Monitoring *Spartina* Marshes in the Argentine Coast: integrating Biophysical Parameters, Hyperspectral Field Data and Satellite Observations.

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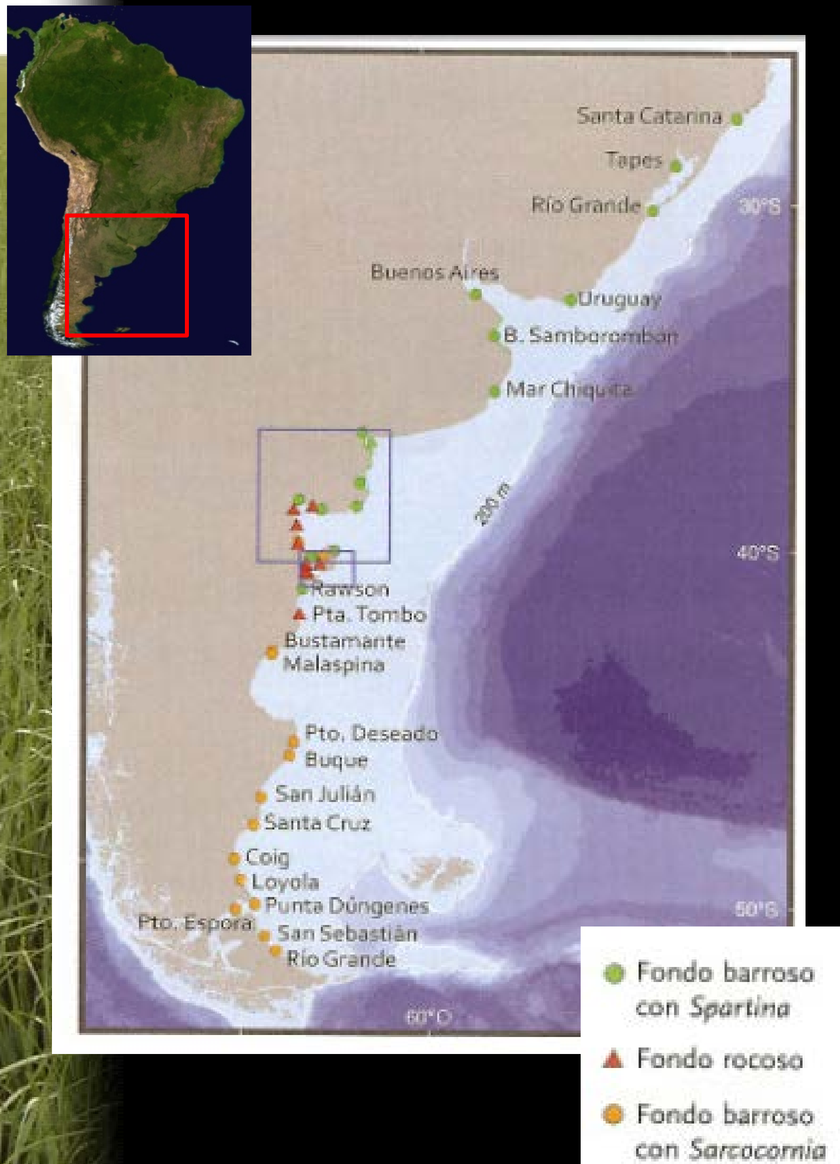
[3] Instituto Argentino de Oceanografía (IADO)

Argentina

Salt marshes of the Southamerican Atlantic Coast



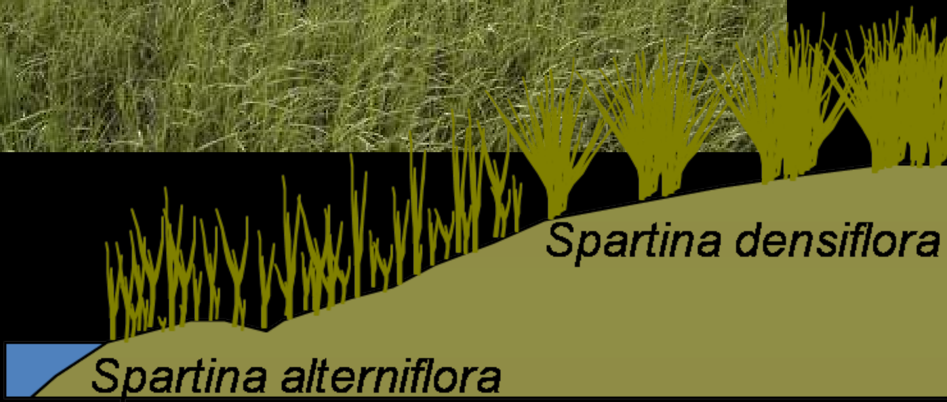
Salt marshes extend from the southern portion of Brazil up to Tierra del Fuego, Argentina.

