Monitoring extreme environmental conditions in wetland macrosystems using optical and RADAR satellite data

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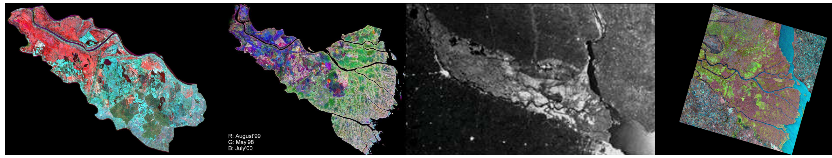
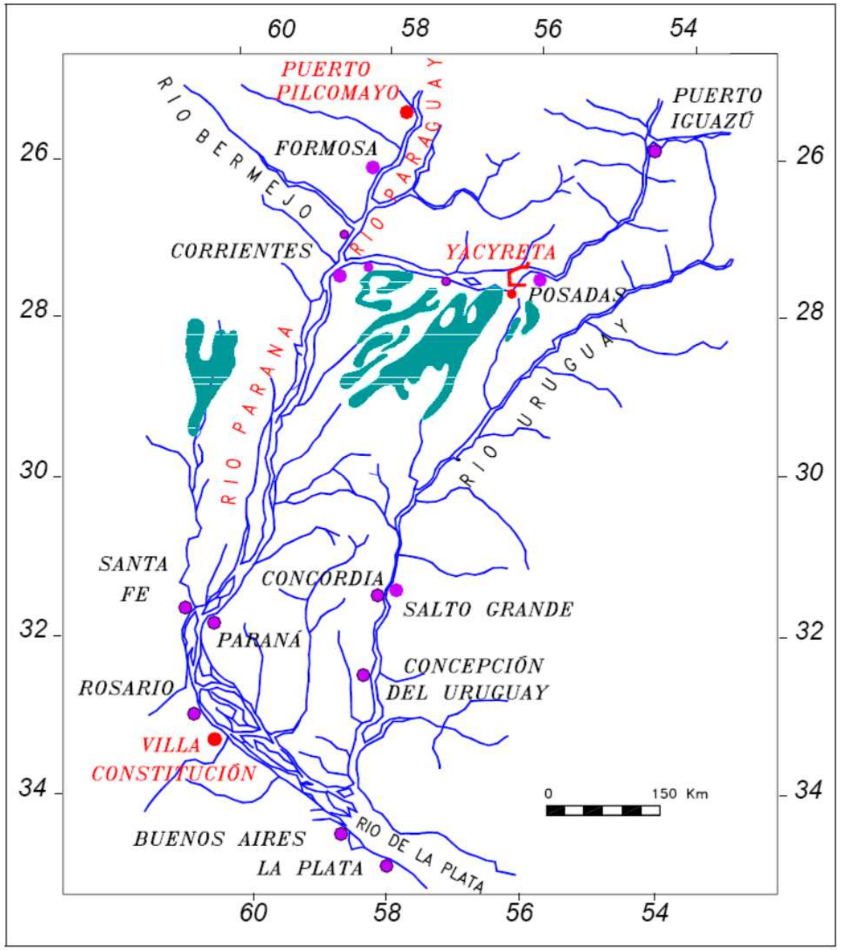
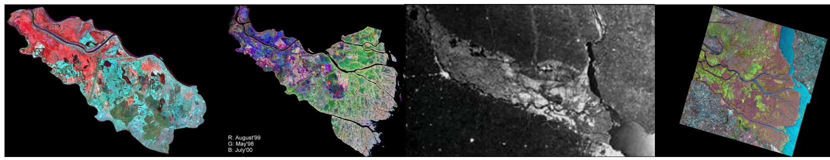
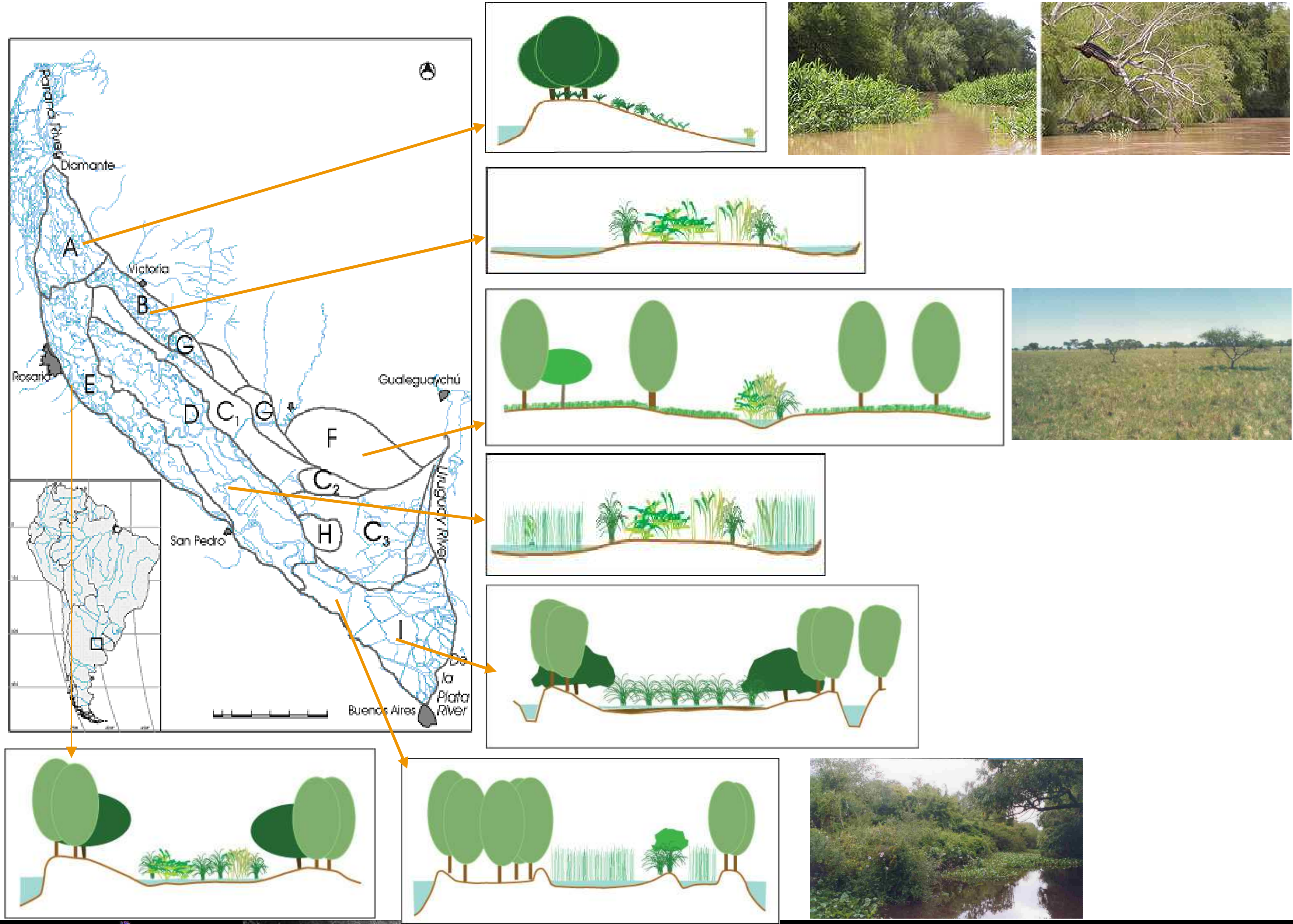


