
- 62% acquired since 2007

■ New Collection

- South needs intensive collection

■ Covered at 66% with:

- 27 images @ 5 m
- 2 images @ 10 m
- 10 images @ 20 m



Congo: 2,5m colour

Congo

Covered at 22%

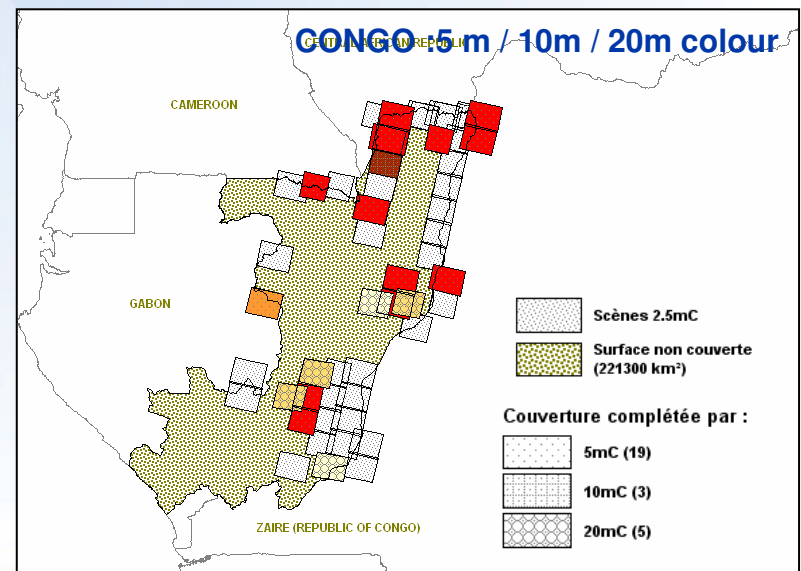
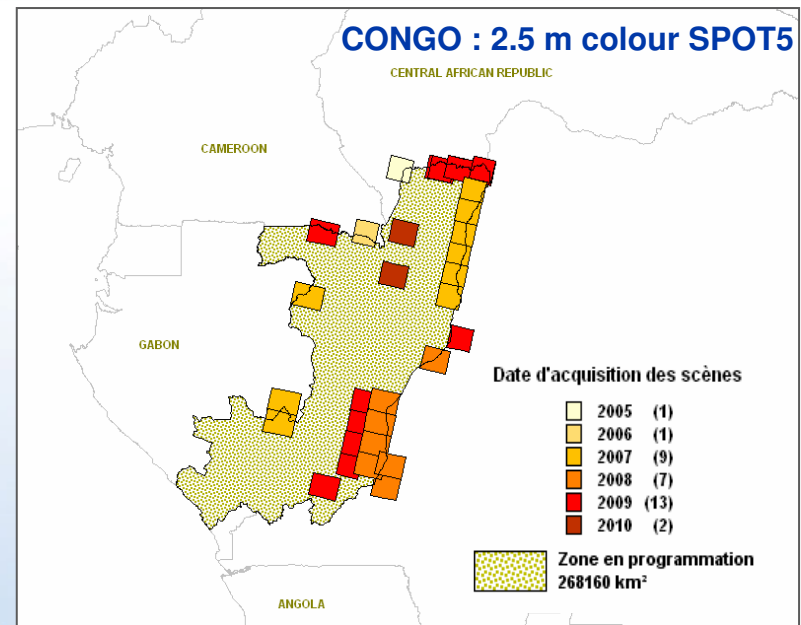
- Lack of dat
- 33 images since 2005

New collection :

- Extremely difficult zone
- Need intensive collection

Covered at 36%

- 19 images @ 5 m
- 3 images @ 10 m
- 5 images @ 20 m



■ Chad (south):