This low energy intertidal environments are dominated by ***Spartina densiflora, S. alterniflora* and *Sarcocornia perennis***

Idaszkin, Y.L., Bortolus, A., and Bouza, P.J., 2010. Ecological processes shaping central Patagonian salt marsh landscapes. *Austral Ecology*, 36(1), 59-67

Spartina alterniflora (Smooth cordgrass)

- Native to the temperate Atlantic Coast of the American Continent
- It occupies lower intertidal zones while in the higer zones *S. densiflora* is found in South America
- Primarily maintained by vegetative reproduction



OBJECTIVE

In order to develop procedures to map and monitor *Spartina alterniflora* marshes, we attempt to integrate Leaf Area Index (LAI) and Biomass (Bio) acquired at field local scale, with satellite remote sensing data.

This work took place at Bahia Blanca Estuary, Argentina.

Bahía Blanca Estuary

One of the most important salt marsh in Argentina, where *S. alterniflora* form Monospecific stands

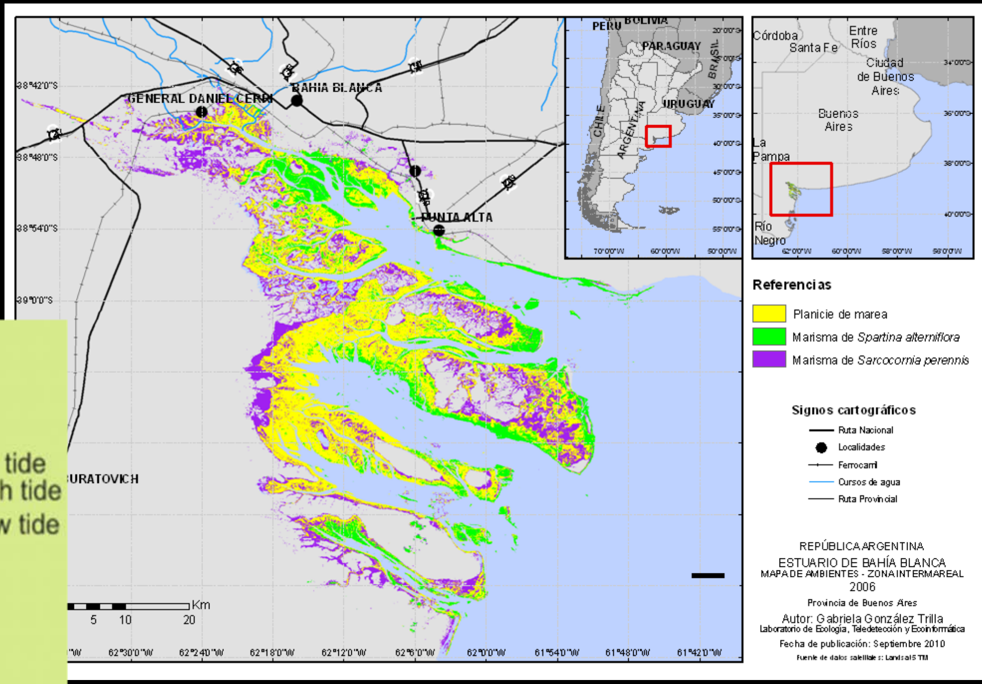
It extends between 38°45' and 39°25' S