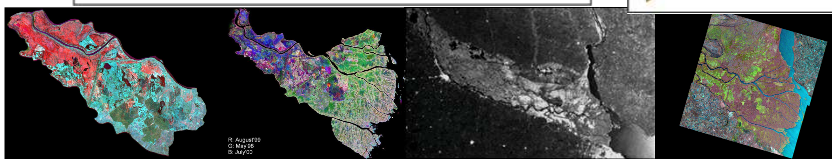
Paraná River Delta - Argentina

NOAA AVHRR Image of Lower Paraná watershed acquired in 1998 during “el Niño” phenomena.









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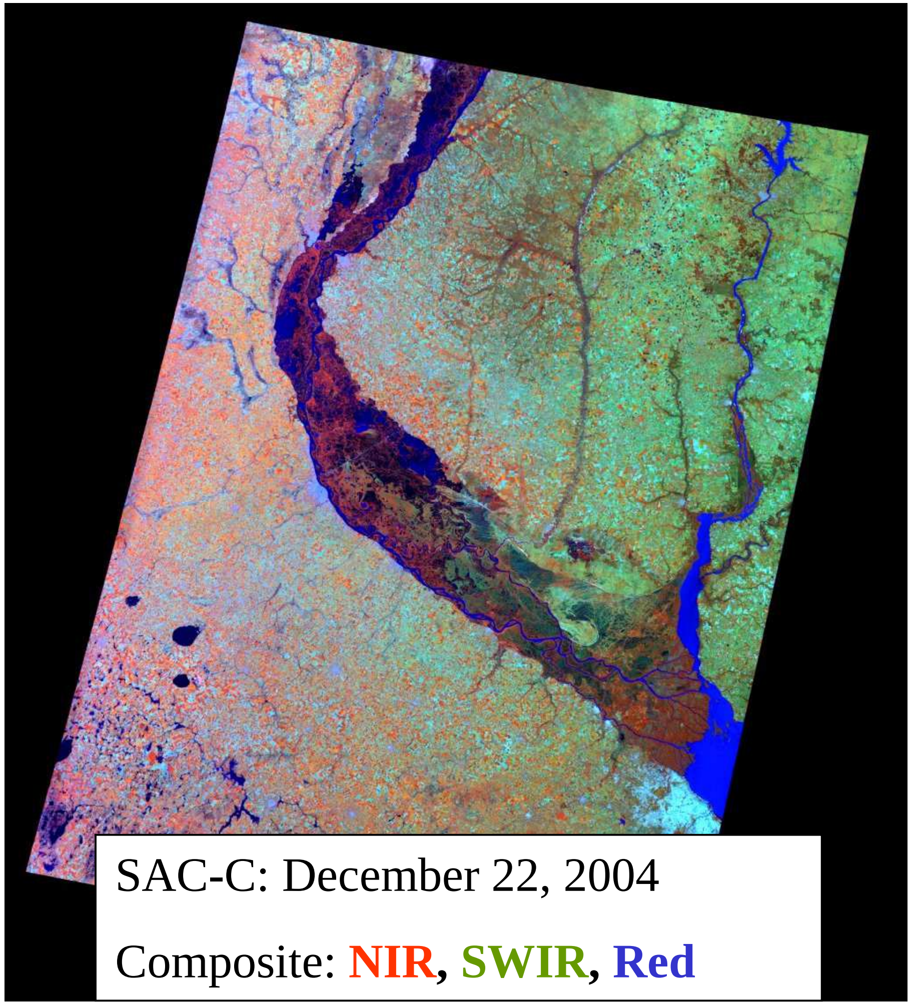
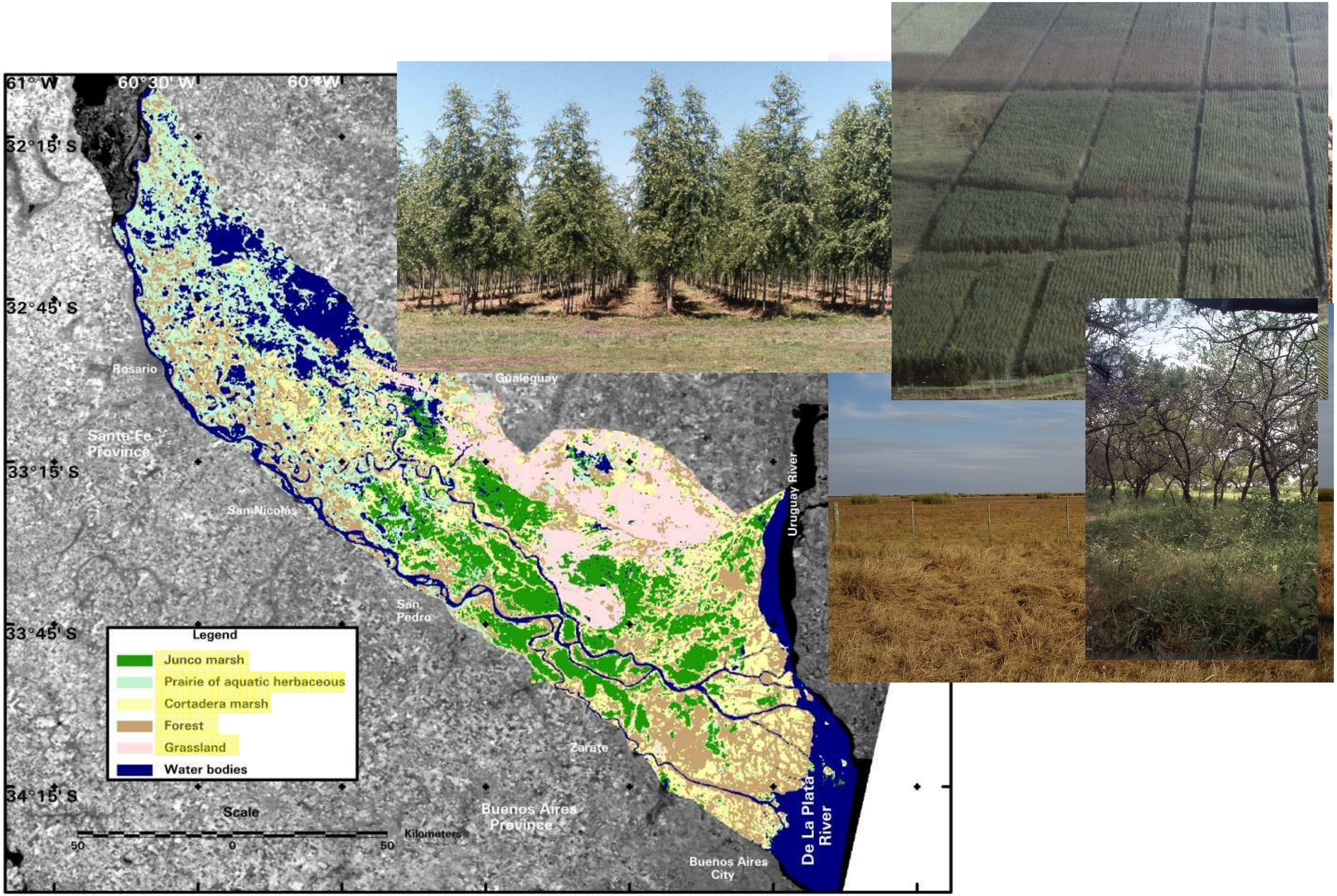
Medium resolution optical data for land cover maps