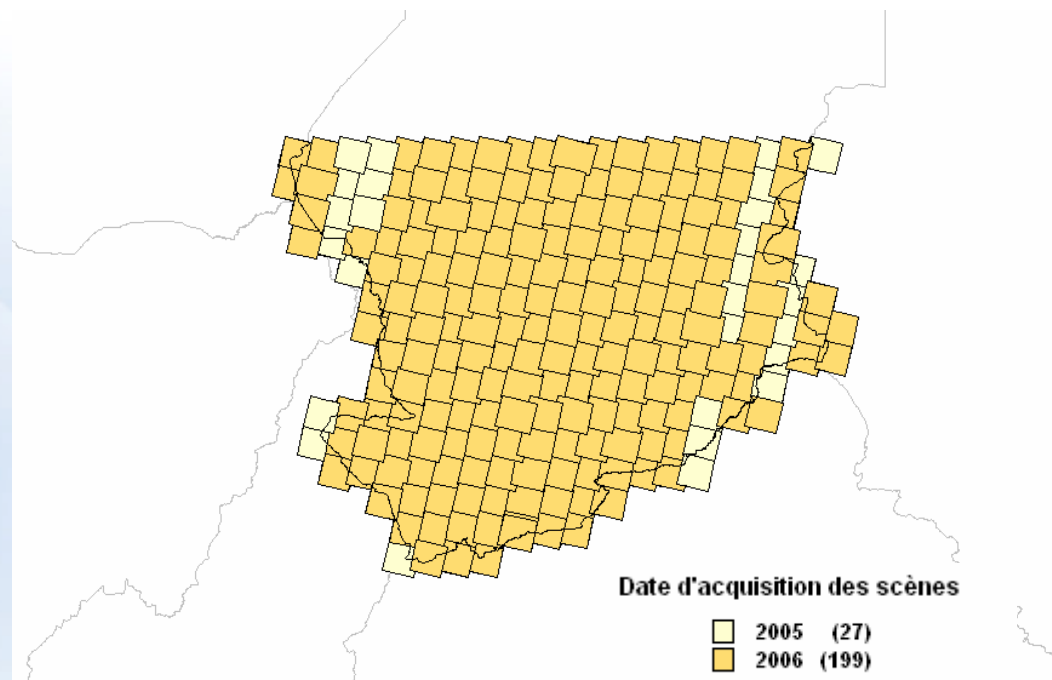
■ Covered at 100%

- 226 images selected
- Mainly collected in 2006, 12% collected in 2005

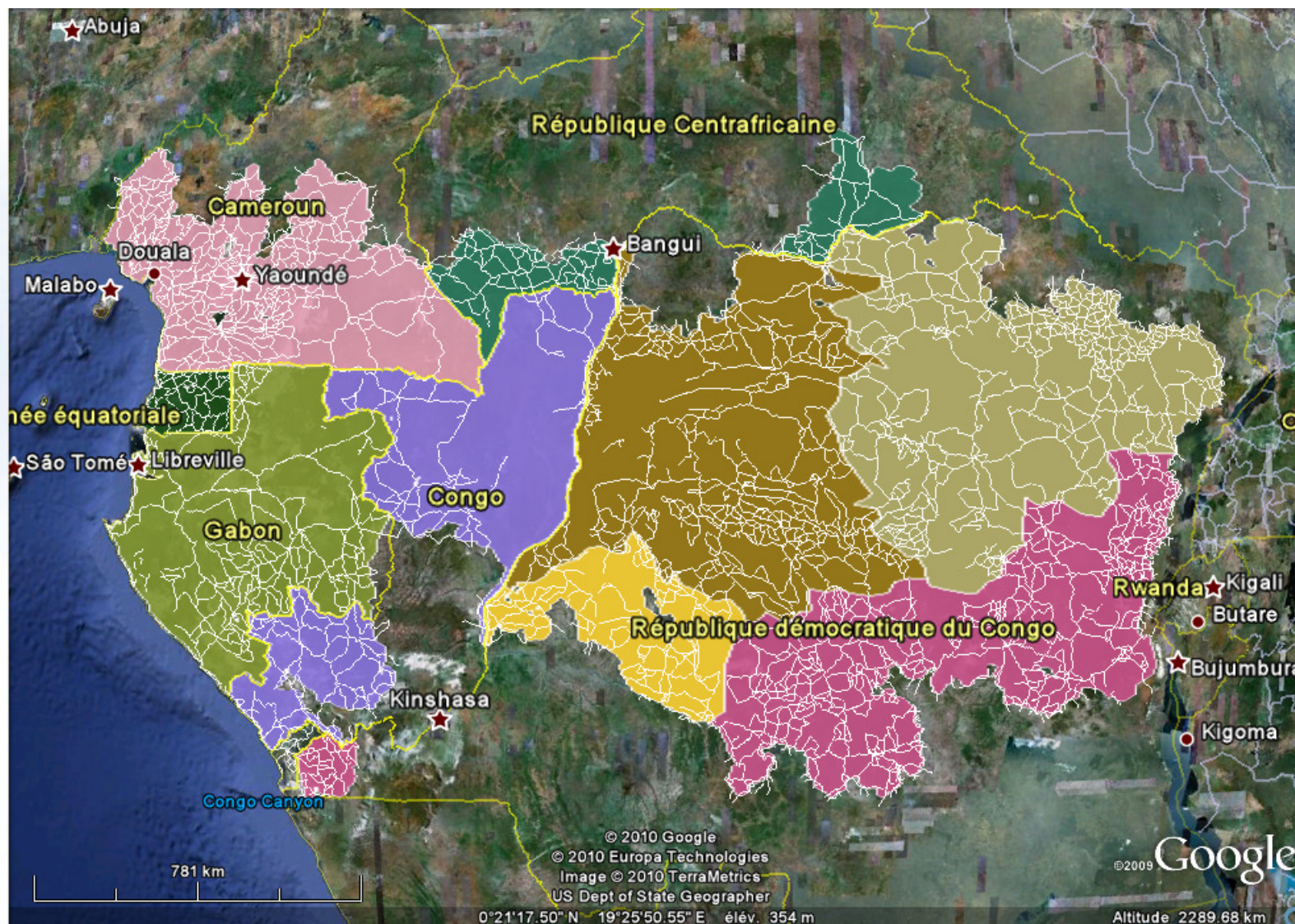
■ New Collection

- Easy to implement

Chad (South): 2.5 m colour SPOT5



Humid Forest ROI: GLC2000

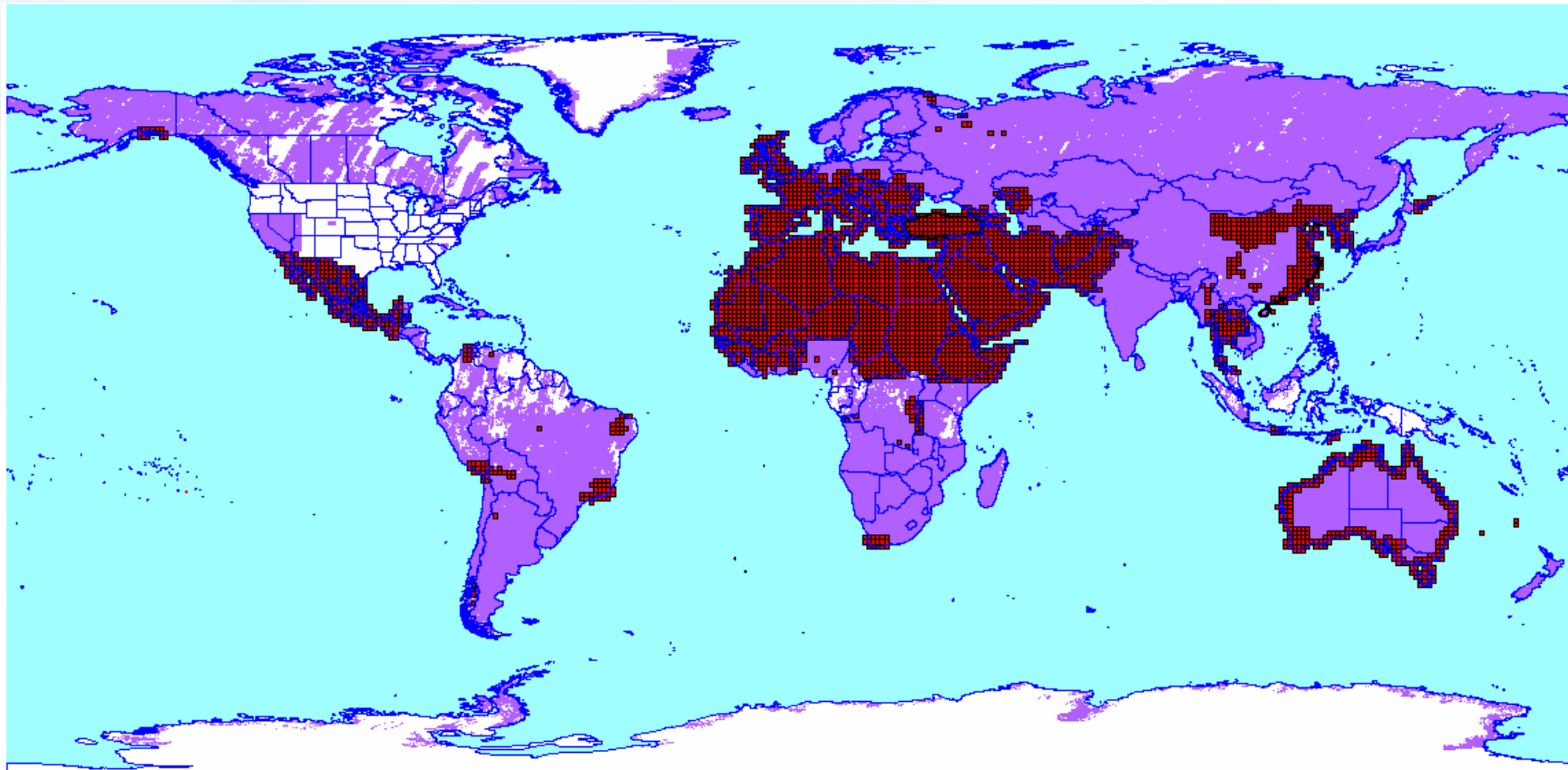


OrthoProcessing with Reference3D - *DTED Level 2 Coverage*

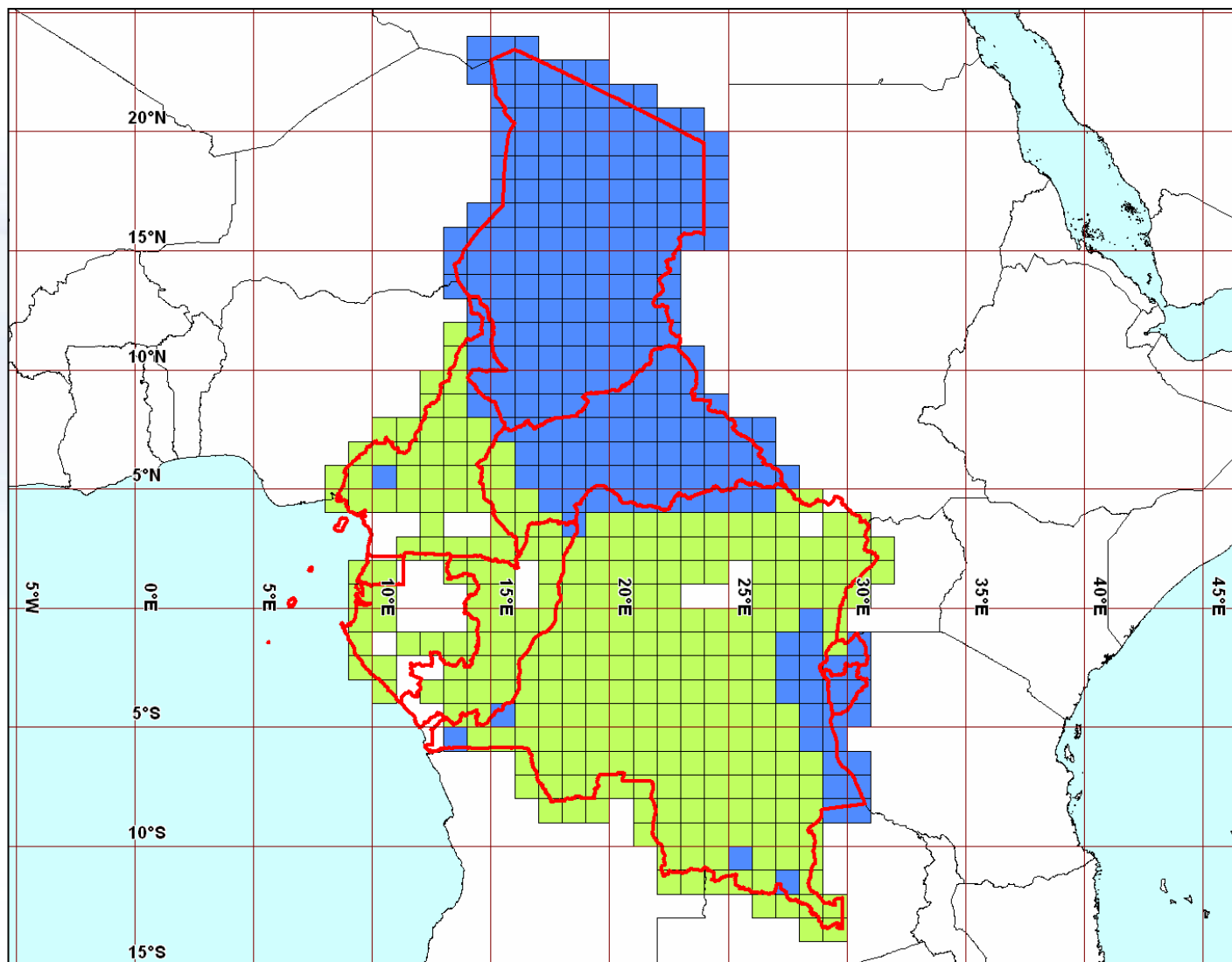
- ▶ 45 million km² off-the-shelf
- ▶ 118 million km² cloud-free stereo pairs available to produce 3D products