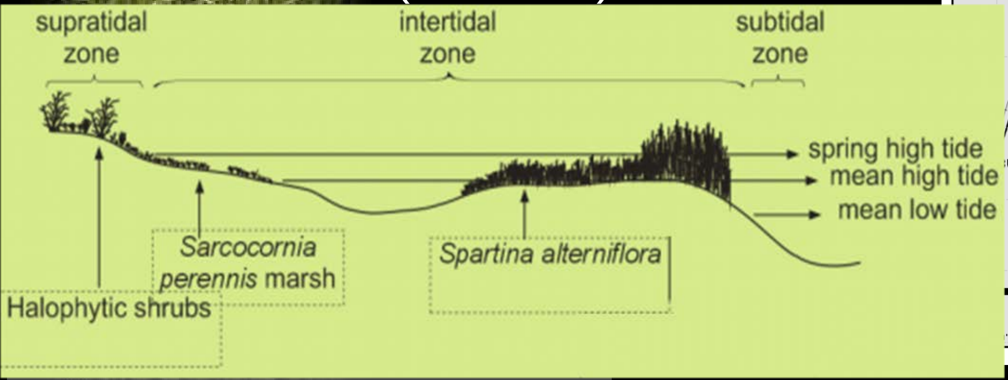
Northern limit of the Patagonian desert

The estuary covers 2500 Km^2 : 410 km^2 of marshes and more than 1150 km^2 of mudflats.

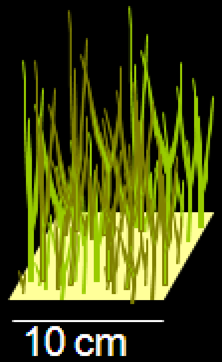
Mesotidal (up to 4m)

Low freshwater inflow (3 m3 s-1)



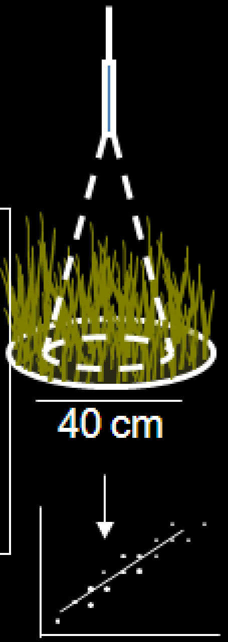


DEVELOPMENT



Field Biomass and LAI data of *S. alterniflora.* (LAI_{field} Bio_{field}).

Regression models between Biomass and LAI and Field radiometer data (Eq_{rad}).

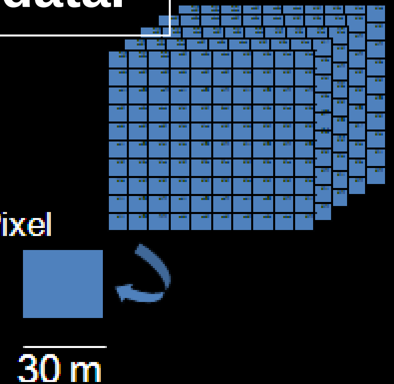


Down/Up scaling

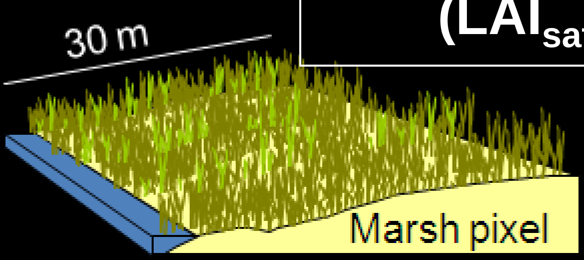
Up scaling

Satellite data.

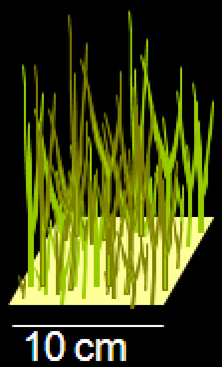
Time series 2005-2007 period



Biomass and LAI estimation based on satellite data (LAI_{sat} Bio_{sat}).



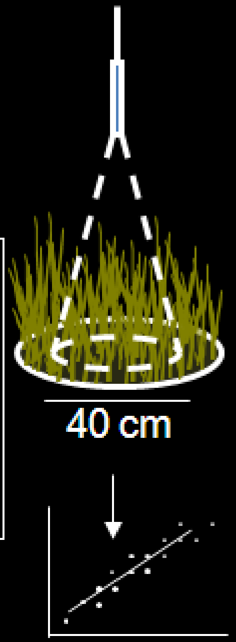
DEVELOPMENT



Field Biomass and LAI data of *S. alterniflora.* (LAI_{field} Bio_{field})

Measured in permanent sample plots (10 cm side), based on allometric equations (2005-2007)

Regression models between Biomass and LAI and Field radiometer data (Eq_{rad}).