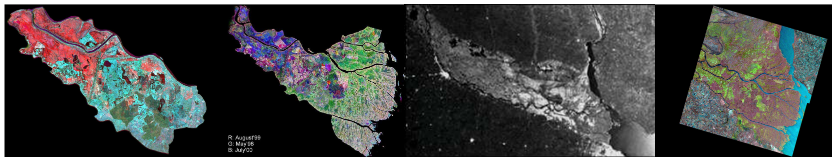
	SACC-MMRS
Space Agency	**CONAE (Argentina)**
Swath	**360 Km.**
Pixel Size	**175 m.**
Repeat Cycle	**9 days**
Number of bands	**5**
Wavelengths	**480-500 nm 540-560 nm 630-690 nm 795-835 nm 1550-1700 nm**
Radiometric resolution	**8 bits**



SAC-C: December 22, 2004

Composite: **NIR**, **SWIR**, **Red**





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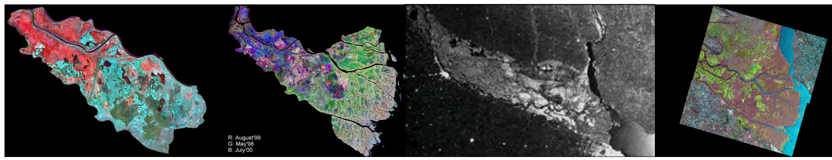
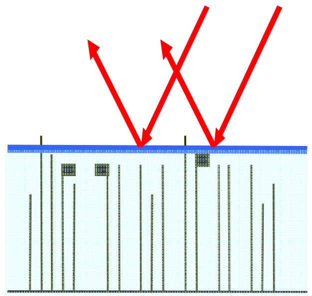
During the flooding event (summer 2007) large cattle raising areas of the region were seriously affected and about 200000 cows had to be moved rapidly to avoid animal deaths and important economic losses. Some cities located at the river margin were flooded and people had to be evacuated from their homes.



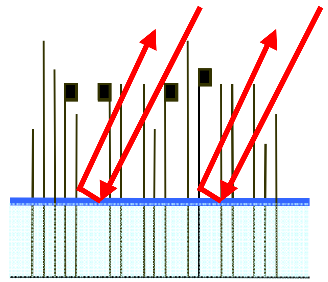
Why RADAR in wetlands?

Microwave sensors can penetrate vegetation and, in particular, synthetic aperture radars sensors (SAR) have been successfully used to map hydrological condition (flooded, non flooded, dry) of wetlands vegetation and water level within floodplains.

Interaction mechanisms



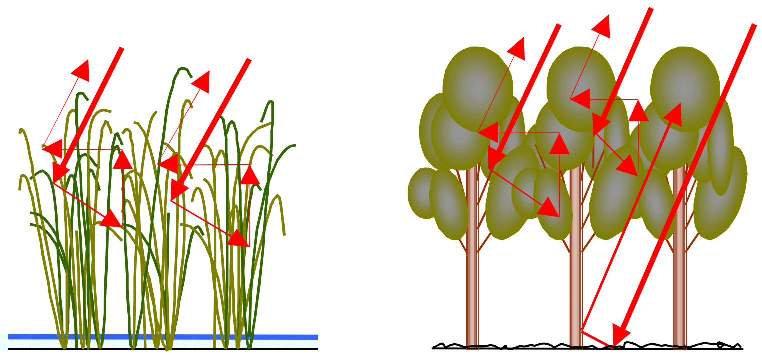
Specular reflection



Double bounce

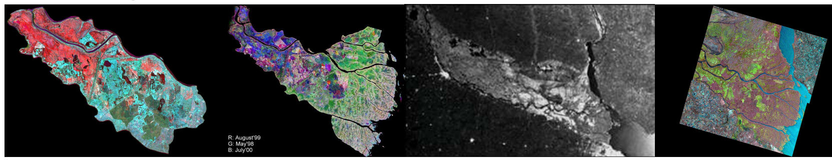
CHALLENGES IN RADAR REMOTE SENSING

Although it has already been proved that σ^0 is sensitive to water level changes, the magnitude and even sign of these changes depends strongly on vegetation type, conditions and SAR incidence angle and frequency of operation.