Certified by various government organizations, including the NGA

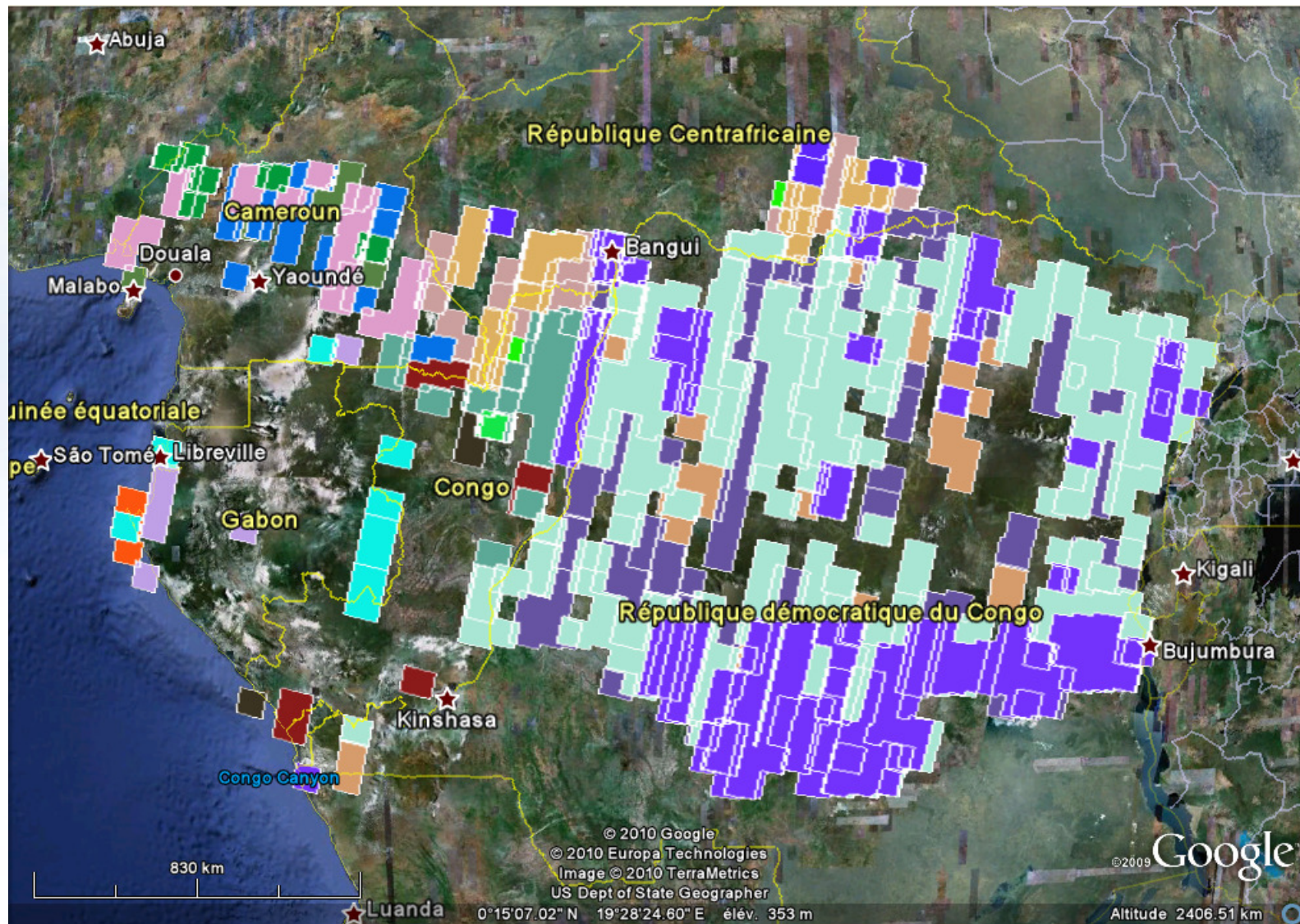
15m RMS on X/Y/Z with 90% confidence



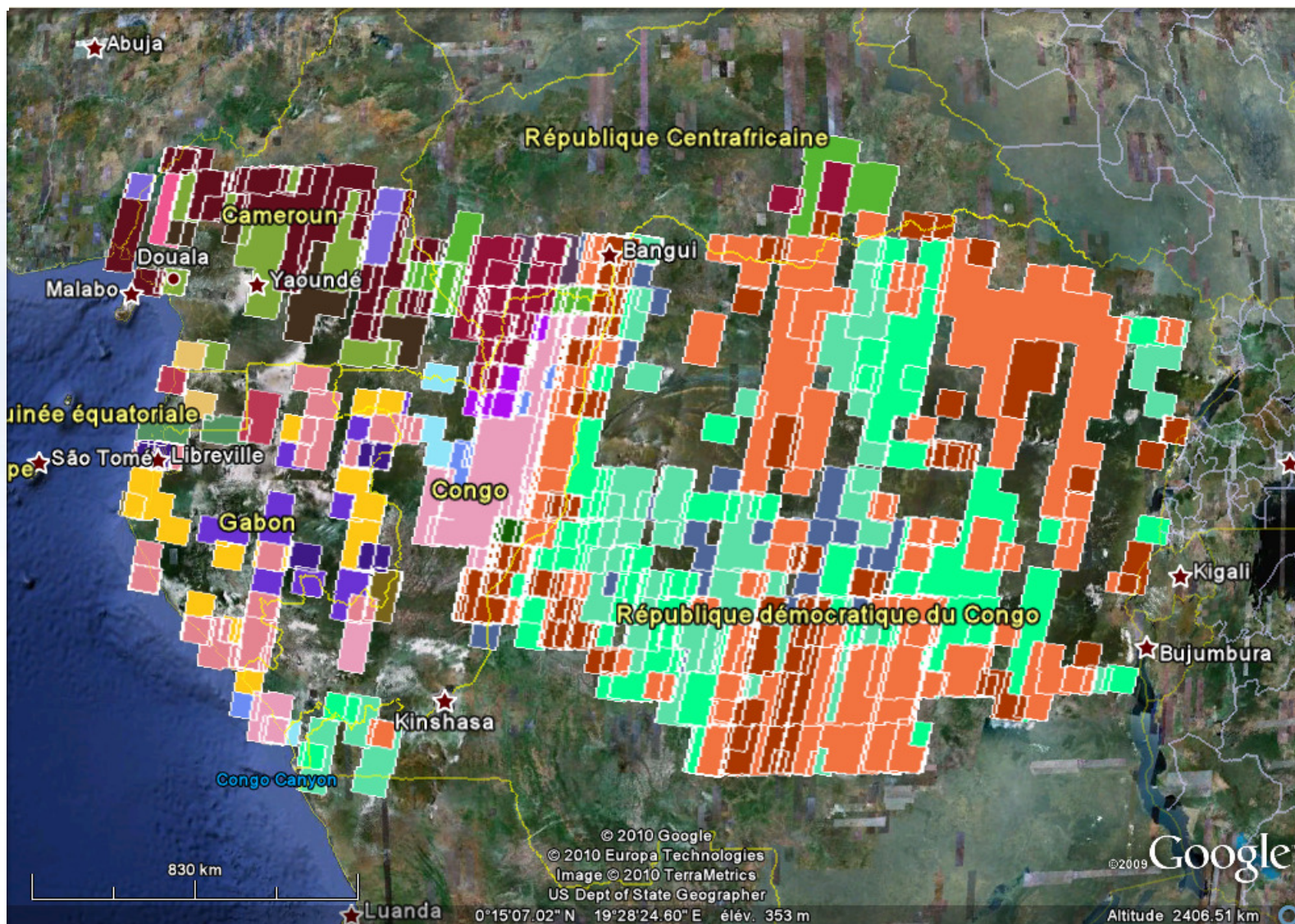
Reference 3D Alpha availability over the ROI (green = REF3D alpha)



