

ALOS

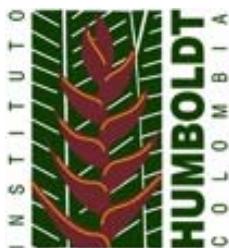
K&C Initiative
An international science collaboration led by JAXA

Integration of Alos PalSAR data to Wetlands Mapping: An ecosystem approach K&C product- Phase 3 report

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PROSPERIDAD
PARA TODOS

Science Team meeting #21 – Phase 3 Result Presentations
Kyoto Research Park, Kyoto, Japan, December 3-4, 2014

Project objectives

SarVision collaborates with IDEAM and Institute Alexander von Humboldt in the frame of a project of the Colombian National Government, Adaptation Fund for climate change, for the:

“Identification of the Wetland ecosystems in the Colombian territory”.

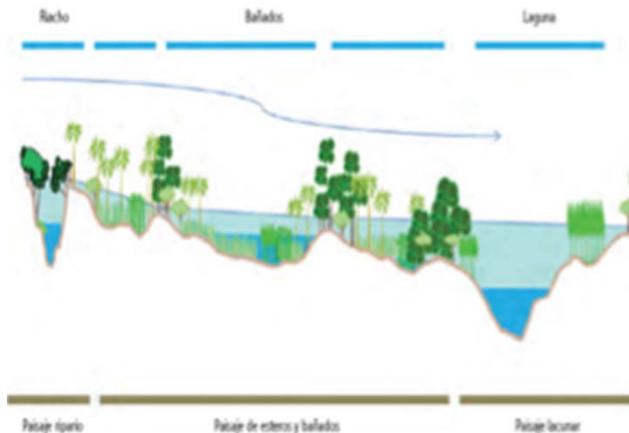
- We present an **ecosystem approach** for the **Analysis of the Alos PalSAR data at 100 and 50 m resolution** for:
 - i. Vegetation structural mapping
 - ii. analysis of dense time series
 - iii. Flooding frequency mapping.

(Marcela)
- A Methodology is presented to **integrate the Alos derived data with other bio-geophysical layers** to allow potential identification of wetlands. Analysis at 50 y 100m resolution

(Carlos)
- **A Validation approach is used to evaluate Accuracy of products**

Theory on Wetland mapping vegetation and water

Ecosystem approach



Wetland definition:

Ecosystem that appears in a **special landform** that promote the **water accumulation** (temporary or permanently) and produce particular **soil conditions** and **hydro biological organisms** adapted to this conditions.

Geomorphology : canal-concave areas- plains,- mountains- slopes

Hydro-soils

Flooding regime: occasionally- seasonally- permanently

Vegetation structure: grasslands-bushland-woodland-Forest

Wetlands existing in Colombia

- highlands lagoons and lakes
 - swamps,
 - peats,
- flooded plains and flooded savannas,
 - Stuaries,
 - rivers,
- cienagas or coastal lagoons
 - Flooded palms or esteros
 - Mangroves



• Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe (1979), *Classification of wetlands and deepwater habitats of the United States*, U.S., Department of the Interior, Fish and Wildlife Service, Washington, D.C.

• Semeniuk, C. A. and V. Semeniuk (1995), "A geomorphic approach to global wetland classification", *Vegetatio*, no. 118, pp. 103–124.

• Secretaría de la Convención de Ramsar (2004), *Manuales Ramsar para el uso racional de los humedales*, Secretaría de la Convención de Ramsar, Gland (Suiza)

Theory on Wetland mapping vegetation and water

Ecosystem approach: Analysis of Alos PalSAR

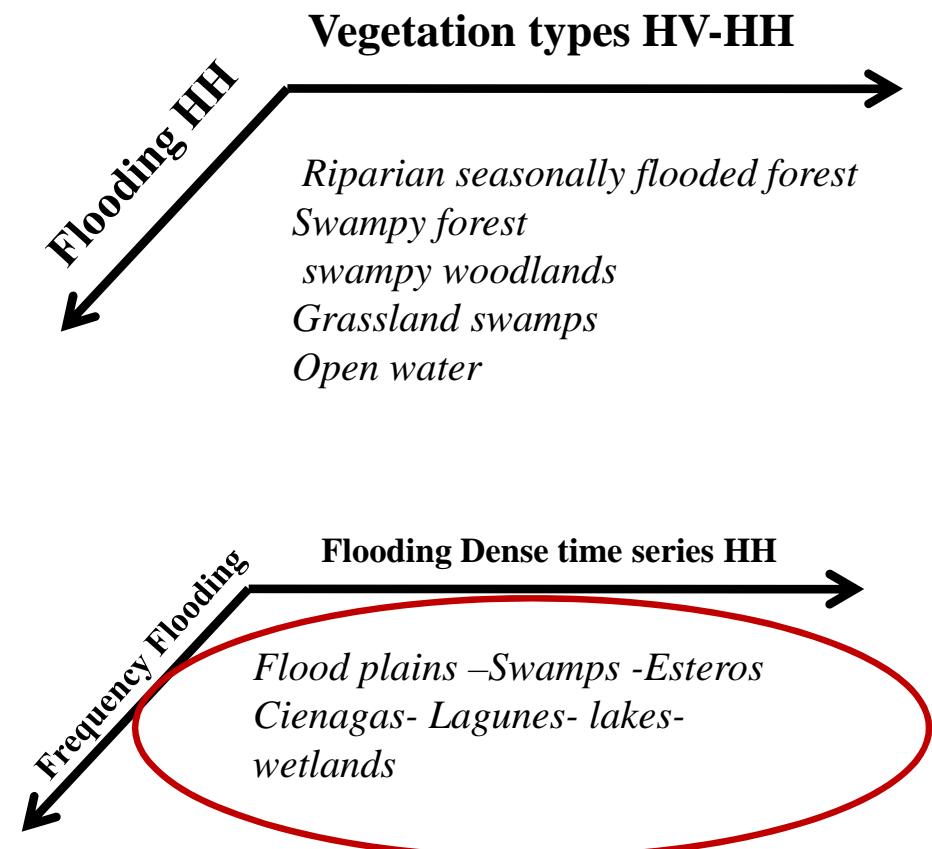
Wetland definition using AlosPalSAR

Vegetation structural Mapping: Analysis of flooding vegetation types

- Legend LCCS combination of structure and wetness or Flooding occasionally/ Temporarily/permanently

Flooding regime: Analysis of flooding :

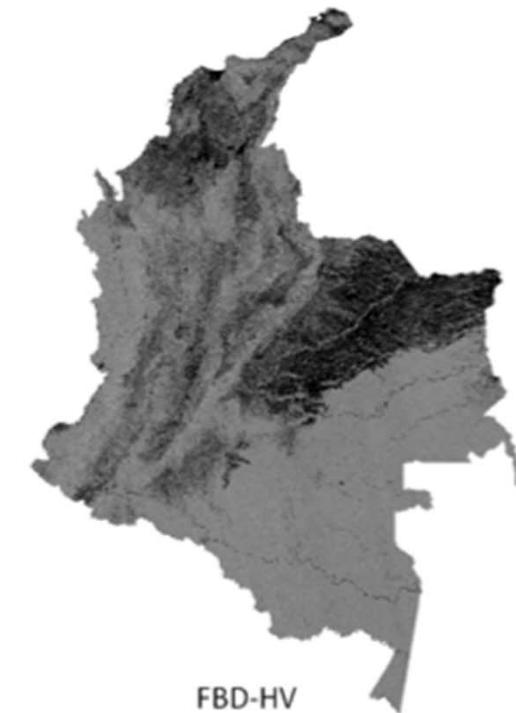
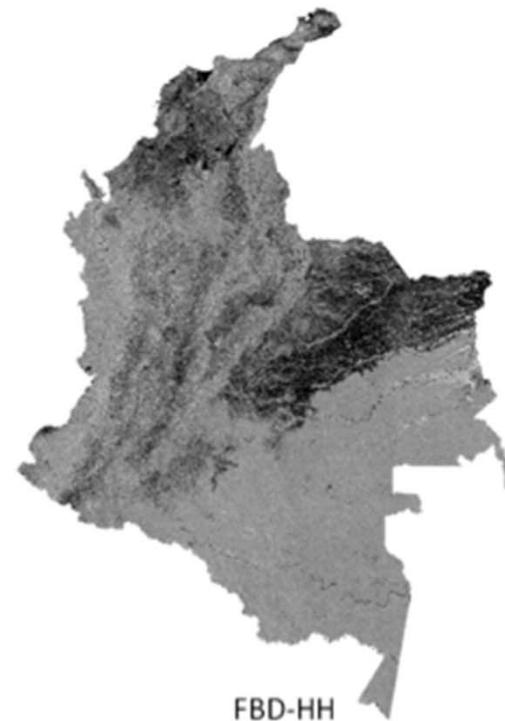
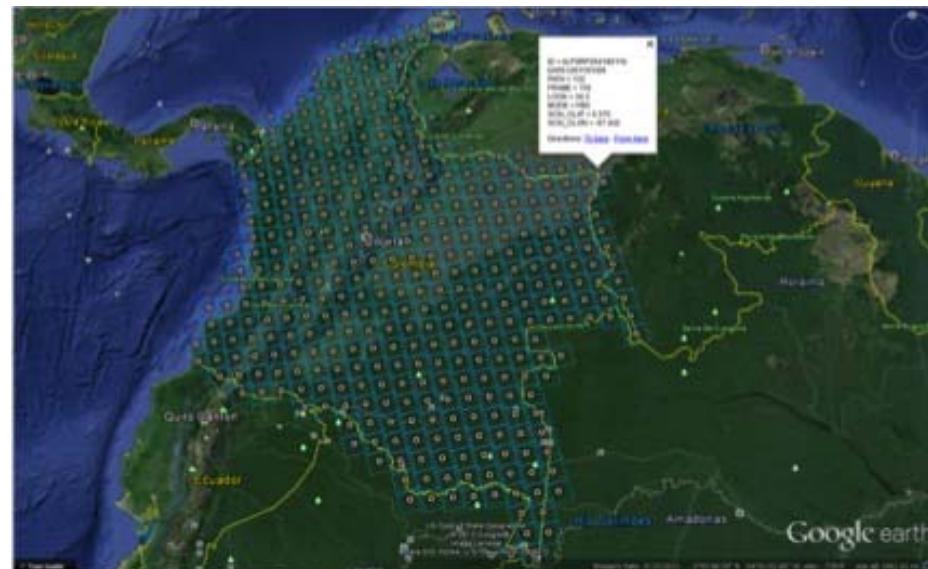
- Dense time series (flooding per mosaics x 28 maps)
- Frequency flooding (compilation of time series x 1 Map)