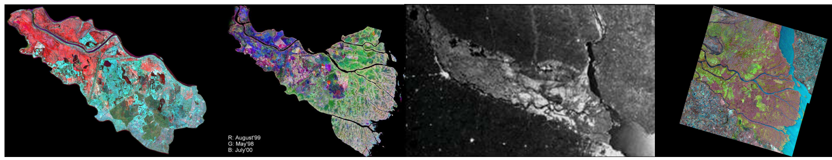
Volume scattering

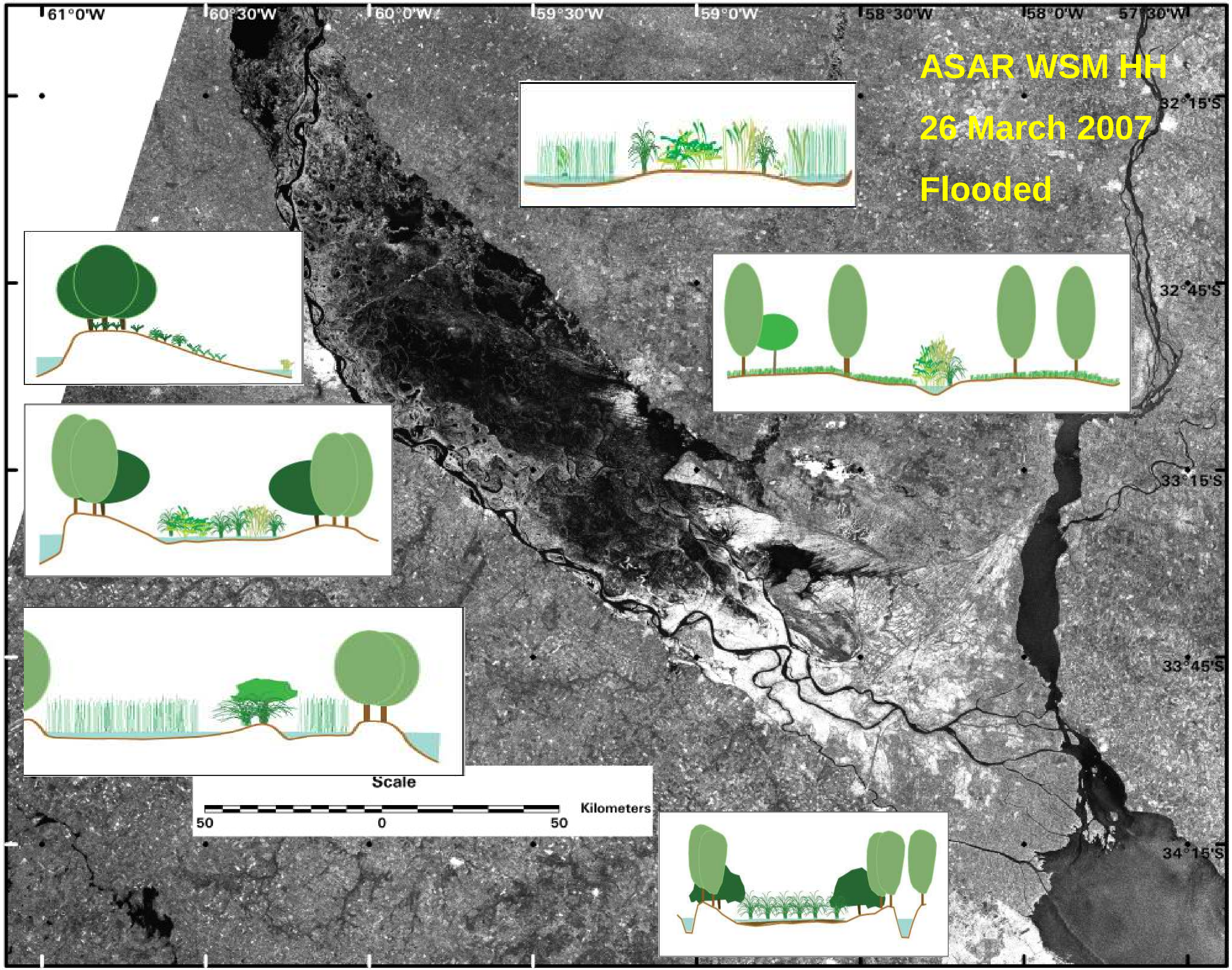
This is because microwave signal interacts with elements of earth surface primarily by its **structural** and **dielectric** characteristics, as well as the **hydrological condition** of the soil beneath it. Thus, the analysis of microwave data must account for these characteristics of vegetation

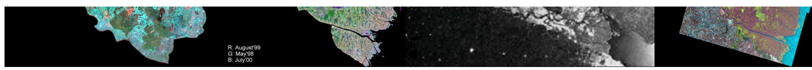


In this work, several ENVISAT ASAR Wide Swath C band HH polarization images were acquired over the area during the periods mentioned above and used to assess changes in soil condition (flooded, non flooded, dry) of different vegetation structures.

Additionally, SACC-MMRS data was used to estimate the area and land cover classes affected by fire.