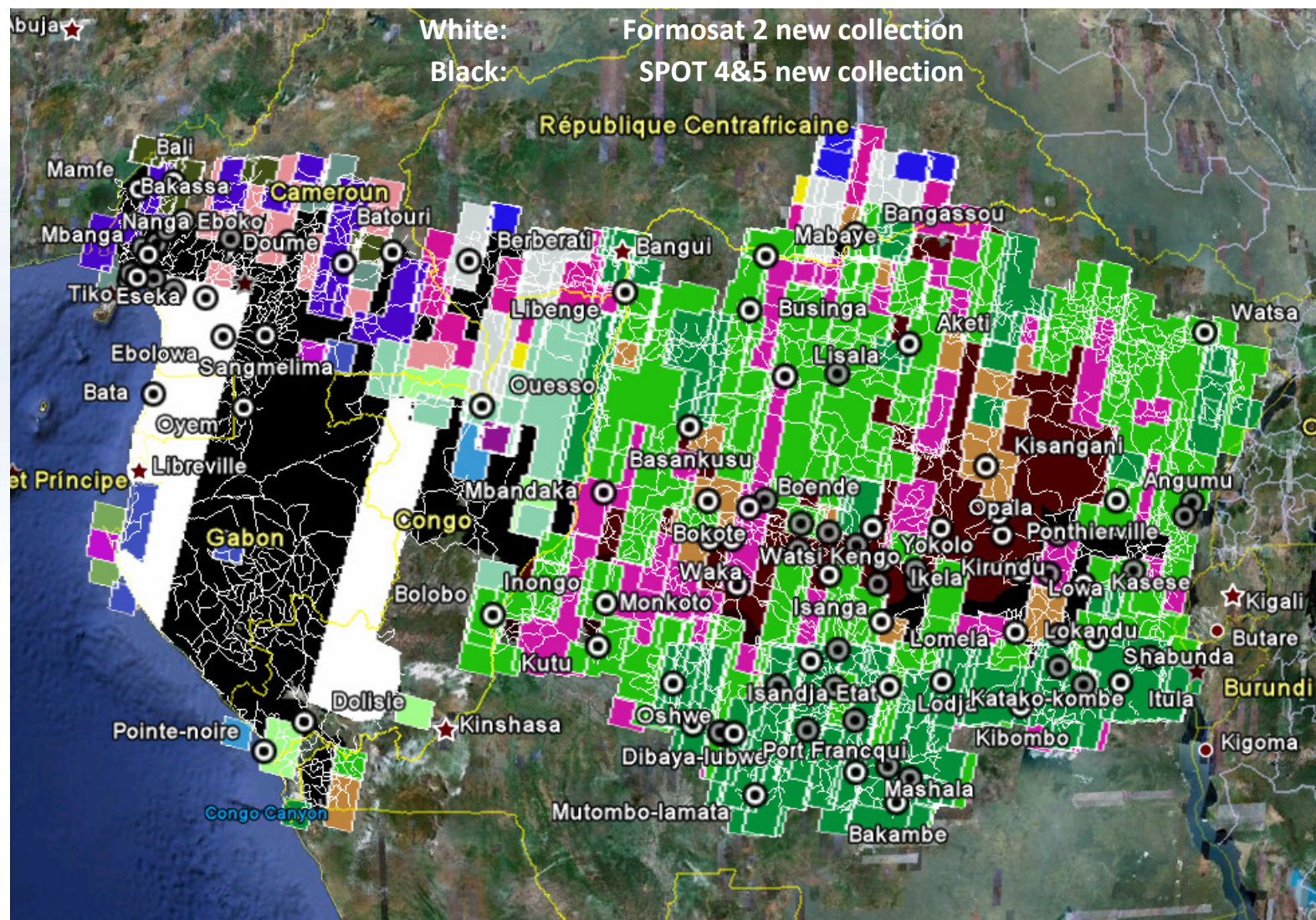
Multispectral data 10m & 20m // 2008 - 2009



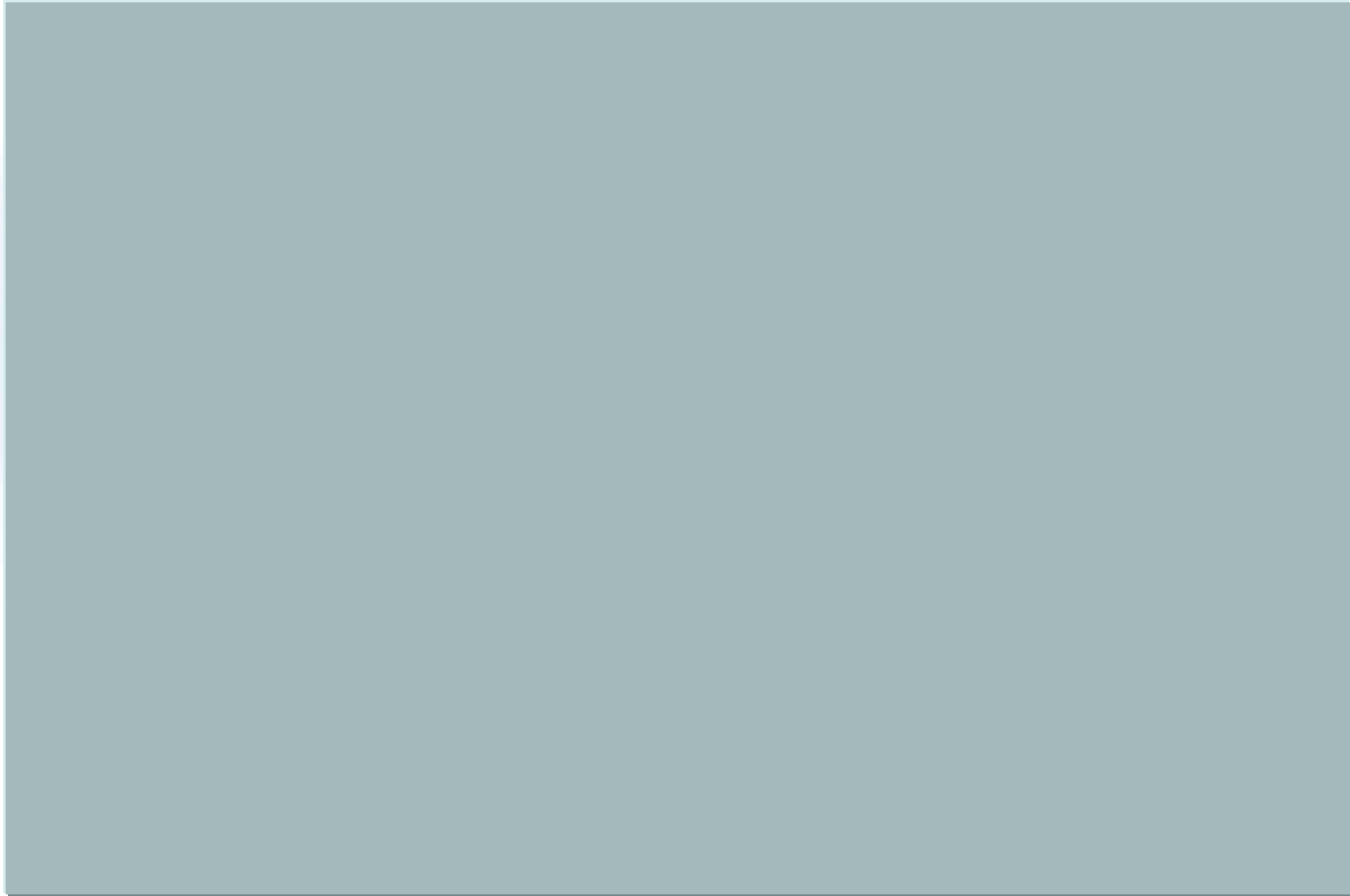
Multispectral data 10m & 20m // 1998 - 2002