Results: Structural Vegetation Map created only with Alos PALSAR

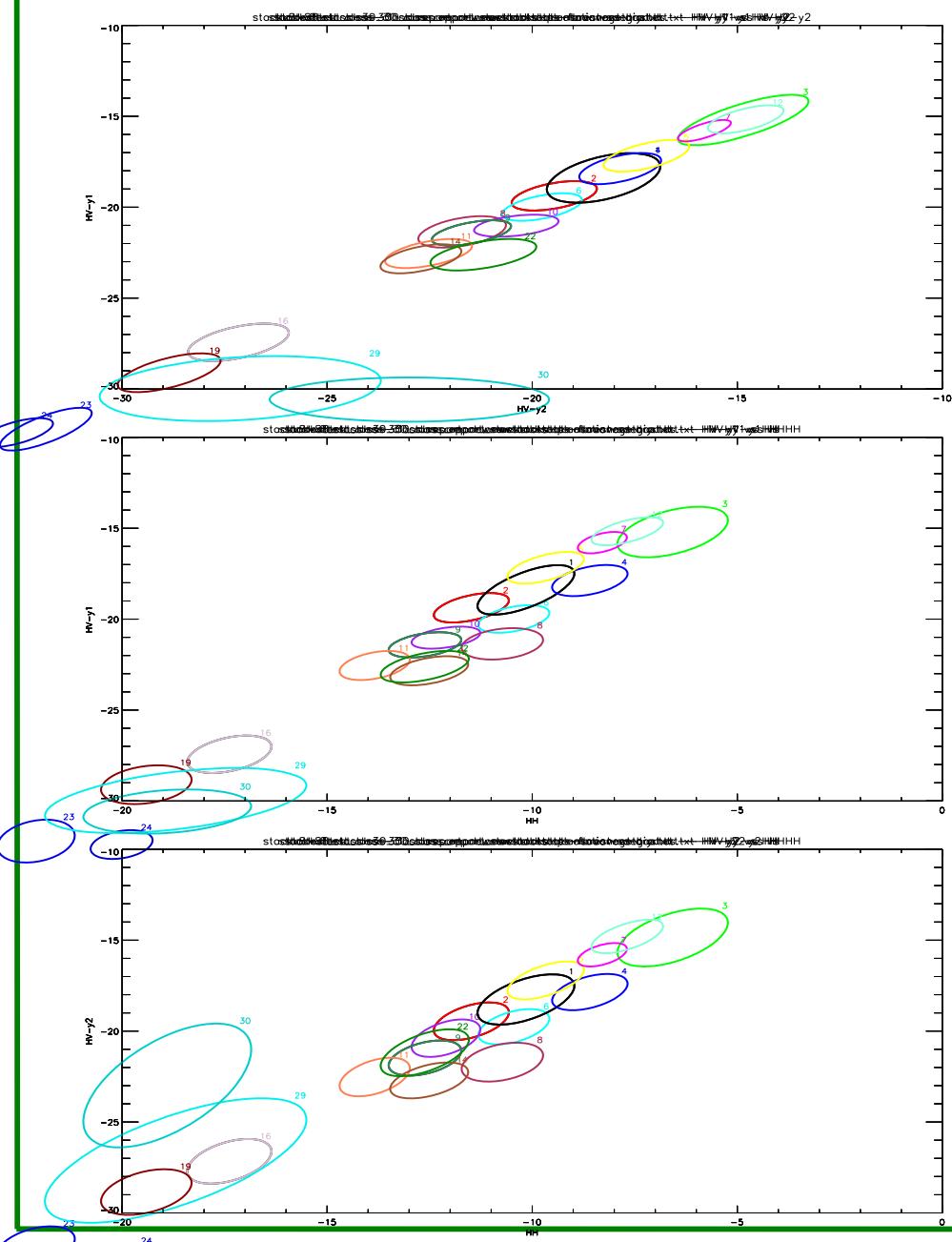
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FBD HH	2007	20070724	20070822	20070805	20070903	20070817	20070731	20070829	20070812	20070726	20070824	20070807	20070905	20070819	20070802	20070831	20070814	20070728	20070826	20070809	20070723	20070821	20070804	20070902	20070816
FBD HV	2007	20070724	20070822	20070805	20070903	20070817	20070731	20070829	20070812	20070726	20070824	20070807	20070905	20070819	20070802	20070831	20070814	20070728	20070826	20070809	20070723	20070821	20070804	20070902	20070816
FBD HH	2008	20080610	20080824	20080807	20080905	20080819	20080802	20080831	20080814	20080728	20080826	20080809	20080907	20080821	20080804	20080902	20080816	20080814	20080828	20080811	20080725	20080823	20080806	20080904	20080818
FBD HV	2008	20080610	20080824	20080807	20080905	20080819	20080802	20080831	20080814	20080728	20080826	20080809	20080907	20080821	20080804	20080902	20080816	20080814	20080828	20080811	20080725	20080823	20080806	20080904	20080818
FBD HH	2009	20090913	20090827	20090810	20090908	20090822	20090805	20090903	20090817	20090731	20090910	20090824	20090807	20090905	20090819	20090802	20090831	20090629	20090912	20090826	20090809	20090723	20090821		
FBD HV	2009	20090913	20090827	20090810	20090908	20090822	20090805	20090903	20090817	20090731	20090820	20090812	20090805	20090824	20090807	20090809	20090821	20090629	20090912	20090826	20090809	20090723	20090821		
FBD HH	2010	20100916	20100715	20100813	20100911	20100825	20100808	20100906	20100820	20100803	20100901	20100815	20100729	20100827	20100810	20100908	20100822	20100805	20100903	20100817	20100915	20100829	20100812	20100910	20100824
FBD HV	2010	20100916	20100715	20100813	20100911	20100825	20100808	20100906	20100820	20100803	20100901	20100815	20100729	20100827	20100810	20100908	20100822	20100805	20100903	20100817	20100915	20100829	20100812	20100910	20100824

193 strips
FBD_HV/HH
FBS-HH
50 m

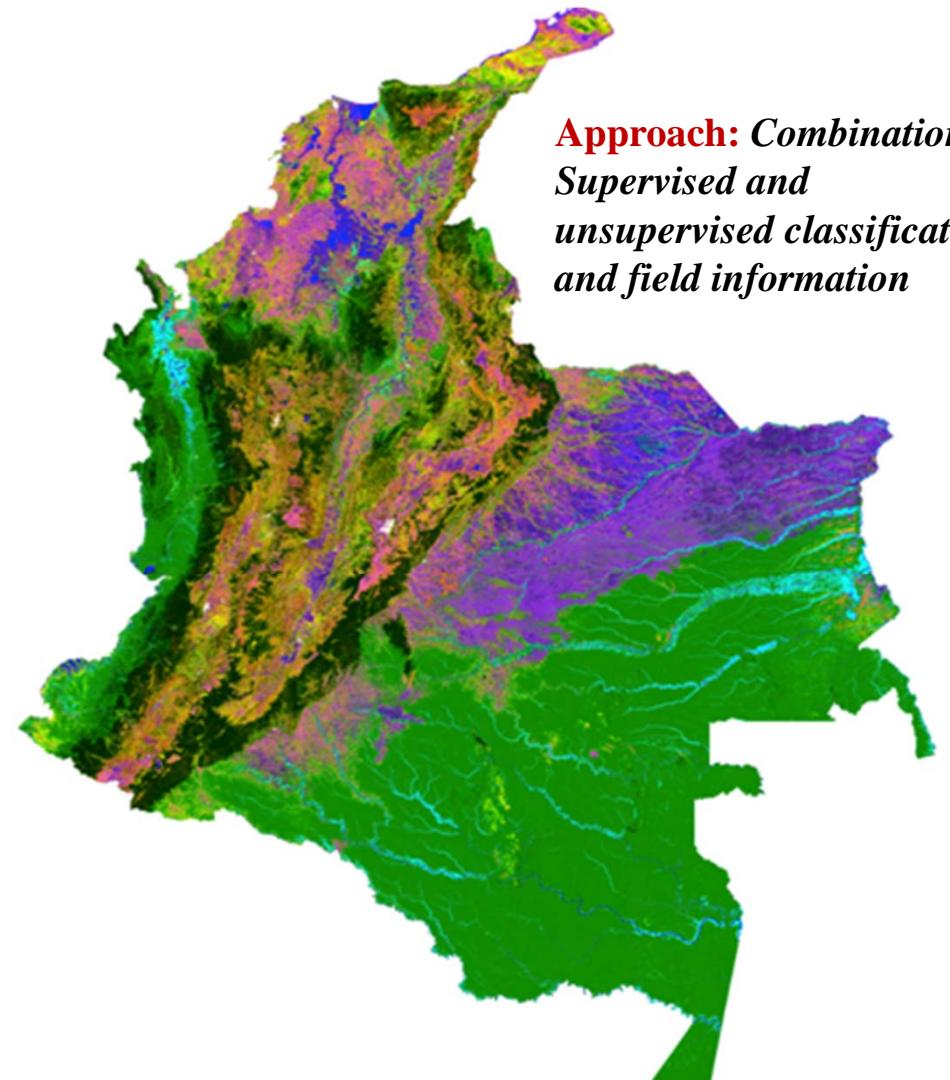


Approach: Combination of Supervised and unsupervised classification and field information

4 mosaics FBD Wet season
2 FBS Dry season



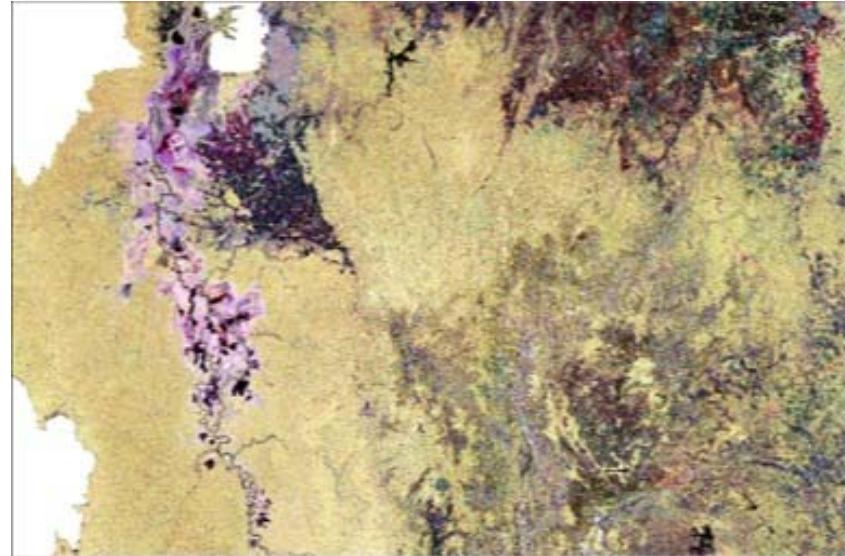
Legend development follows LCCS-FAO system