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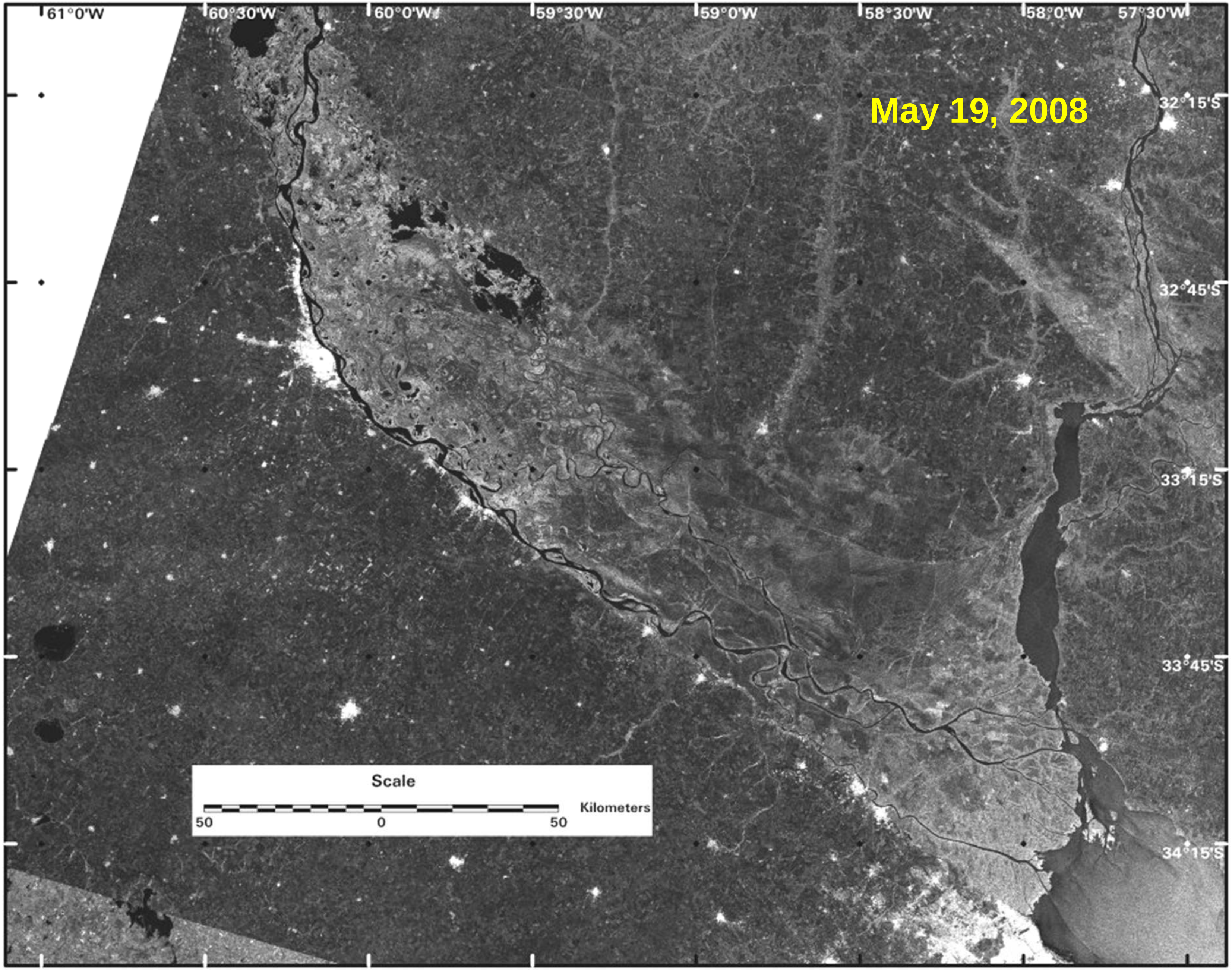
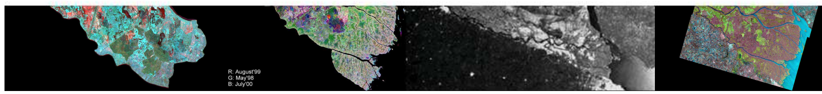
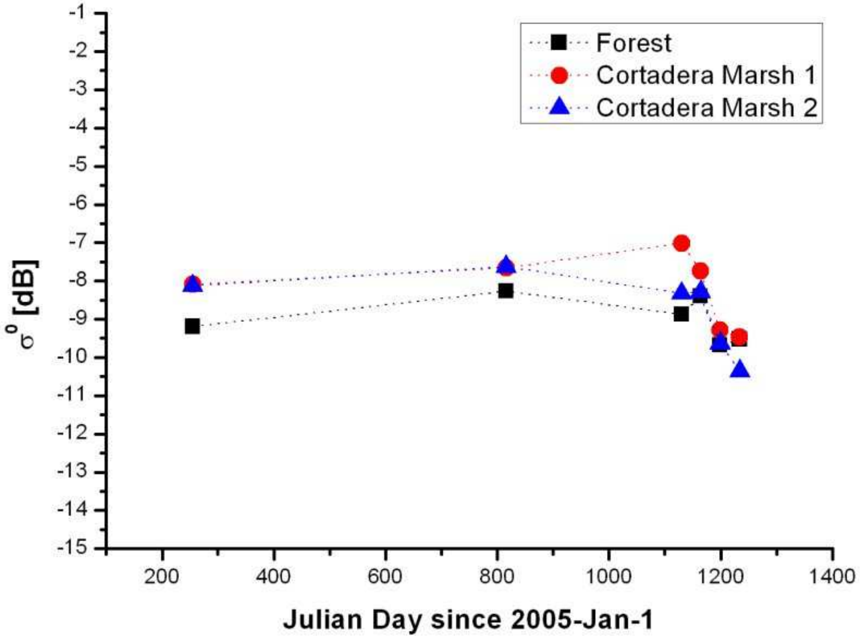
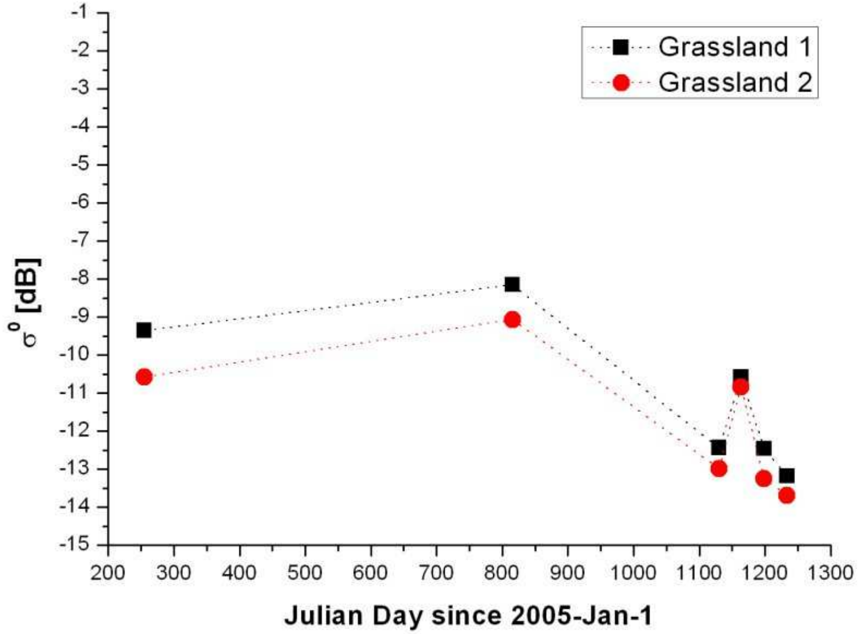


May 19, 2008
61°0'W
60°30'W
60°0'W
59°30'W
59°0'W
58°30'W
58°0'W
57°30'W
32°15'S
32°45'S
33°15'S
33°45'S
34°15'S
Scale
50
0
50
Kilometers