Zones under programming to complement 2008-2010 coverage

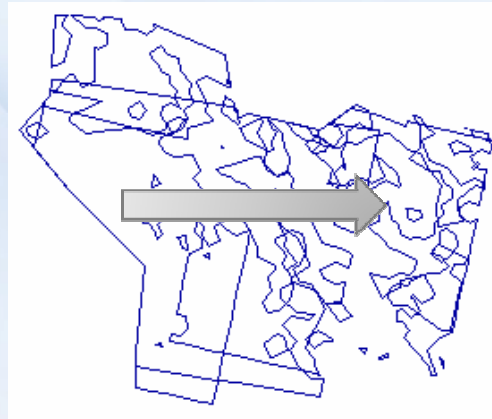
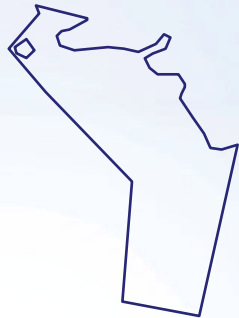


Probability of acquisition calculated on the new collected zones



Automated Cloud masking & image selection over cloudy zones

Cloud free zones extracted from cloud masks

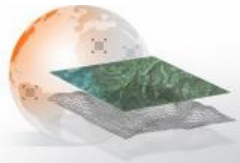


Cloud masks fusion



Resulting « cloud free » zones

Patchwork : image selection



Patchwork Online **Beta 0.1a**



Bonjour **Geraldine**

[Deconnexion](#)

Map

Retrait de couverture

Numéro de ticket:

Context

Critères de couverture

Capteur

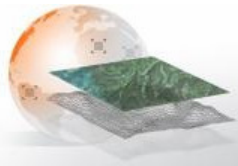
- SPOT
 - 2.5 m C
 - 2.5 m NB
 - 5 m C
 - 5 m NB
 - 10 m C
 - 10 m NB
 - 20 m C

extraction

couverture

batch interactif

Patchwork : Results & outputs



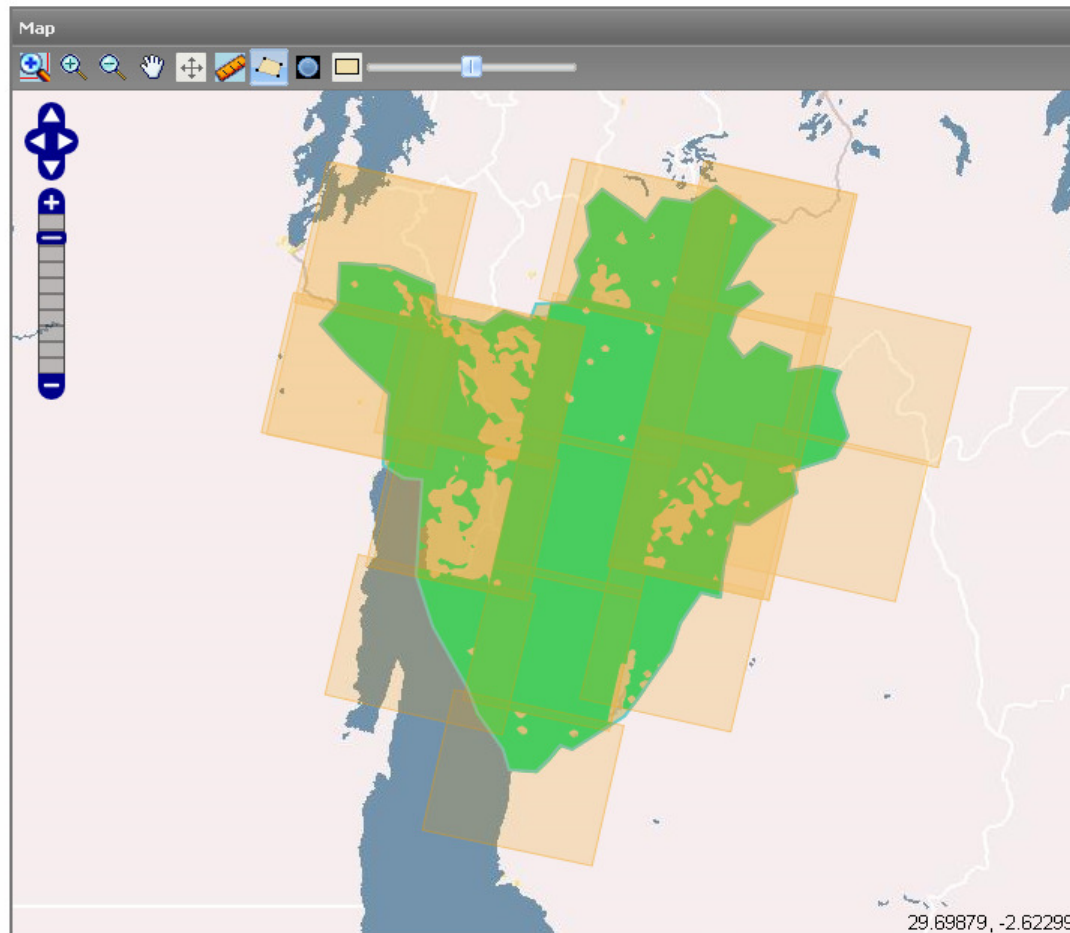
Patchwork Online **Beta 0.1a**



Bonjour **Geraldine**

Id Contexte 201002031132370796082

[Deconnexion](#)



Retrait de couverture

Numéro de ticket:

Contexte

Calcul de couverture **Couverture proposée**

Caractéristiques de la couverture

Etat de la demande: UnCompleteCoverage

Surface de la zig: 28230.84 **Surface de la couverture: 24373.2227**

Taux de satisfaction: 0.863355 Nb scènes retenues: 26

N°	Statut	Produit	Spot	KWJ	Date	Nuage
1	Imposée	2.5 m C	Spot5	125/356	2009-06-22	A
2	Imposée	2.5 m C	Spot5	125/358	2007-09-26	A
3	Imposée	2.5 m C	Spot5	125/357	2007-09-26	A
4	Imposée	2.5 m C	Spot5	125/355	2009-08-08	B
5	Imposée	2.5 m C	Spot5	126/356	2009-01-11	B
6	Imposée	2.5 m C	Spot5	124/356	2008-12-26	C
7	Imposée	2.5 m C	Spot5	126/358	2007-07-21	B
8	Imposée	2.5 m C	Spot5	125/358	2009-08-08	B

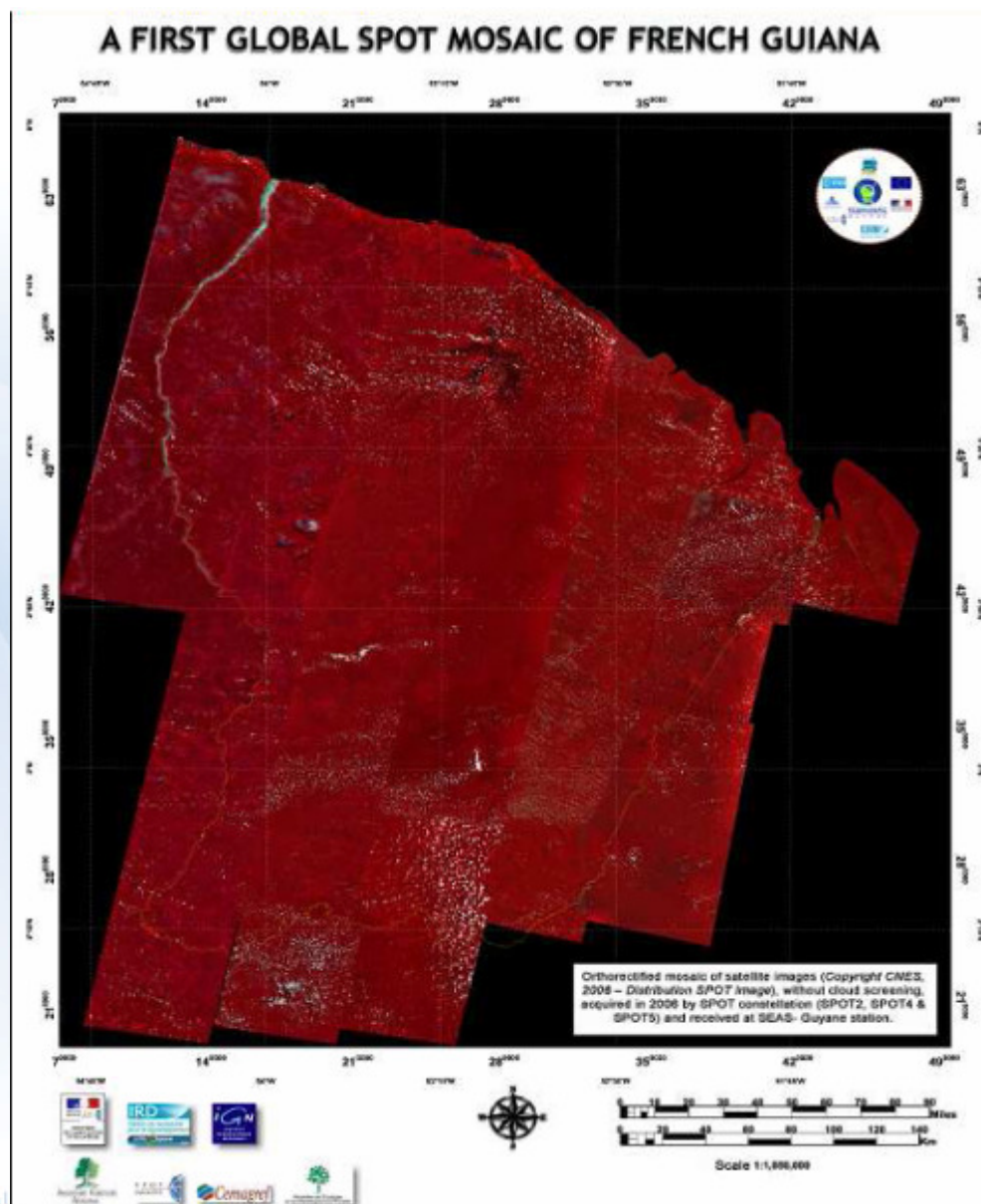
- extraction
- couverture
- batch interactif