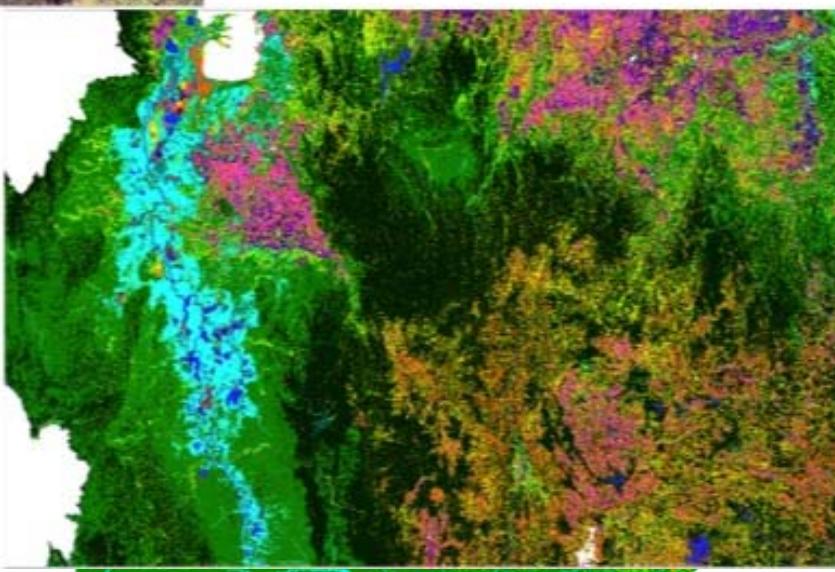
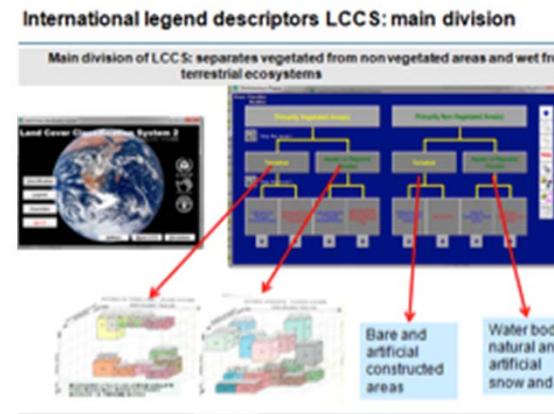
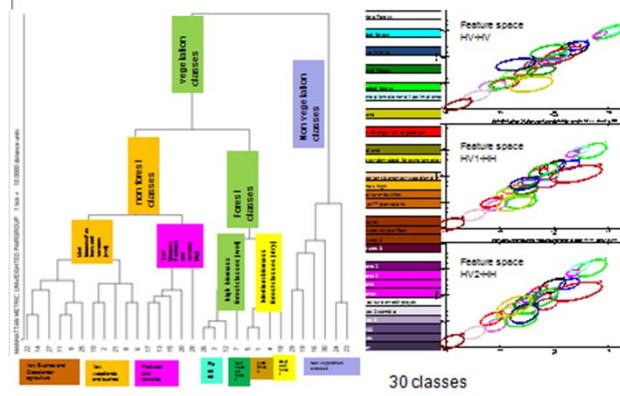
Approach: Combination of Supervised and unsupervised classification and field information

•Hoekman D.H, M. Vissers and T. Tran, 2010. Unsupervised full-polarimetric SAR data segmentation as a tool for classification of agricultural areas" IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (JSTARS). In press.

Results: Structural Vegetation Map created only with Alos PALSAR



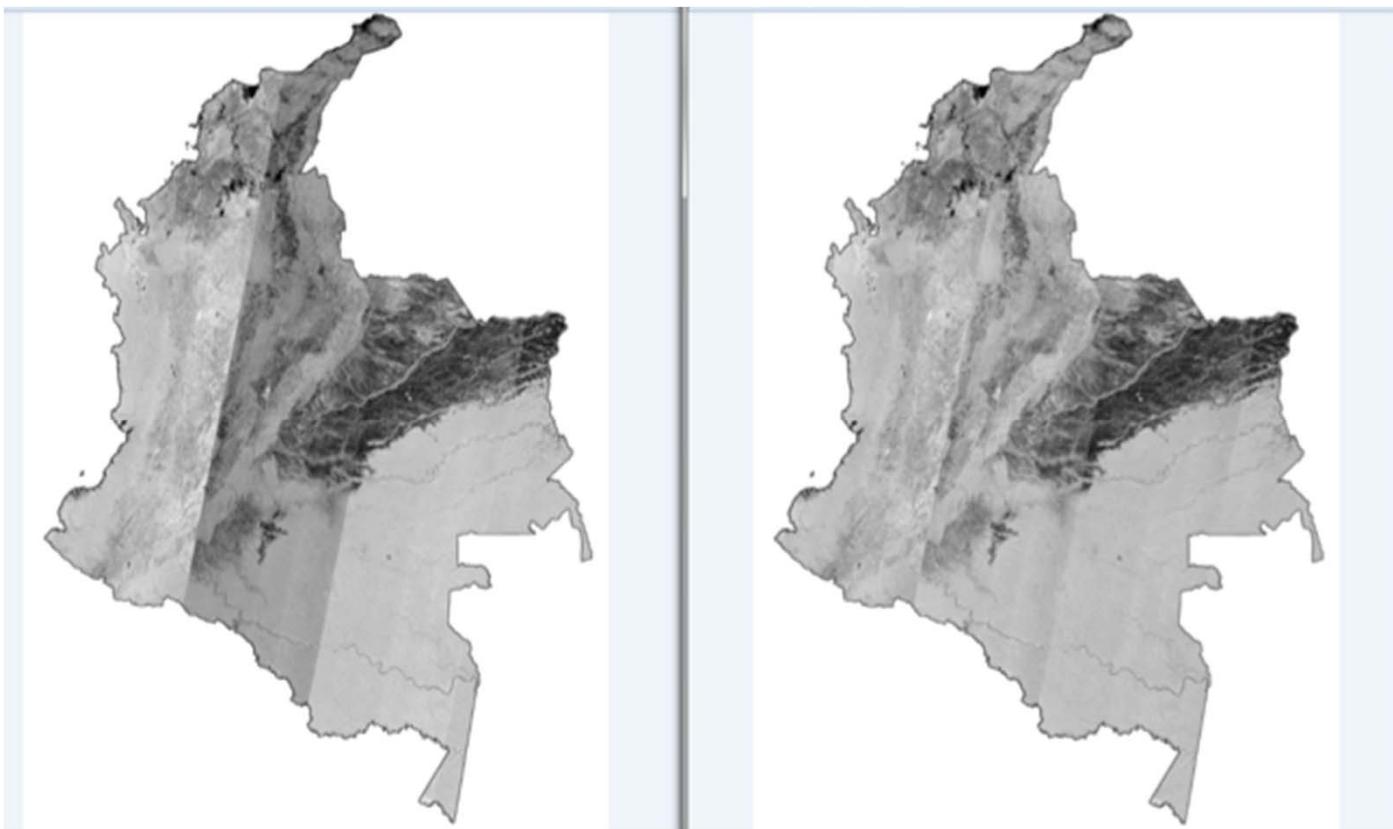
Atrato-Choco



Cobertura	LCCS Code
Bosque	20596-13221-L1L5O1O14
Bosque	20596-13221-L25L8O1O14
Arboladas	20791-4186-O1O14(1)
Aqua	
Bosque	41024-33981-L1L5O1O14(2)
Vegetación secundaria	21380-7285-01O14
Arbustales densos	20969-13395-01O14
Arbustales	21089-4358-01O14
Arbustales abiertos	40789-39611-L1L5O1O14
Pastizales	21348-218-01O14
Sabanas	21348-3222-01O14
Sabanas Húmedas	40864-30567-01O14
Areas construidas	5003-13

Validation:
92 % accuracy

Results: Flooding Maps Dense Time series



457 strips - 36 mosaics - 28 complete

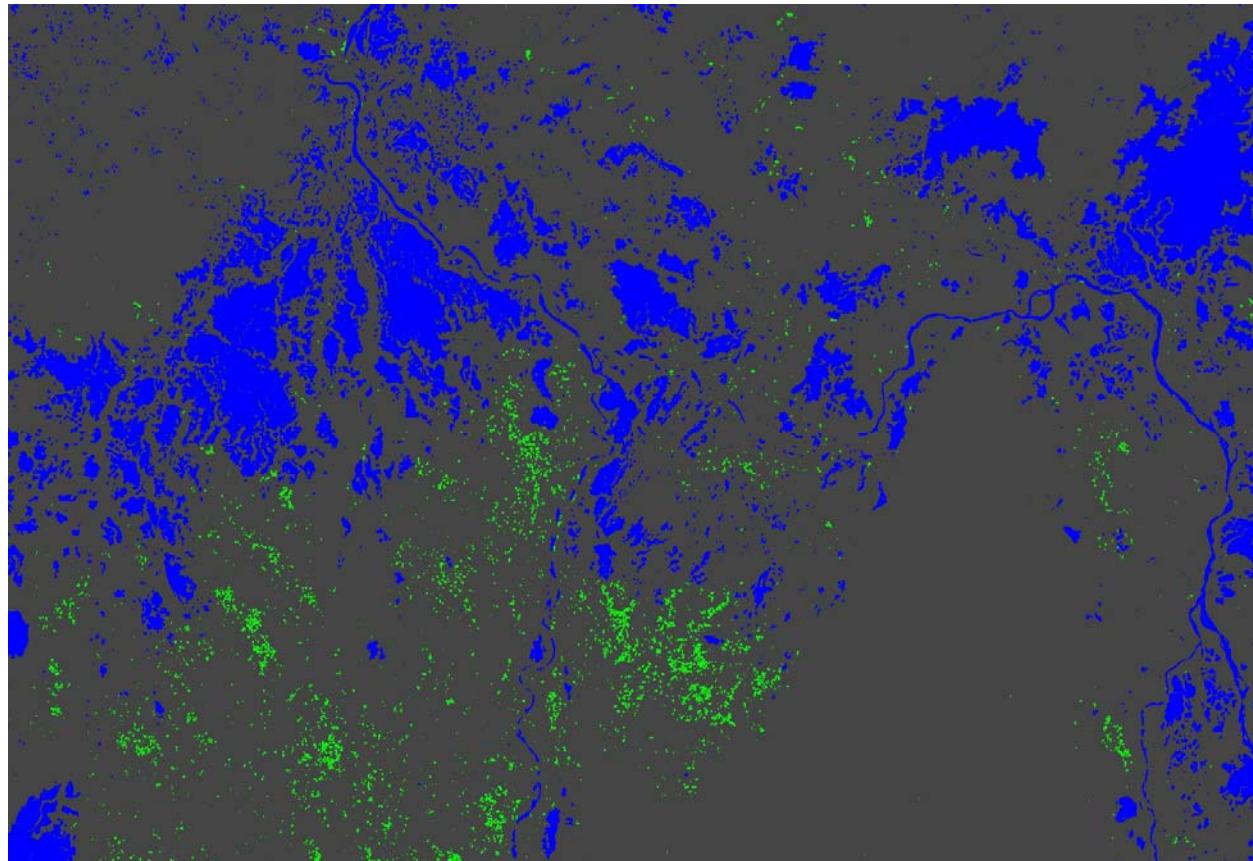
Supervised classification two main classes:
open water and flooded under canopy