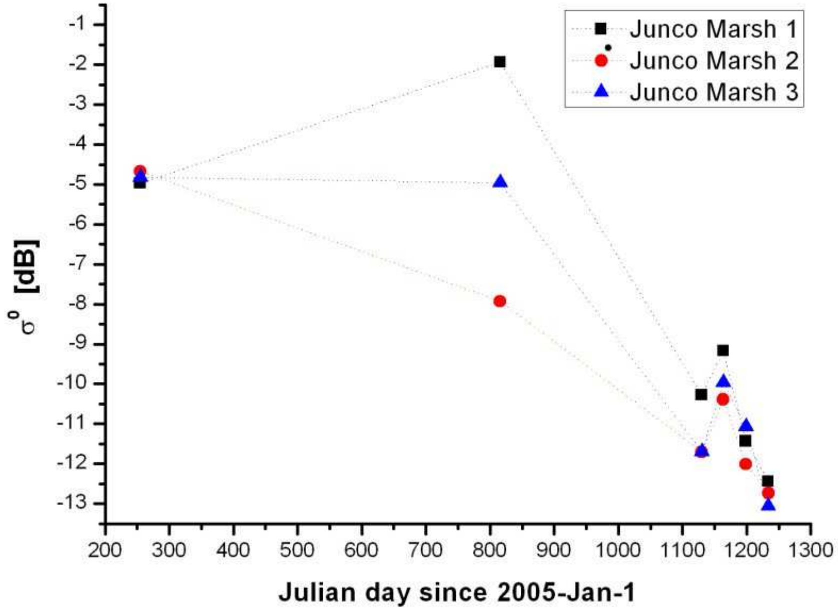




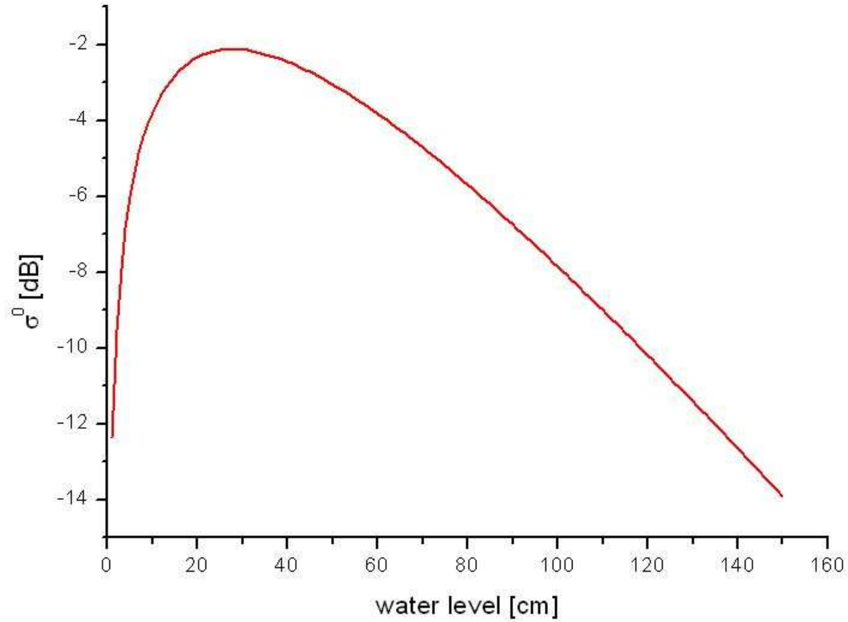
Forest
Cortadera Marsh 1
Cortadera Marsh 2
σ⁰ [dB]
Julian Day since 2005-Jan-1



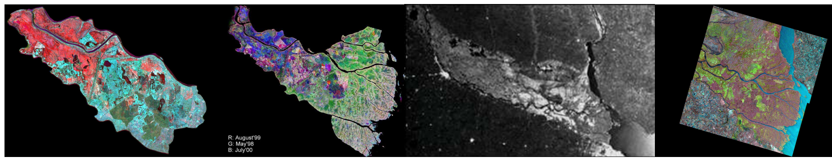
Grassland 1
Grassland 2
σ⁰ [dB]
Julian Day since 2005-Jan-1