Real application at SPOT Ground receiving station in French Guyana



→ The First Emission calculation provided by an annex1 country over Tropical Forest

- Approved by UNFCCC
- Based on Remote Sensing & Sampling
- Tier2 approach



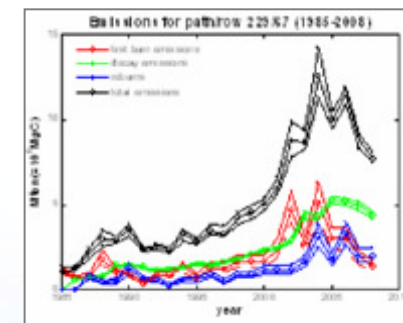
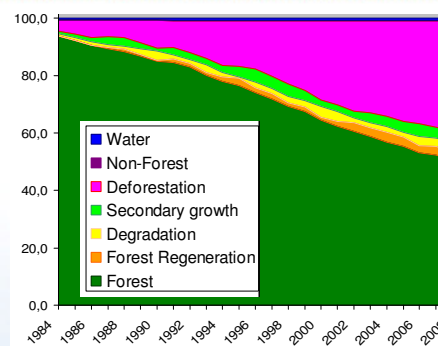
CO²

- 1. Forest Offer: the AMAZONIA Baseline project**
- 2. the French Aid REDD program on Congo basin**
- 3. SPOTIMAGE major contributions to the REDD**

REDD+ calls for a range of satellite based services

HISTORICAL « baselines »

- Forest area historical changes
- Benchmark forest map
- Carbon stock and historical CO2 emissions
 - issue: link with in-situ data (e.g. biomass) & models (CO2 emissions)



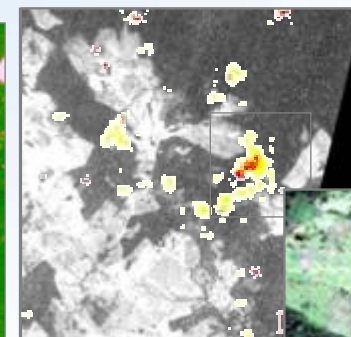
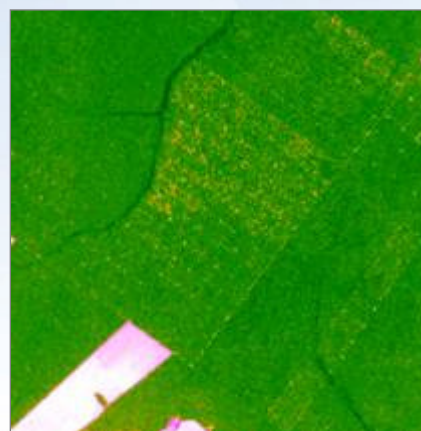
VHR MAPPING to manage land tenure, and build « environmental cadastre »

- SPOT MAPS at 2,5 m resolution
- Seamless false color mosaics



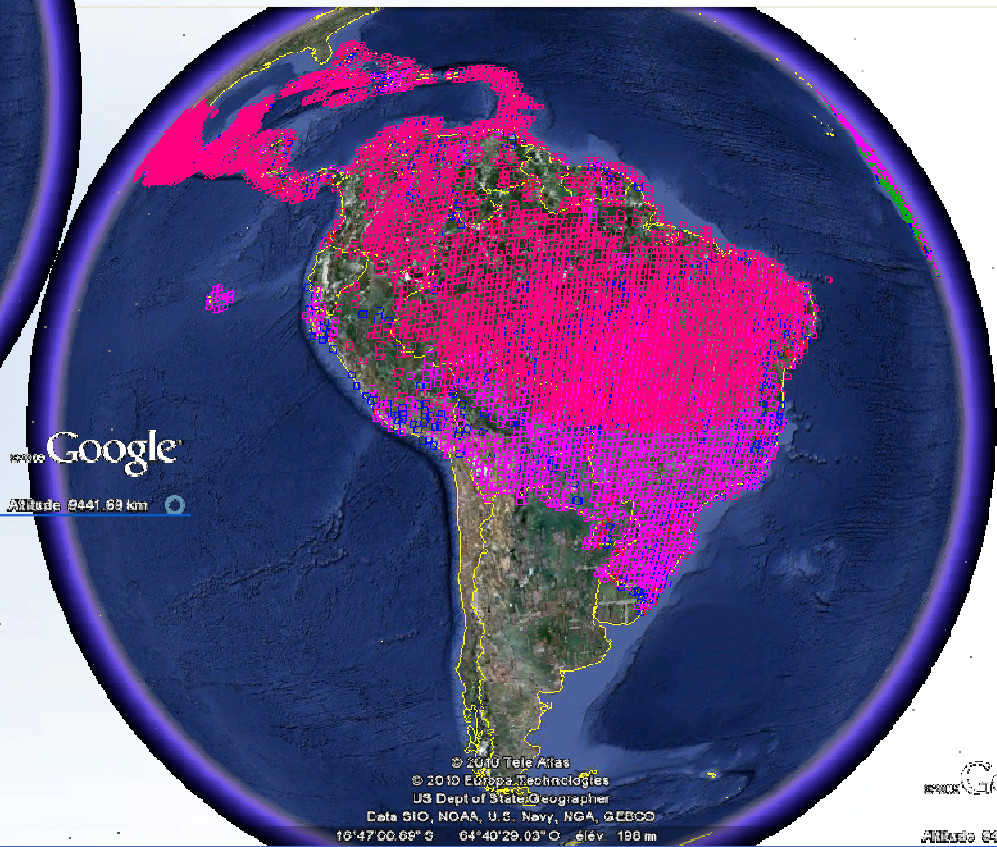
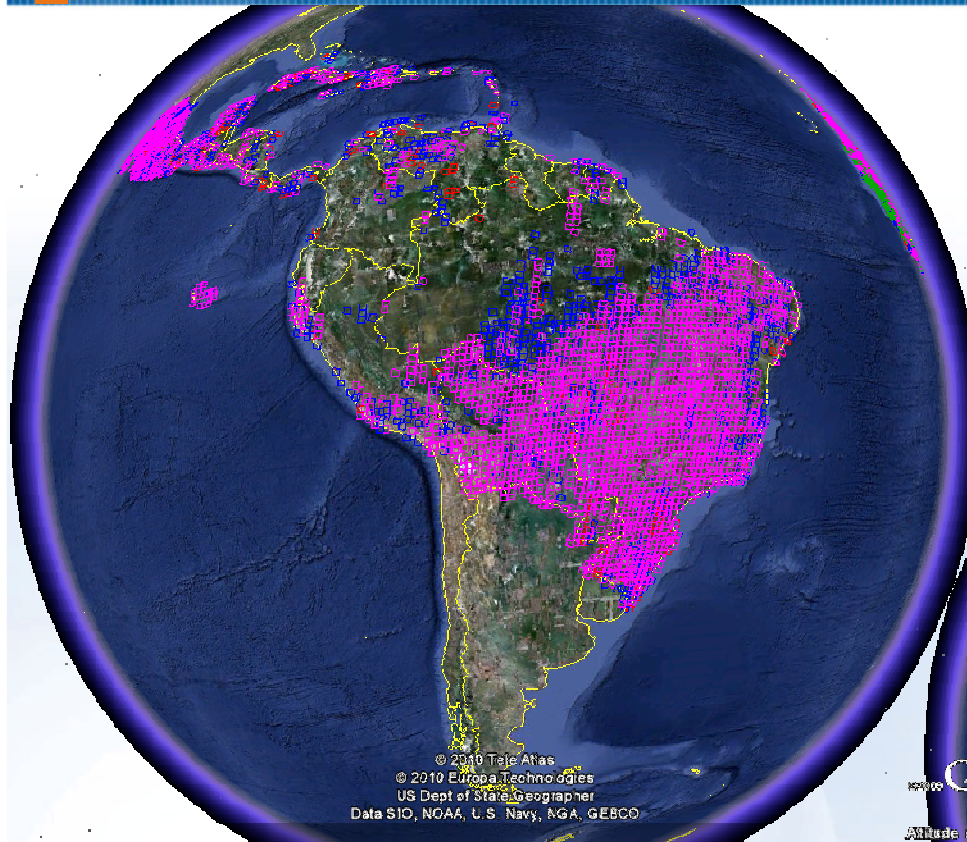
MRV MONITORING with various sensors :