	457	455	454	452	451	449	448	446	445	443	442	440	439	437	436	434	433	431	430	WB
1		20081113	20081109							20070126		20071204	20081129	20081124	20081119		I	WB		
2		20081229	20081224							20070126		20071204	20081124	20081129	20081104		C	Not useful		
3		20070121	20070030							20070121		20071204	20081124	20081129	20081104		C	Not really		
4		20080101	20080101							20070121		20071204	20081124	20081129	20081104		C	Not really		
5		20070116								20070126		20071204	20081124	20081129	20081104		C	In archive		
6		20070701								20070701		20071204	20081124	20081129	20081104		C			
7	20070821	20070816		20070811					20070821	20070816	20070801	20070727	20070723	20070717	20070712	20070712	C			
8		20070929		20070929					20070929	20070916	20070911	20070911	20070905	20070905	20070827	20070827	C			
9	20071006		20071001						20071006		20071027	20071022	20071017	20071012	20071012	20071027	C			
0	20071121		20071116						20071101		20071204	20081124	20081129	20081117	20081117	20071127	C			
1	20080104		20080104		20071221				20071221		20071212	20081124	20081129	20081117	20081117	20081037	I			
2		20080104		20080104		20071221			20080104		20080113	20080113	20080113	20080113	20080113	20080113	C			
3	20080407		20080402		20080115				20080121	20080118	20080115	20080115	20080115	20080115	20080115	20080115	C			
4	20080518		20080513						20080501		20080523	20080523	20080518	20080518	20080518	20080518	C			
5	20080708		20080701		20080421				20080518		20080608	20080608	20080608	20080608	20080608	20080608	C			
6		20080818		20080801					20080801		20080724	20080724	20080715	20080715	20080715	20080715	C			
7	20080823		20080823		20080823				20080823		20080913	20080908	20080903	20080824	20080824	C				
8	20081008		20081118		20081113	20081108			20081103	20081126	20081024	20081024	20081033	20081114	20081095	20081095	C			
9		20081108		20081108		20081108			20081108		20081212	20081212	20081214	20081214	20081214	20081214	C			
0		20081118		20081118		20081118			20081118		20081212	20081212	20081214	20081214	20081214	20081214	C			
1		20090405		20090405					20090405		20090426	20090426	20090426	20090426	20090426	20090426	C			
2		20090706		20090621					20090621		20090621	20090621	20090608	20090608	20090608	20090608	C			
3		20090911		20091006					20090913		20090913	20090908	20090908	20090908	20090908	C				
4		20091011		20091006					20090913		20091027	20091027	20091022	20091022	20091022	20091022	C			
5		20100106		20100106					20091123		20091123	20091123	20091123	20091123	20091123	20091123	C			
6		20100203		20100203					20100223		20100223	20100223	20100228	20100228	20100228	20100228	C			
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8		20100709		20100709					20100624	20100624	20100619	20100619	20100619	20100619	20100619	20100619	C			
9		20100905		20100905					20100828	20100828	20100821	20100821	20100819	20100819	20100819	20100819	C			
0		20110109		20110109					20110229	20110229	20110221	20110221	20110118	20110118	20110118	20110118	C			
1		20110109		20110109					20110229	20110229	20110221	20110221	20110118	20110118	20110118	20110118	C			
2		20110116		20110116					20110116		20110116	20110116	20110111	20110111	20110111	20110111	C			

- Data Evaluation
- Data screening
- Orthorectification
- Calibration
- Slope correction

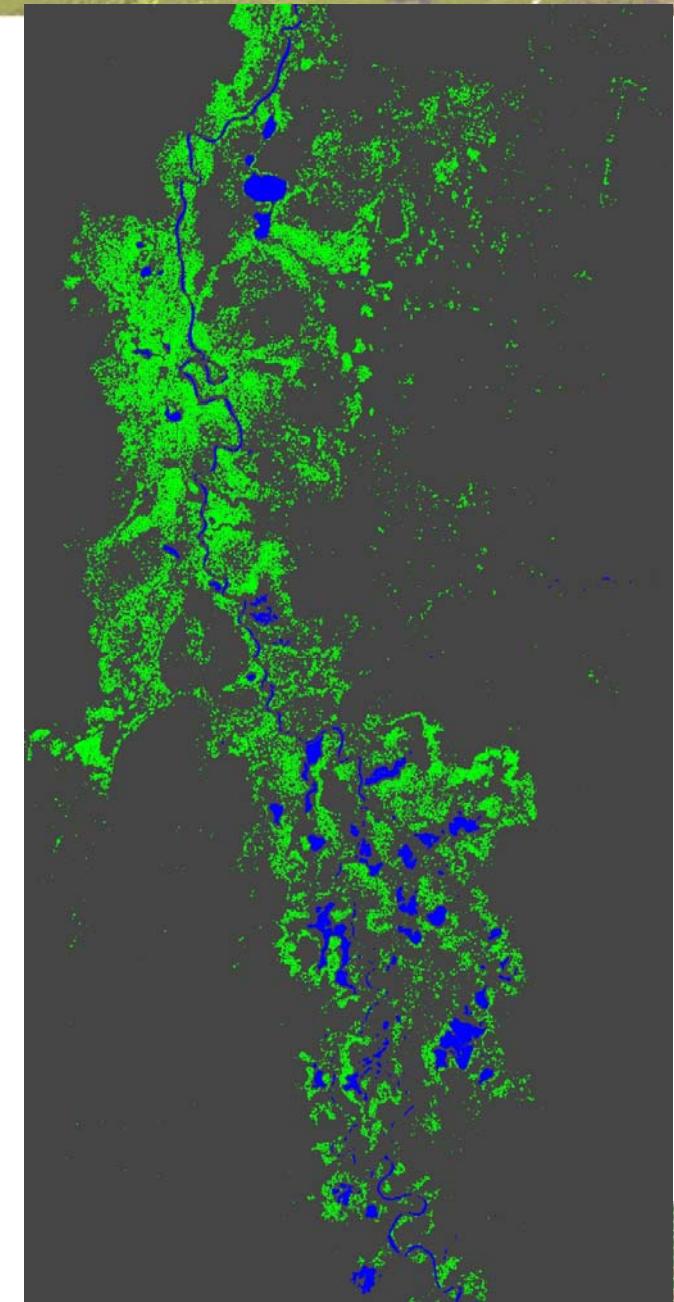
Flooding Maps Dense Time series:

Open Water: La Mojana : internal delta



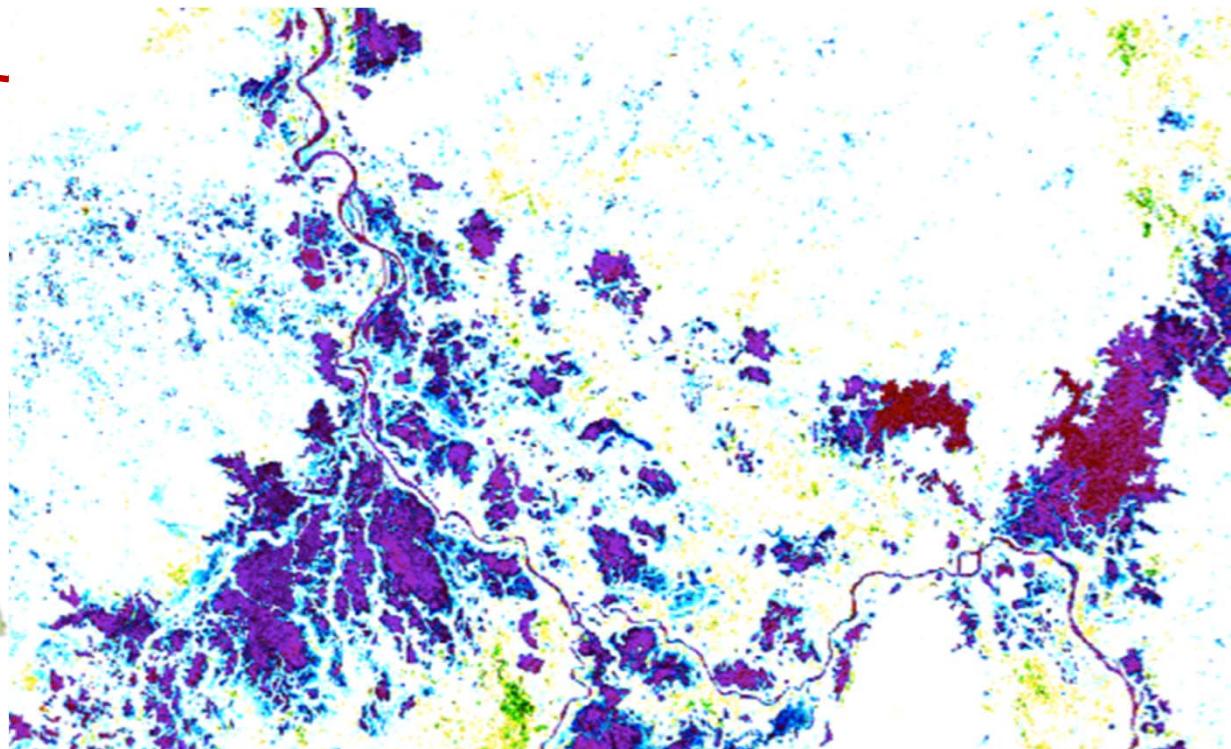
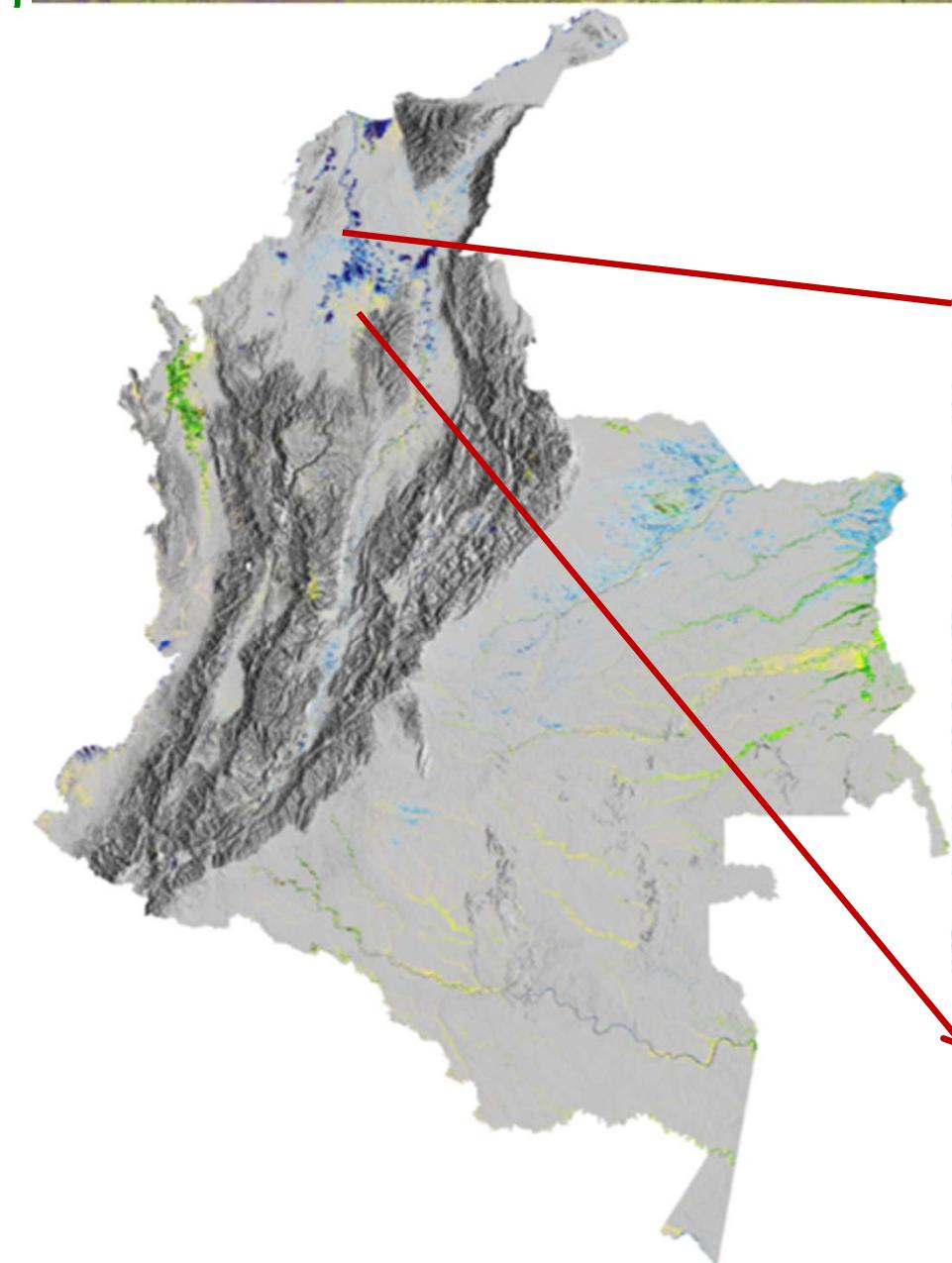
Flood under the canopy: Atrato – Choco