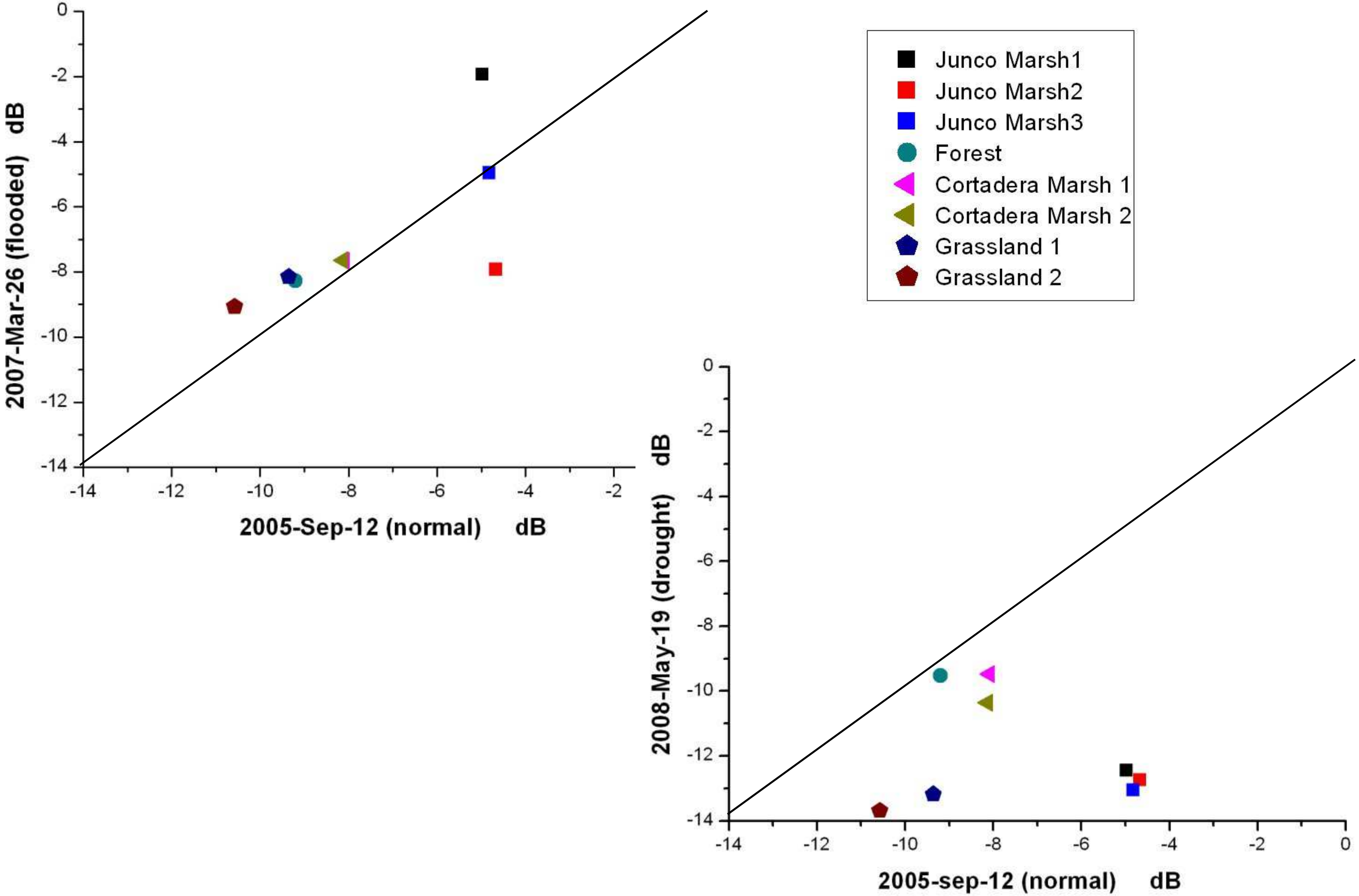


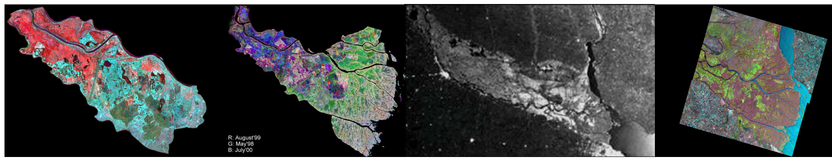
Junco Marsh 1
Junco Marsh 2
Junco Marsh 3
σ⁰ [dB]
Julian day since 2005-Jan-1



σ⁰ [dB]
water level [cm]







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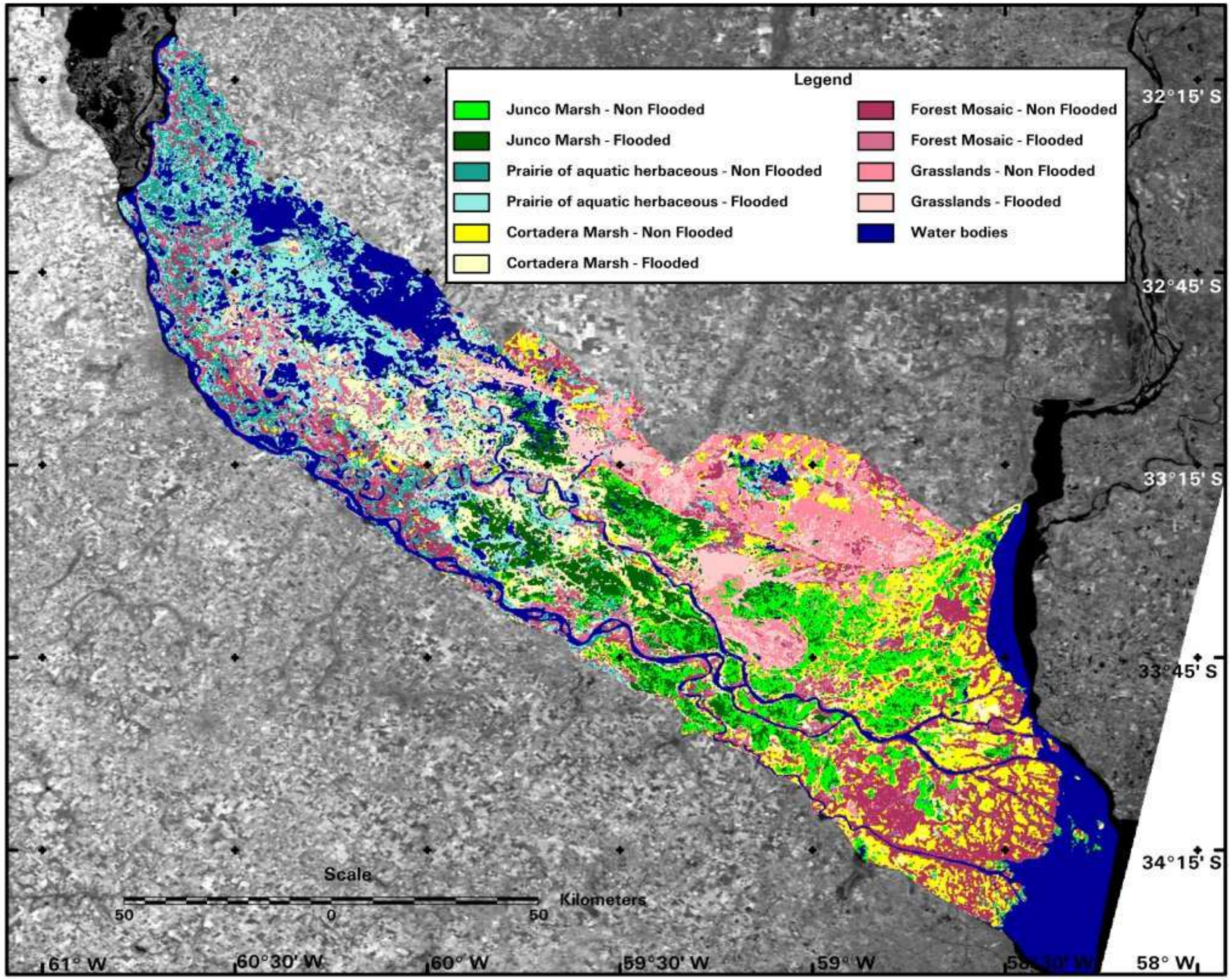
Products generated with ASAR WSM images.

Flooding of summer 2007. Maping the extent of the flood and the ecosystems affected.



This map was created using change detection based on the image difference method.

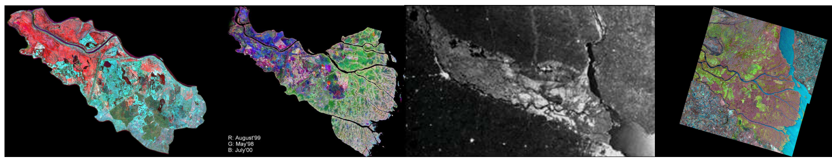
This map was created by crossing the flooding map with the land cover map.