- Monitoring, Reporting, Verification
- Quality assessment sampling



SPOT5 Data Base (2.5-m colour) covering forests of South America

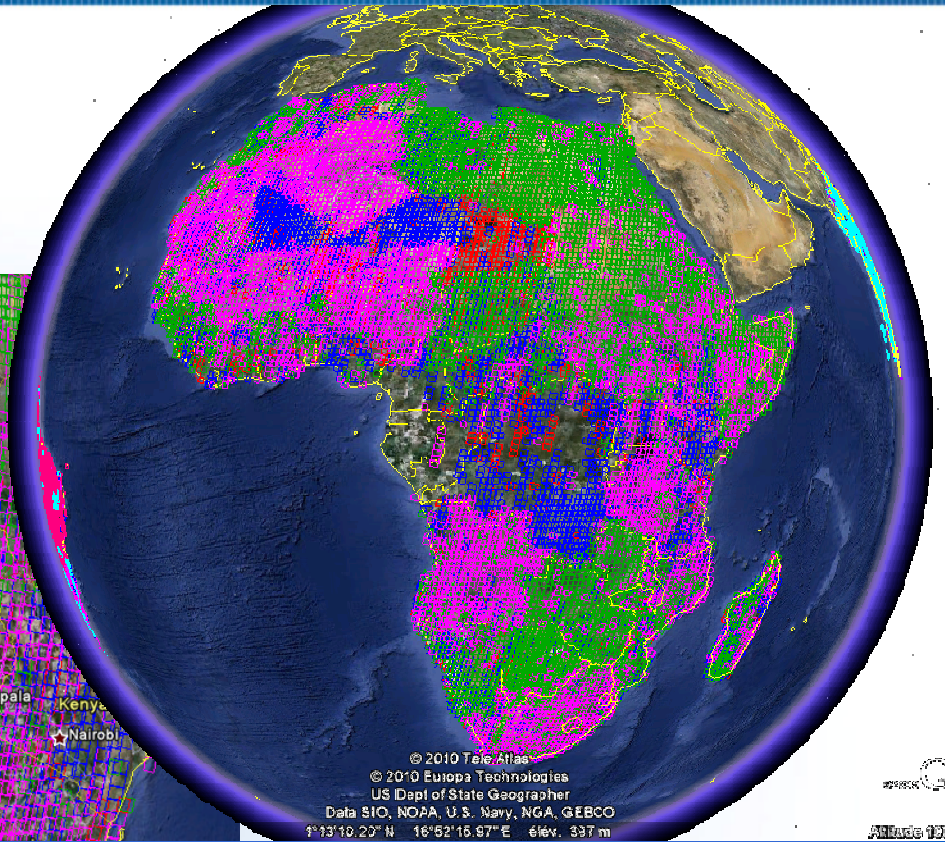
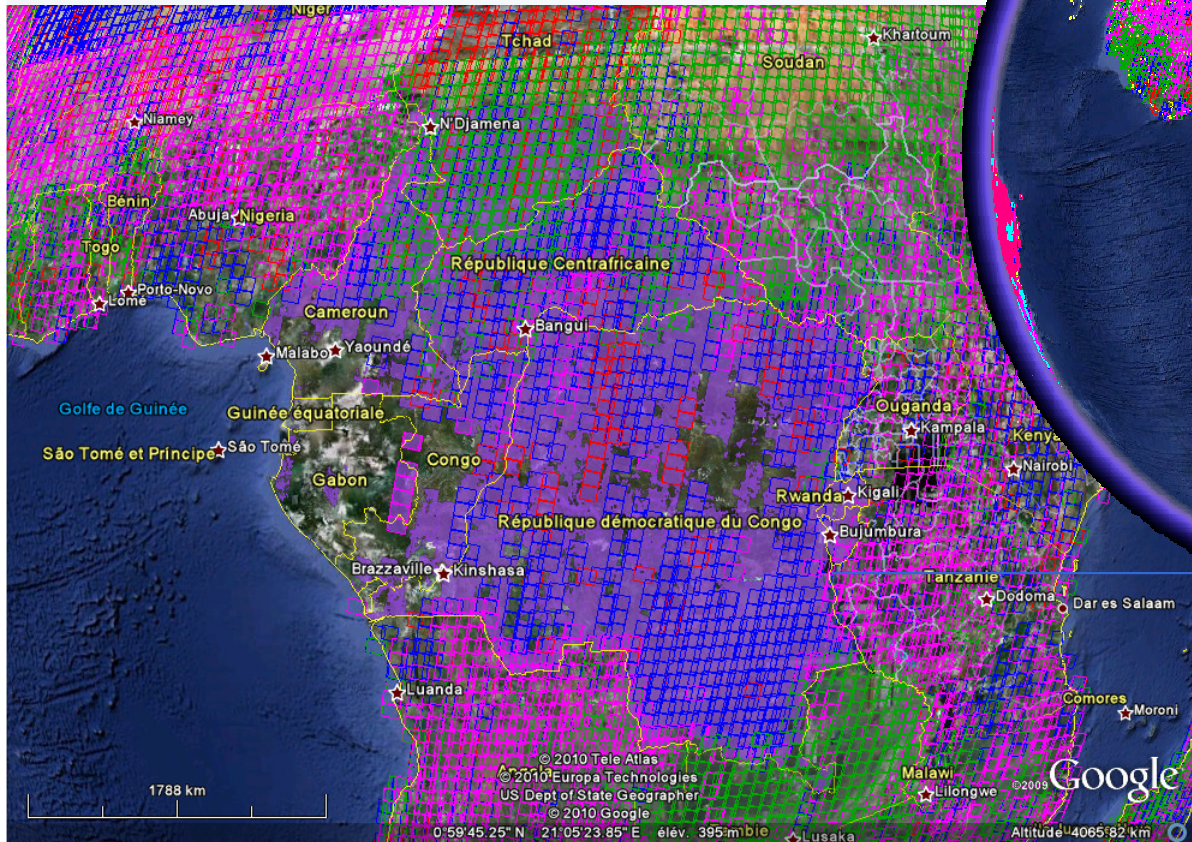
ACQUISITION PERIOD: 2006 to 2009
IMAGES < 10% CLOUDS



Right Side : Completed with SPOT4
data collected from French Guyana
Station in 2006 & 2007.
Denote interest of Receiving stations