(area almost permanently cover by clouds This dynamic is never been mapped before)



Flooding Frequency Maps:

Open Water: La Mojana : internal delta

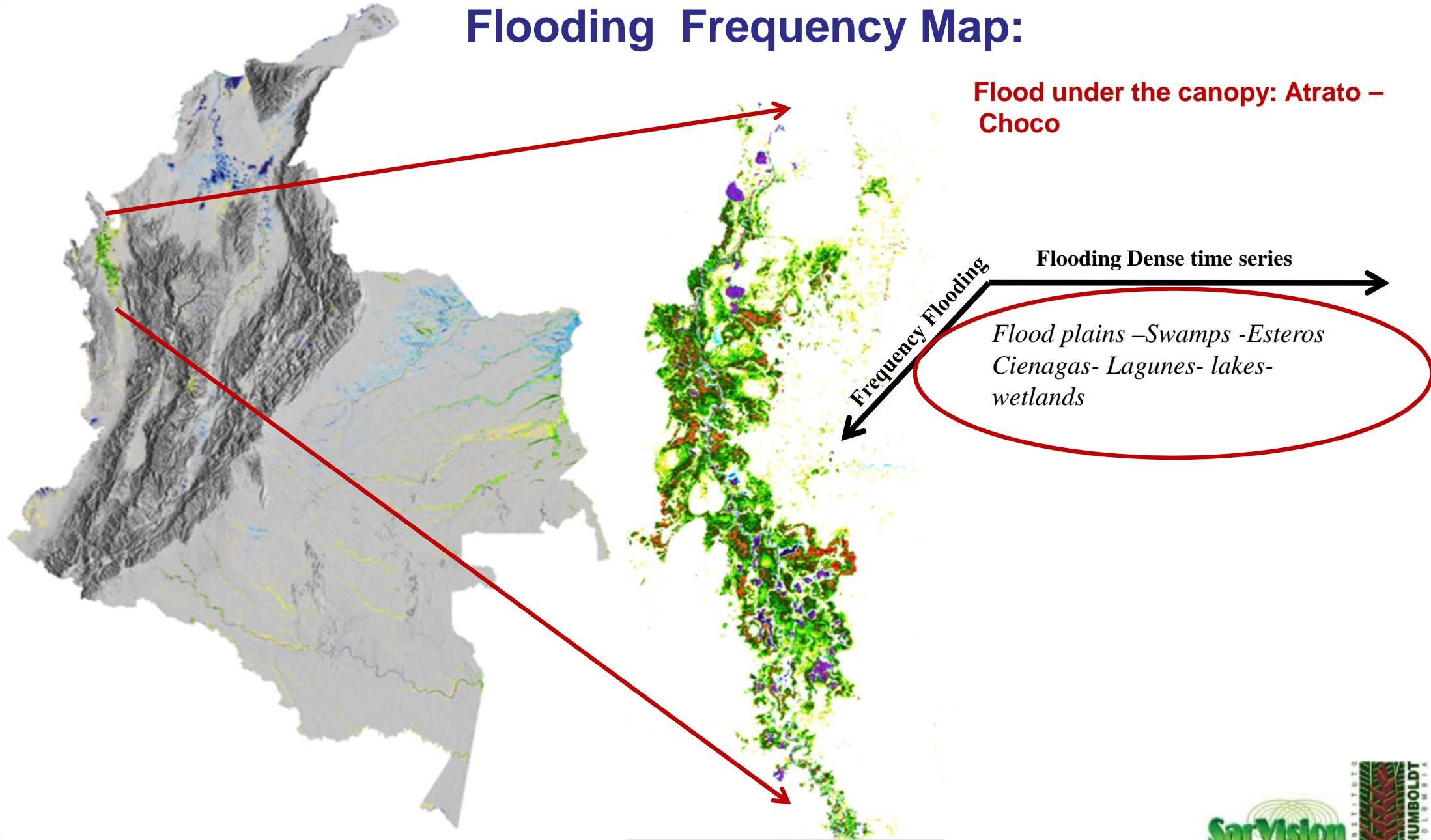


Frequency Flooding

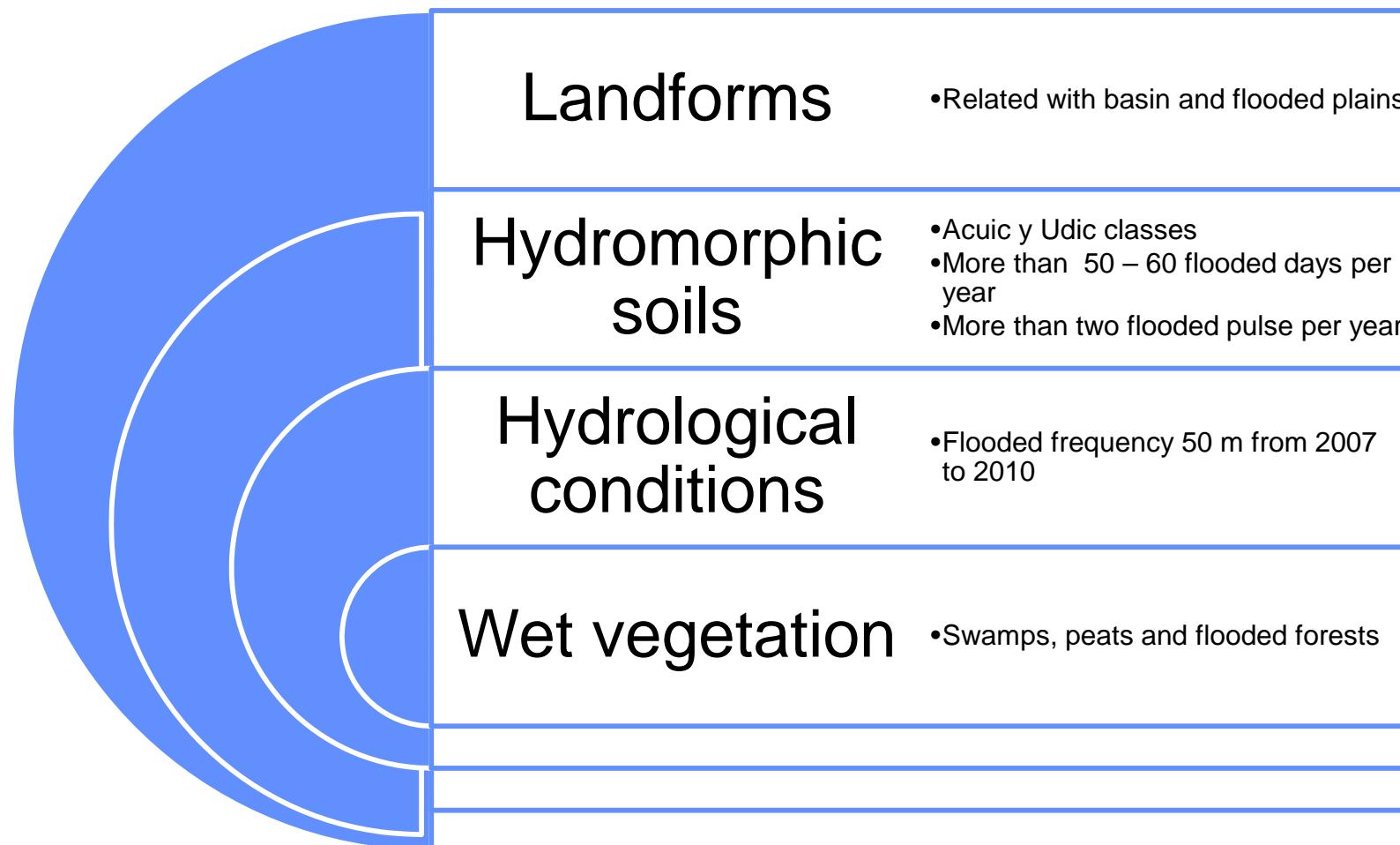
Flooding Dense time series

Flood plains -Swamps -Esteros
Cienagas- Lagunes- lakes-
wetlands

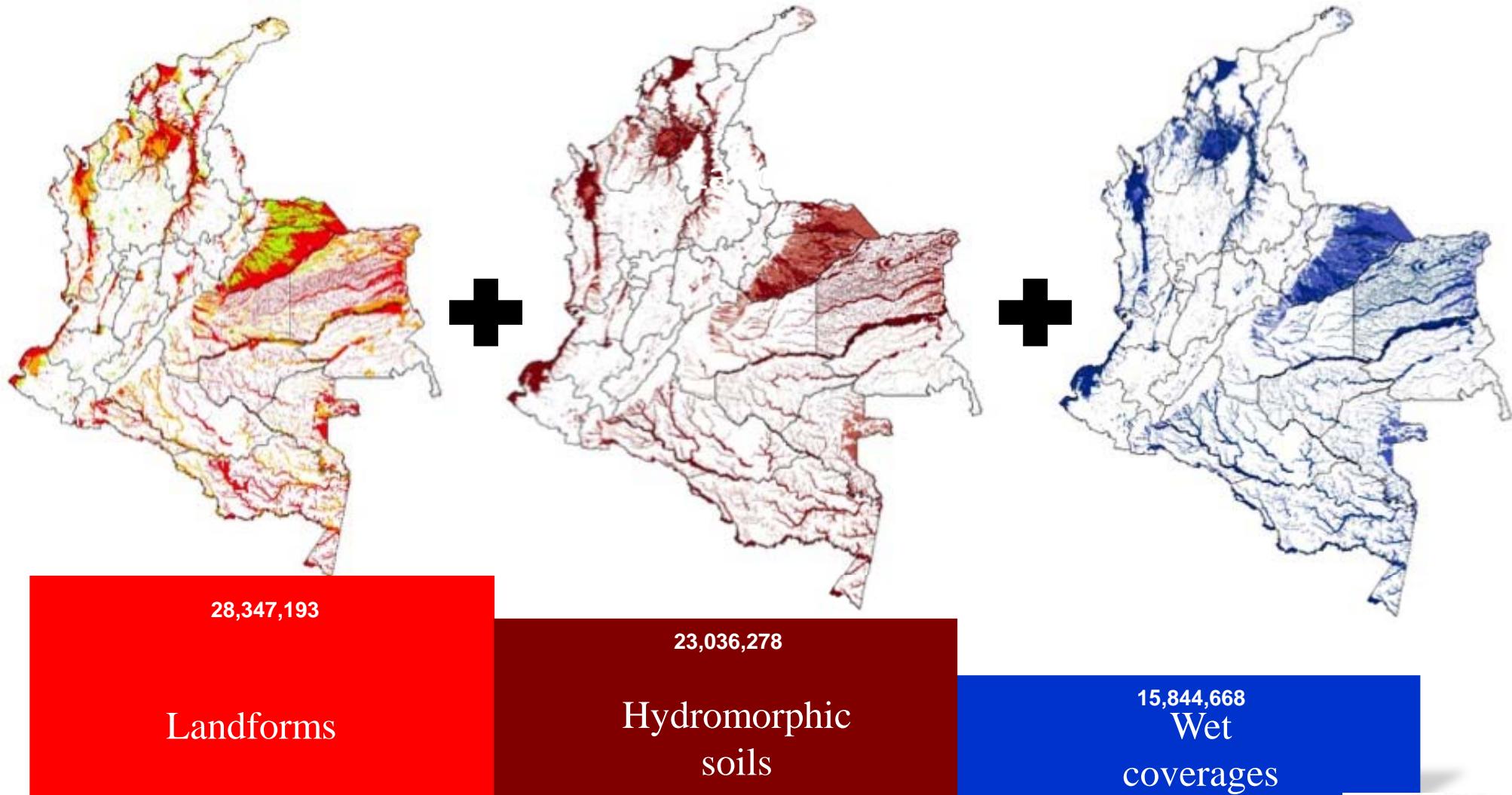
Flooding Frequency Map:



According to the theoretical frame, the main criteria to the wetland process identification are these:

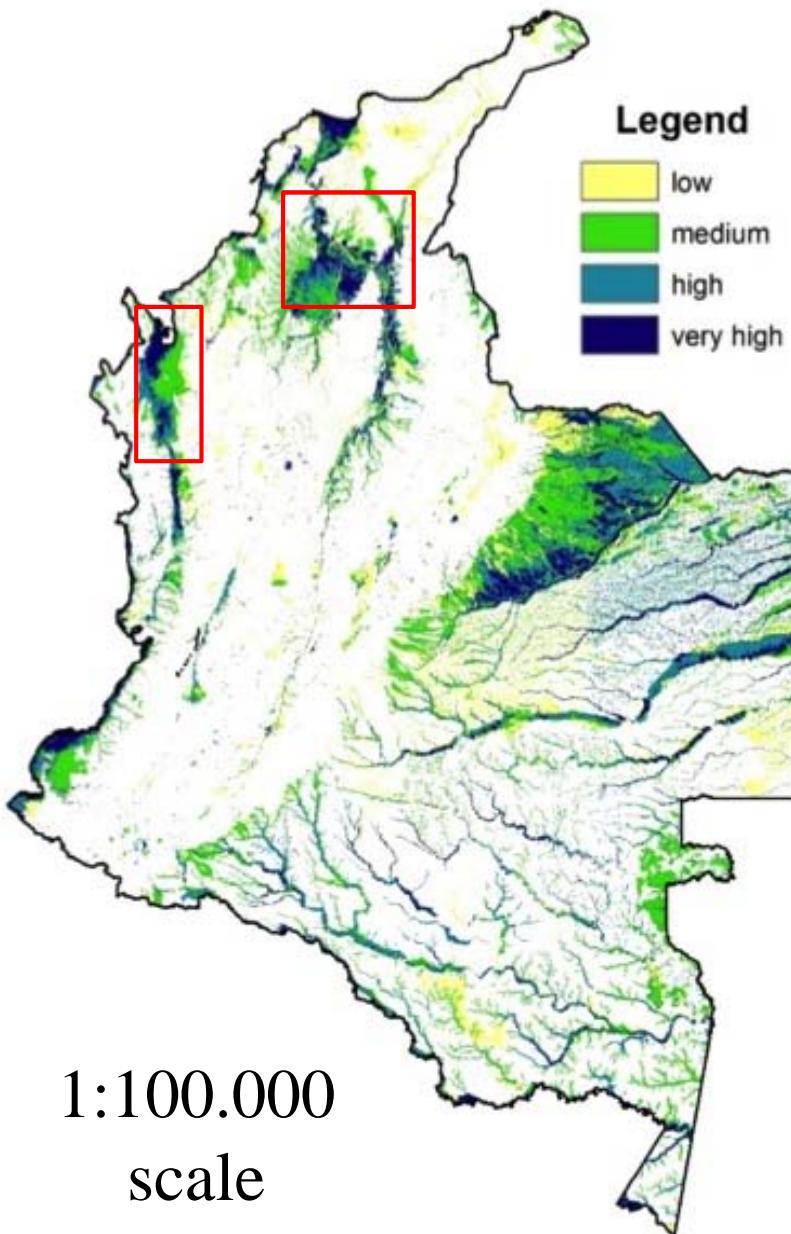


Colombia counts with **GIS layers as basic spatial information for landforms, soils and coverages :**
With the team specialist we selected the **classes that are relevant for the wetland identification** and
we refined this information to a 1:100.000 scale .



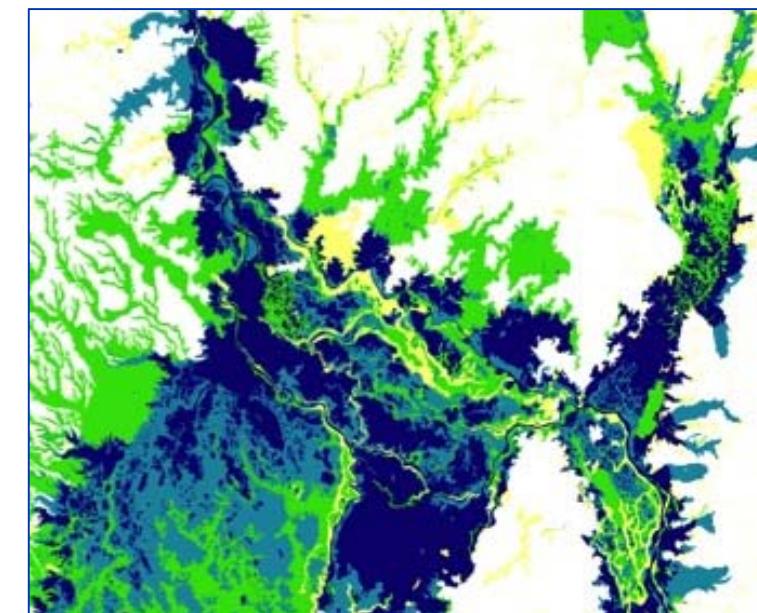
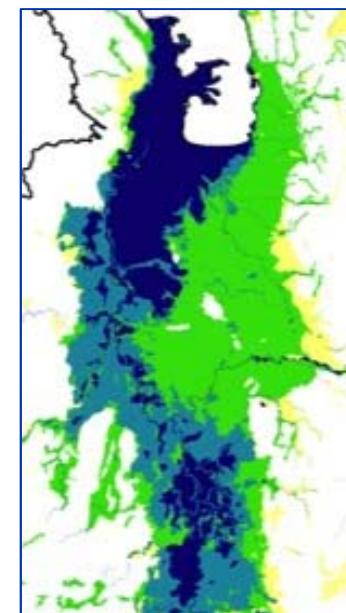
Landforms

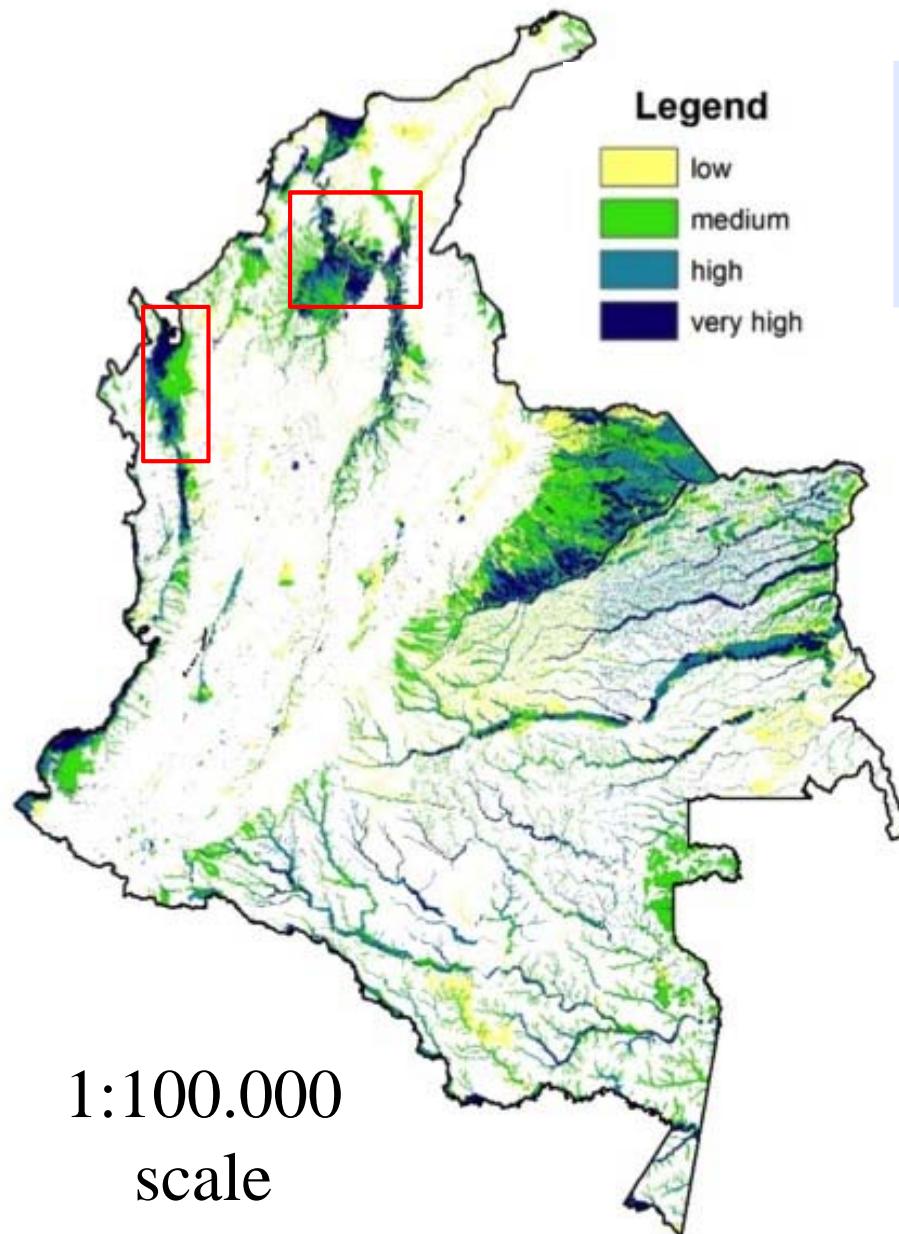
Hydromorphic
soils15,844,668
Wet
coverages



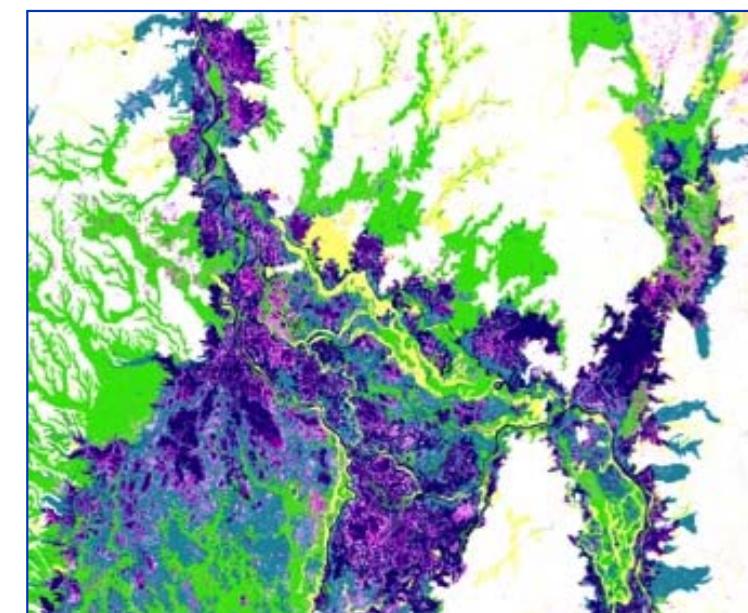
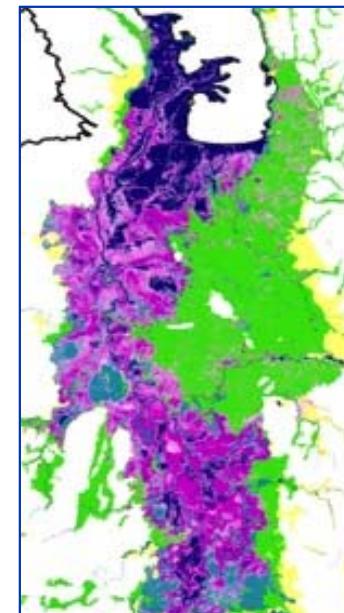
Wetlands potential map is the combination of the refined basic information.