It was considered that any area with a change of more than 2 dB (increase or decrease) was flooded.

Herbaceous vegetation (specially prairies of aquatic herbaceous and junco marshes) were more affected by flooding than forests

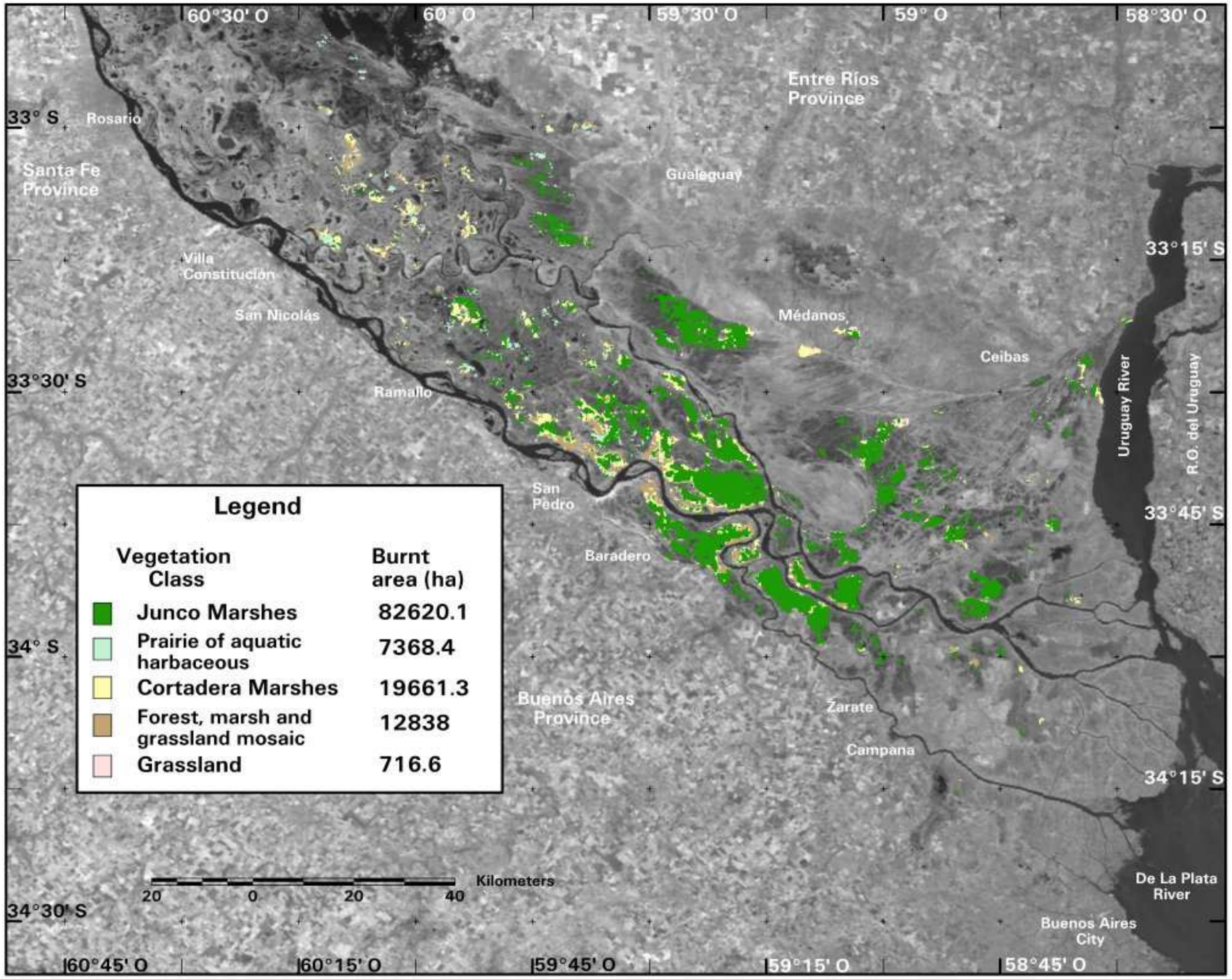
The flooded area up to 2009-March-26 was 840946.5 ha (approximately 50% of the Paraná River Delta)

The total area affected was larger, since in the following weeks the rainfall was more that 300mm.



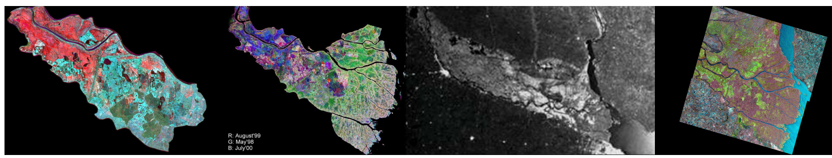
Products generated with SACC-MMRS images.

Drought of summer 2008. Mapping the burnt areas and the ecosystems affected.



This map of burnt areas was generated by segmentation of the NIR band of SACC-MMRS image from Apr 21, 2008. The area burnt up to that date was approximately 123204 ha

The most affected vegetation cover was junco marshes, followed by Cortadera marshes and forests.



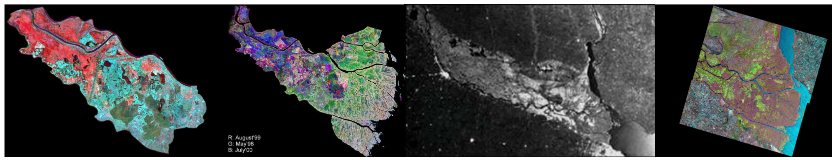
Concluding remarks I
Optical data.

• We were able to generate the first land cover map at regional scale, up to the level of physiognomic groups using medium resolution optical data (SACC-MMRS).

• In order to get a more detailed map, it would be necessary to use optical images with better spatial and spectral resolution, with the increase of processing time that involves.

• SACC images were also able to determine the extent of burnt areas.

• By intersecting both optical products we were able to assess the damage provoked by fire in each ecosystem.



Concluding remarks II
SAR data.

• Using medium resolution SAR data, we were able to estimate the extent of the last flooding in the area.

• Intersecting the land cover map with the flooded area map we were able to assess which ecosystems were more affected.

•SAR systems in wetlands are better used combined with optical and thermal systems. As we saw, SAR systems are able to discriminate different hydrological conditions (normal, flooded, dry), but no all of them (extremely dry – burnt).

•Also, it is not simple to distinguish between hydrological and phenological changes. So, a monitoring scheme should use also a optical system to check for changes in the near infrared, to separate these two effects.