SPOT5 Data Base (2.5-m colour) covering forests of Africa

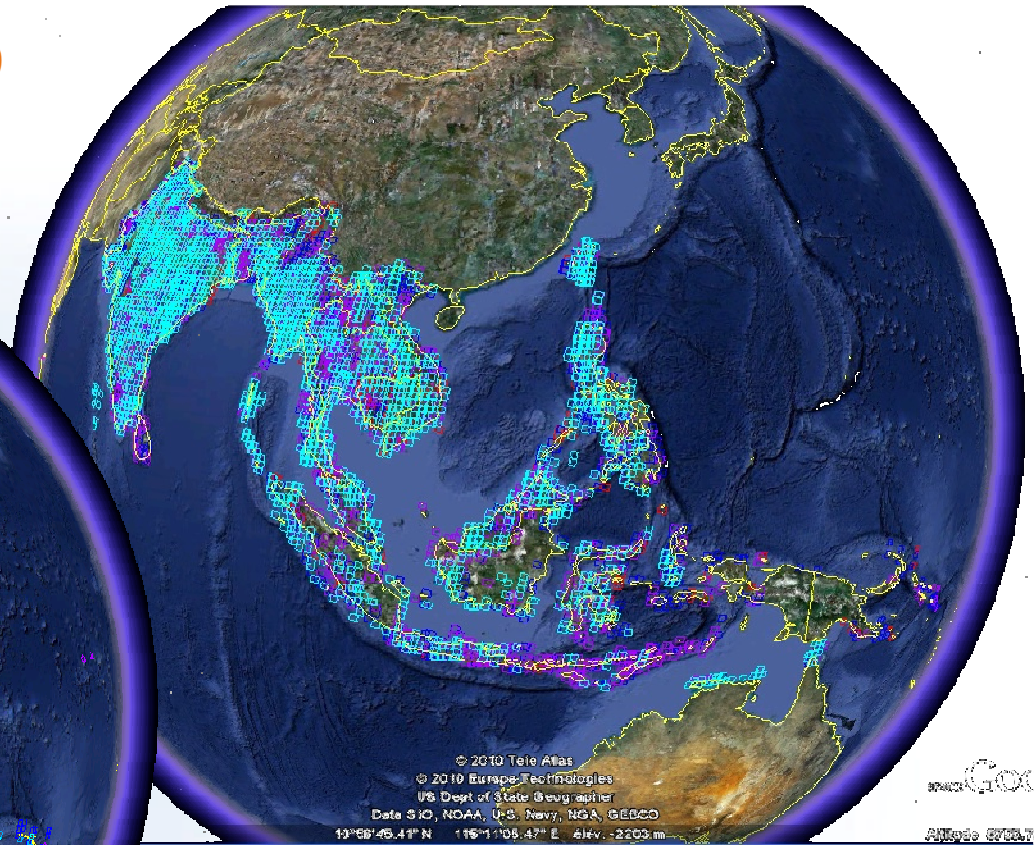
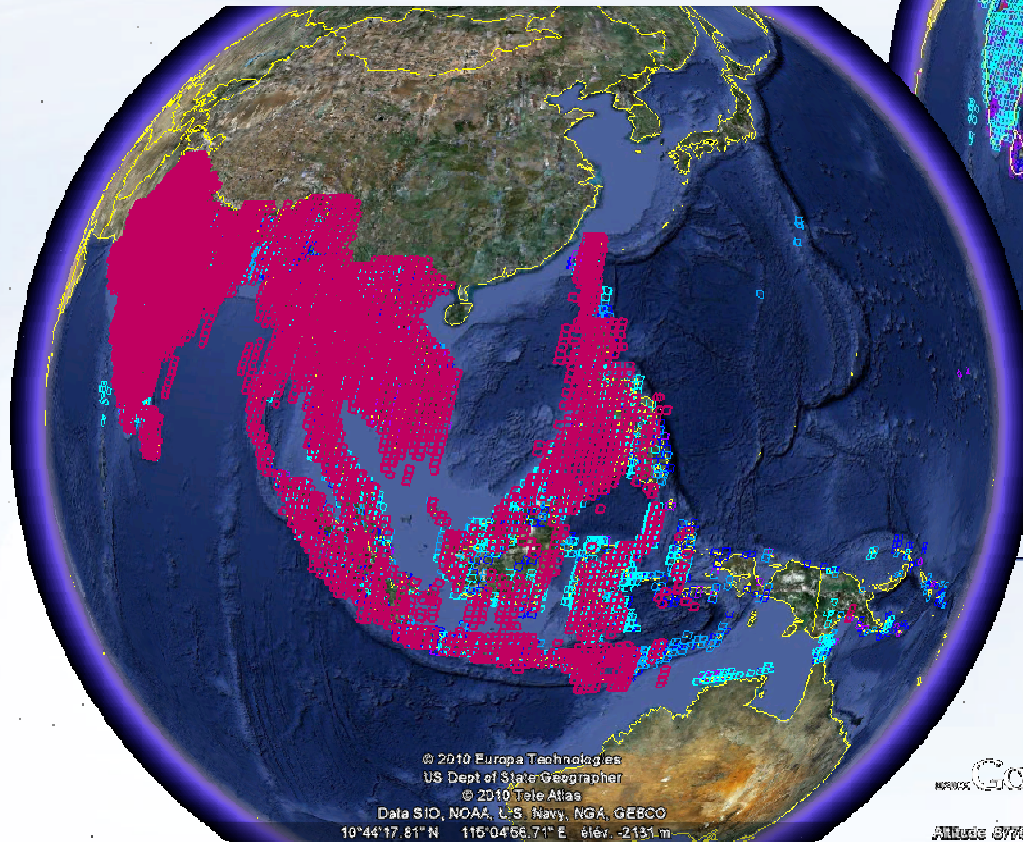
ACQUISITION PERIOD: 2006 to 2009
IMAGES < 10% CLOUDS



Left Side : Completed in purple with SPOT5 data partly cloudy combined after cloud masking.

SPOT5 Data Base (2.5-m colour) covering forests of South East Asia & India

ACQUISITION PERIOD: 2006 to 2009
IMAGES < 10% CLOUDS



Left Side : Completed in purple with 10m & 20m data acquired over the same period

■ Data ACCESS and CONTINUITY until 2023

- SPOT 4 & SPOT5 current satellites
- SPOT6 & SPOT7 future systems (Astrium funded)
- Pléiades 1 & Pléiades 2
- F2 & K2 from NSPO & KARI

■ OPERATIONS

- PROGRAMMING & Data COLLECTION
- MULTI-SENSOR COORDINATION (SPOT- Pléiades - F2 - K2 etc...)

■ DATA PRE-PROCESSING

- Automated GEOMETRY
- Pre-processing (automated BIOPHYSICAL products)

■ LICENSING

- Capacity to implement adequate REDD licensing (ownership and rights on satellite data)

■ Data ACCESS through ESA TPM contract

- SPOTIMAGE agreed on enlarging the standard TPM licensing (more or less limited to European scientists)
- There is a list of about 800 images that was established to be used for National Demonstrators activities
- A specific budget is required to repatriate about 600 images from foreign Ground Receiving Stations

■ Data ACCESS through EADS-ASTRIUM//AFD contract on Congo

- Possible contribution of Benefiting countries (10 today)
- Access to SPOT & F2 ortho products via REDD projects approved by national designed authorities
 - 1200 SPOT images from Archive
 - 1100 SPOT images newly collected
 - 1900 F2 images newly collected

■ LICENSING

- REDD licensing: capacity to share data freely at no cost for any approved REDD contributors to REDD projects)

Major Sensors operated by SPOT IMAGE meeting REDD needs

SPOT
IMAGE



A Unique Constellation

Medium & High Resolution Optical Satellites

6 Satellites

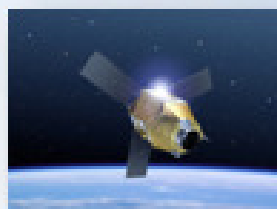
Pléiades 1 & 2	50cm-2m Data
SPOT 6 & 7	2m-8m Data
SPOT 4 & 5	2.5m-20m Data

1 Launch / year

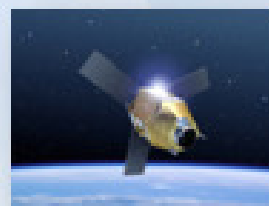
For the next 4 Years



Today



2010



2011



2012



2013

SPOT 4 & 5
2.5m – 20m

Pléiades 1
50cm

Pléiades 2
50cm

SPOT 6
1,5m

SPOT 7
1,5m



Thank you for your attention



A satellite image of the Earth showing the continent of Europe on the right and the continent of Africa on the left, separated by the Mediterranean Sea. The image is taken from a high angle, showing the outlines of the continents and the surrounding oceans. The text is overlaid on the left side of the image.

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***Sustainable Business Development
Manager***

SPOT IMAGE