Details after and before adding radar information: this map has 4 classes from very high to low wetland potential.





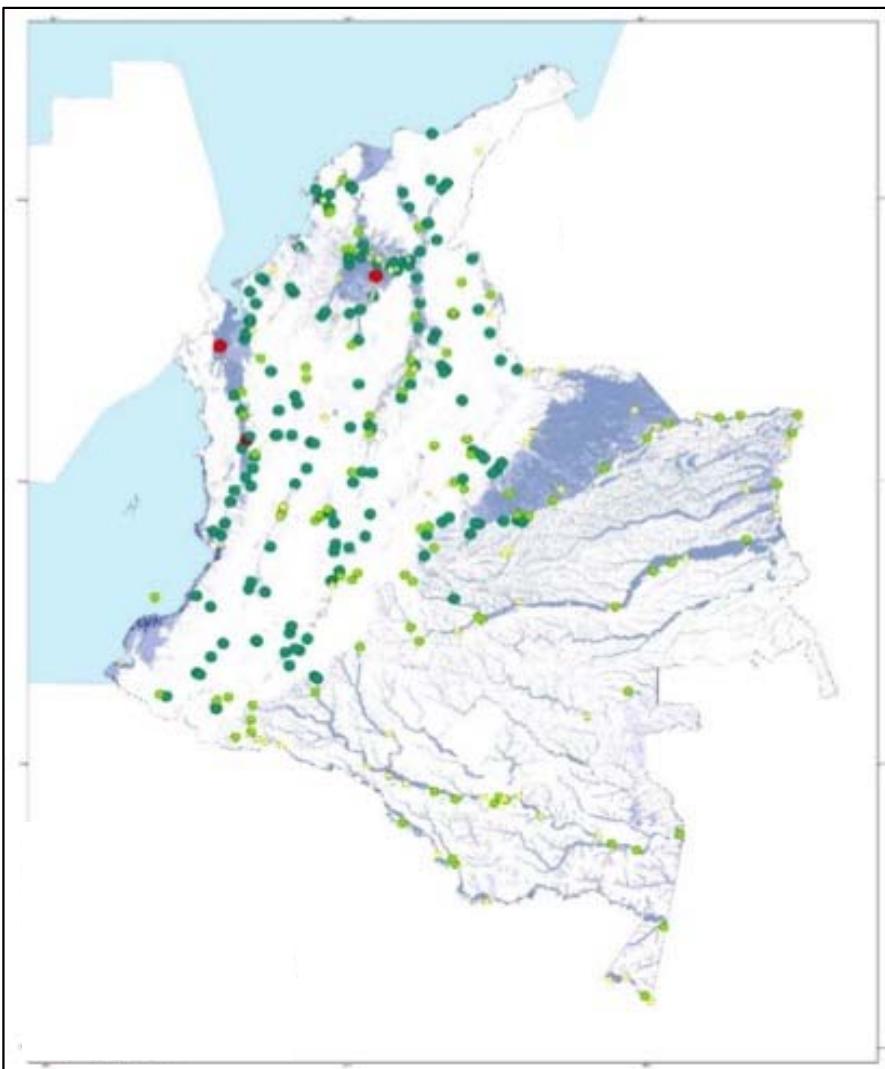
The Alos PalSAR is able to give a **new dimension** for the wetlands management in Colombia due to identifications of the flooded under the canopy which changes the management strategies that until now have been focus in the **water mirrors**



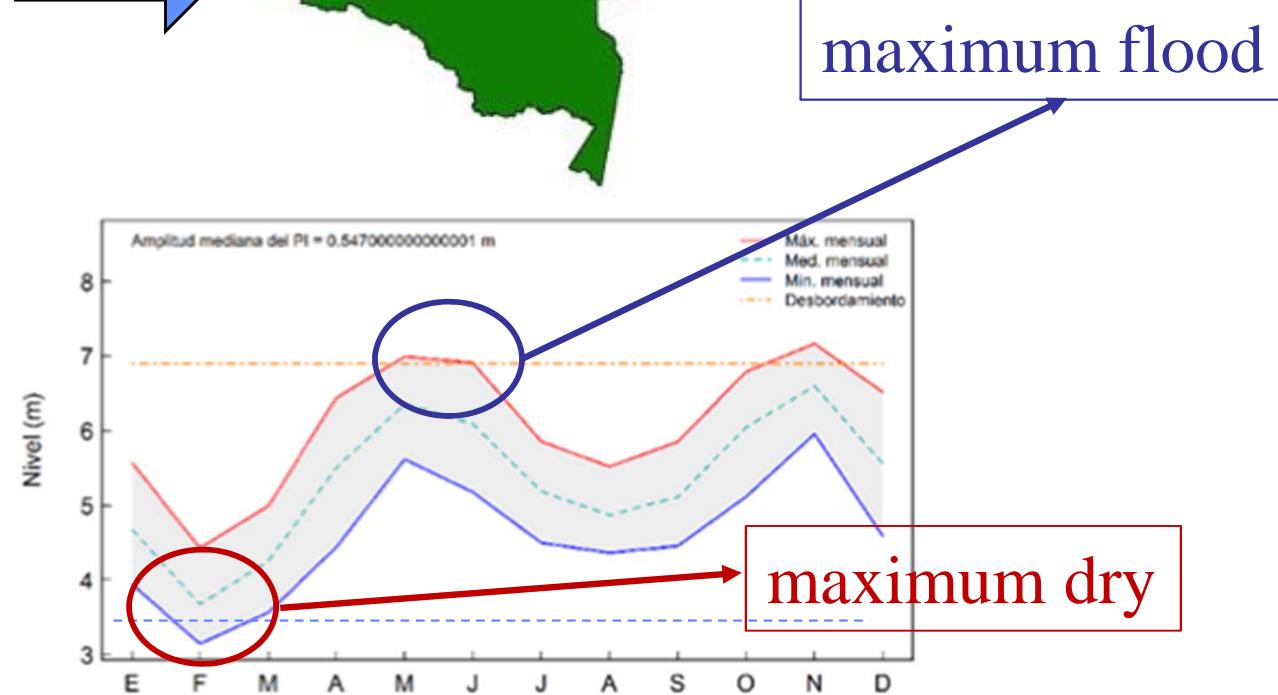
Hydrological component coming from local measurement-

Location of 357 hydrological stations

We analyzed : levels and water flow from 1974 – 2012 (40 years)

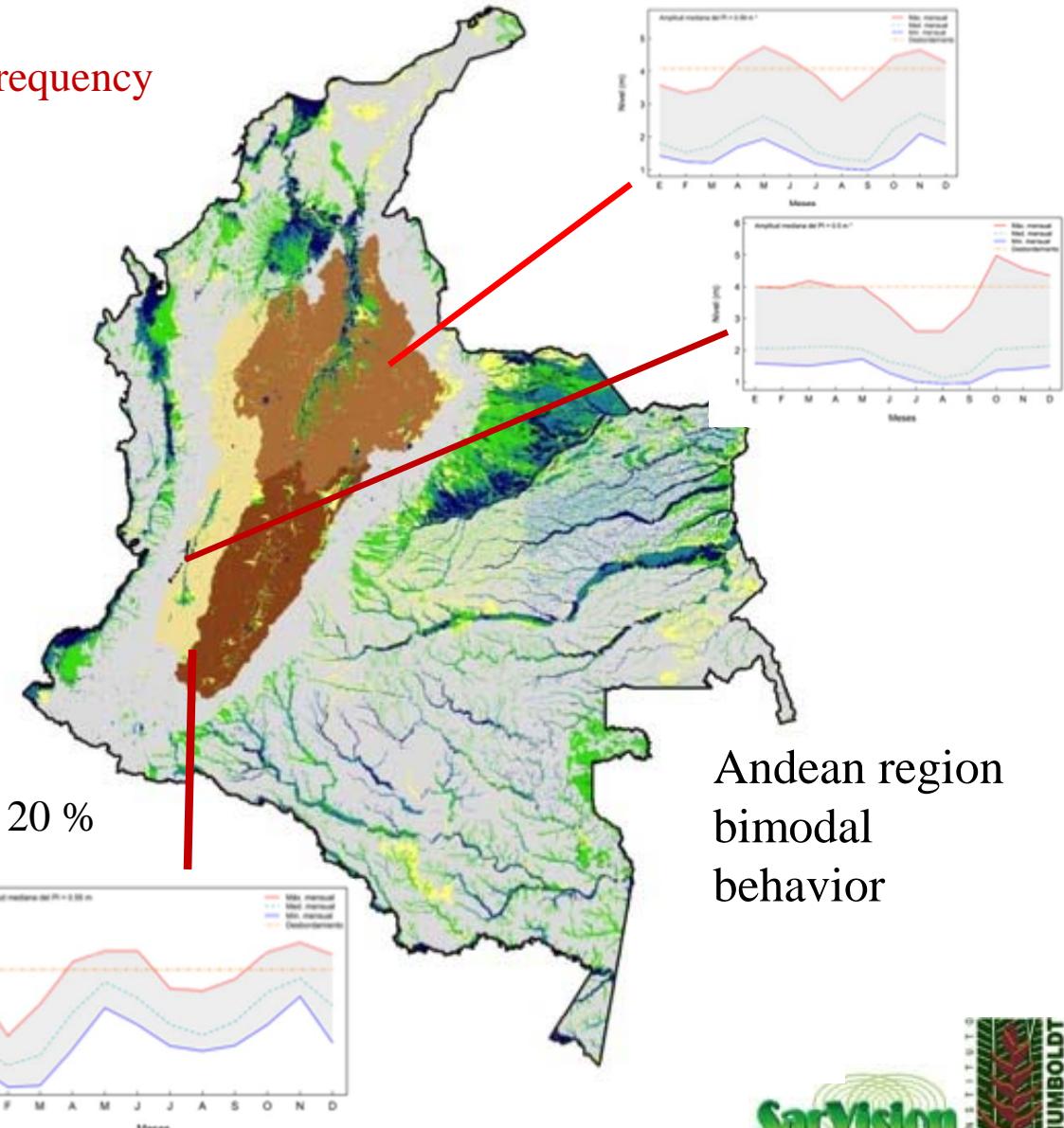
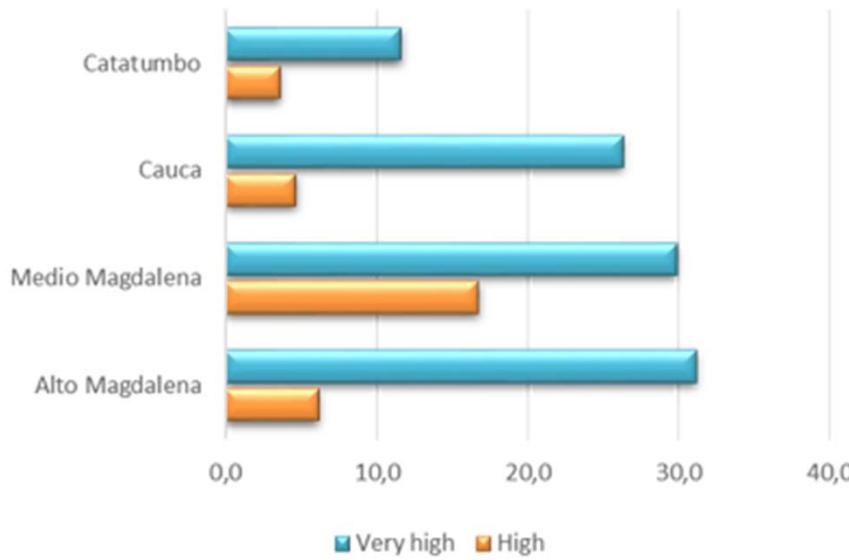


From this analysis we identify 8 regions with similar **hydrological regimes or flooded and dry pulses**



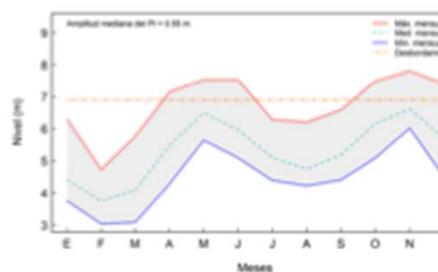
Hydrological component - Flooded frequency evaluation

We found more spatial correlation of the Alos Flood frequency at very high wetland potential classes



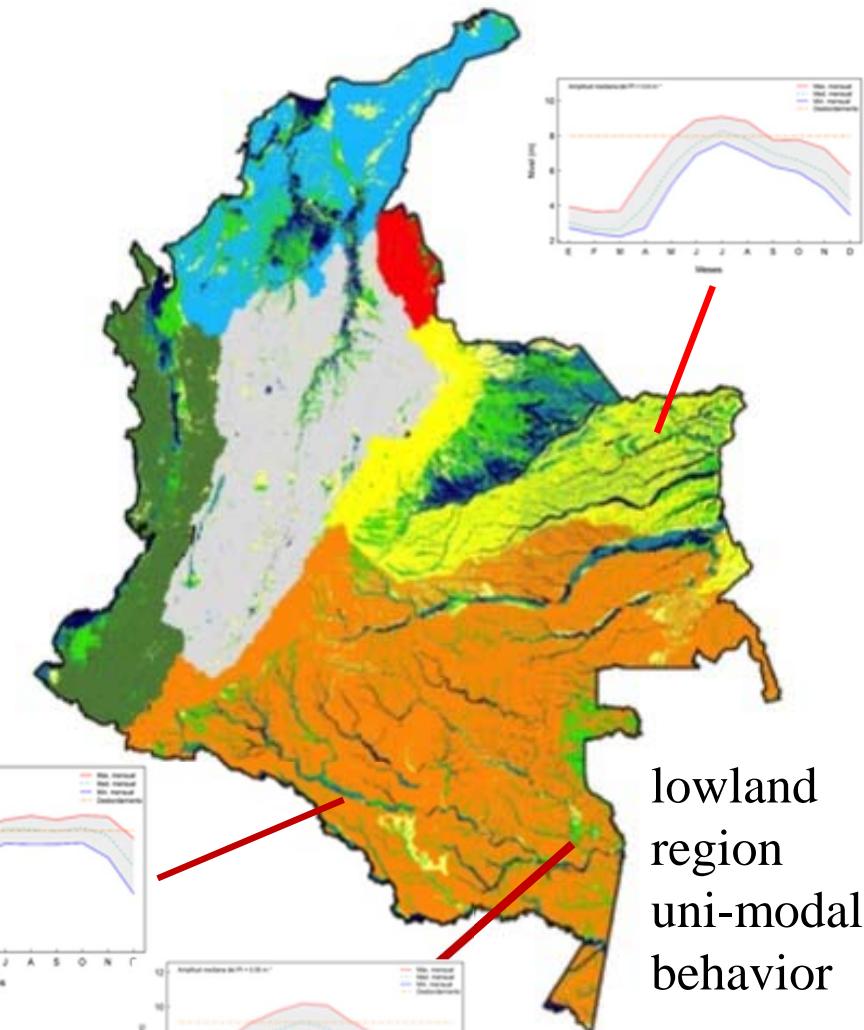
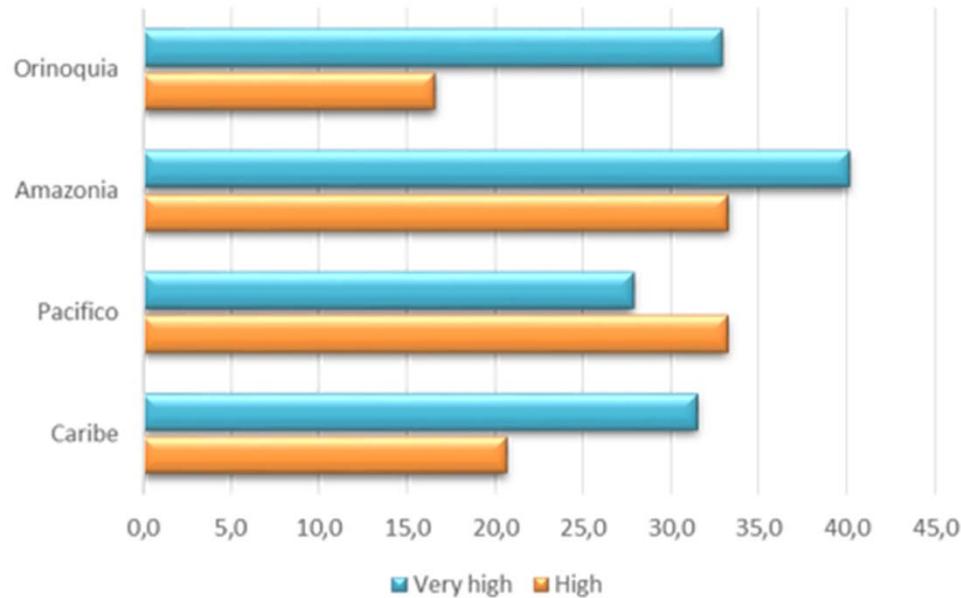
for the Andean region we found correspondance around 20 %

Mountain areas



Hydrological component - Flooded frequency evaluation

We found more spatial correlation of the Alos Flood frequency at the high and very high wetland potential classes



for the Lowlands we found correspondace around 40 %

Lowland areas

Some highlights into the Validation Process

- Validation is performed by IDEAM Institute that did not participated in map production
- 19 validation windows representing the main wetland complexes of the country
- Use of high resolution images, and other radar data available RADARSAT
- Validation methodology follows good practices for accuracy definition, after:

- Olofsson, P., Foody, G. M., Stehman, S. V., & Woodcock, C. E. (2013). Making better use of accuracy data in land change studies: Estimating accuracy and area and quantifying uncertainty using stratified estimation. *Remote Sensing of Environment*, 129, 122–131.
- Olofsson, P., Foody, G. M., Herold, M., Stehman, S. V., Woodcock, C. E., & Wulder, M. A. (2014). Good practices for estimating area and assessing accuracy of land change. *Remote Sensing of Environment*, 148, 42-57.

Preliminary results:

- Good detection for flooded forests and water mirrors
- We have problems with confusion between water and dry shrubs and dry pastures and bare soils with open areas (reflection of the wave in this covers)
- City peripheries appear to be flooded due to double bounce
- Since the diversity of Colombia is very high the Validation process is still in progress.
- Final report will include confusion matrixes

Just arrived!!

Validation results Overall accuracy!

$\hat{p}_{\cdot 1} = \sum_{i=1}^n W_i \frac{n_{i1}}{n_i}$: ERROR	referencia			Total comisión	Fiabilidad
	Inundación a cielo abierto	Inundación bajo dosel	No inundado		
$\hat{A}_1 = A_{tot} \times \hat{p}_{\cdot 1}$	Inundación a cielo abierto	1704	12	67	1783
	Inundación bajo dosel	2	1326	455	1783
	No inundado	31	288	7422	7741
Total Omisión	1737	1626	7944	11307	0.89
Precisión	0.98	0.82	0.93	0.91	0.924383125

Structural Vegetation Map

MATRIZ DE ERROR	referencia			Total comisión	Fiabilidad
	Inundación a cielo abierto	Inundación bajo dosel	No inundado		
Mapa	Inundación a cielo abierto	1487	35	139	1661
	Inundación bajo dosel	166	1148	355	1669
	No inundado	117	167	5581	5865
Total Omisión	1770	1350	6075	9195	0.84
Precisión	0.84	0.85	0.92	0.87	0.893529092

Frequency flooding 50m

MATRIZ DE ERROR	referencia			Total comisión	Fiabilidad
	Inundación a cielo abierto	Inundación bajo dosel	No inundado		
Mapa	Inundación a cielo abierto	1176	42	606	1824
	Inundación bajo dosel	151	1095	474	1720
	No inundado	71	161	5997	6229
Total Omisión	1398	1298	7077	9773	0.75
Precisión	0.84	0.84	0.85	0.84	0.846004298

Frequency flooding 100m

Working perspectives

Consolidate a 10 years national flooded and vegetation types base line to: **Use of PalSAR 2 will be essential to complete the baseline**

- Understand the hydrologic dynamics of the Colombia wetlands
- Determine the structure and extension of the wetland vegetation types to provide information to the environmental agencies for restoration and compensation projects (mining and infrastructure)
- Offer information for wetland zoning and management process based in flooded frequencies
- Integrate **other Radar frequencies ,C band SENTINEL** to complement and correct the baseline
- Use of MODIS information and other optical high resolution for delineation at more detail

Radar Capacity buildings was done within the frame of this project in which 20 professionals on remote sensing belonging to the different environmental institutes , had now the capacity to continue and extend this work in he frame of the establishment of a future monitoring system !

Acknowledgements:

JAXA and K&C

Dirk Hoekman : **Wageningen University**

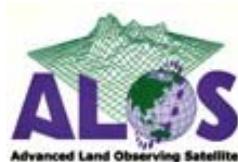
Jeronimo Rodriguez, Ursula Jaramillo, Sandra Vilardy, Lina Estupiñan, Cesar Aponte.

Instituto Humboldt

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PROSPERIDAD PARA TODOS