Down/Up scaling

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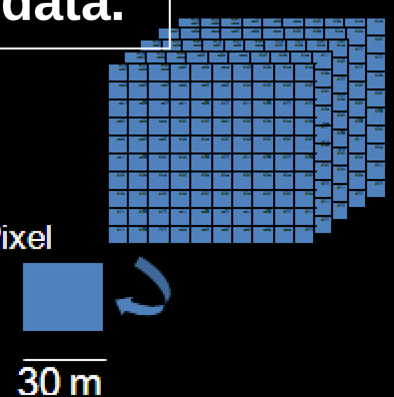
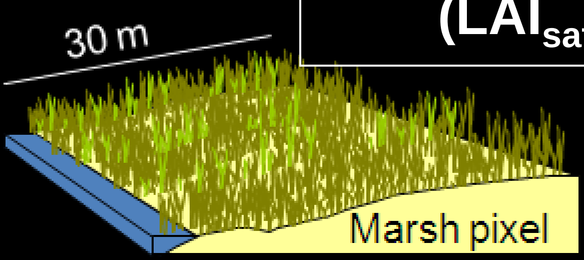
Biomass and LAI estimation based on satellite data (LAI_{sat} Bio_{sat}).

Satellite data.

Time series 2005-2007 period





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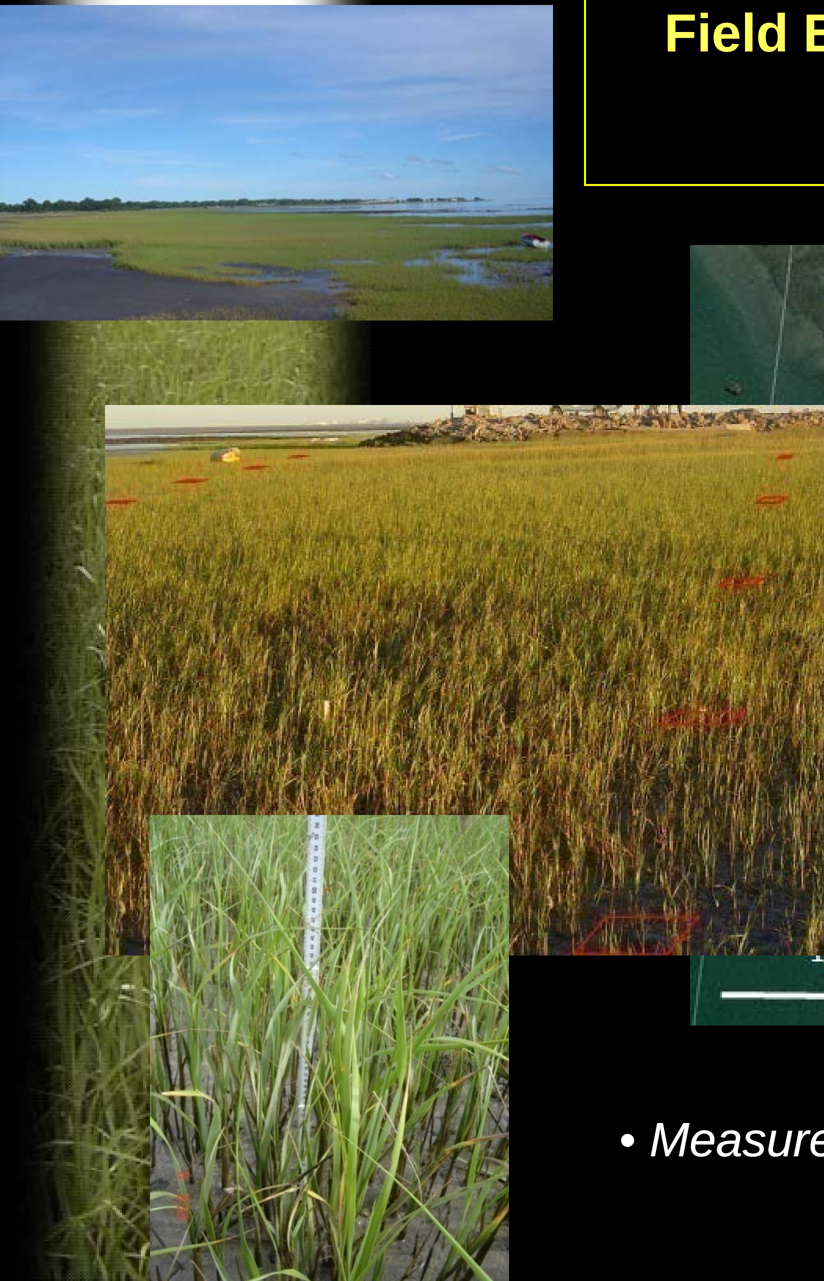
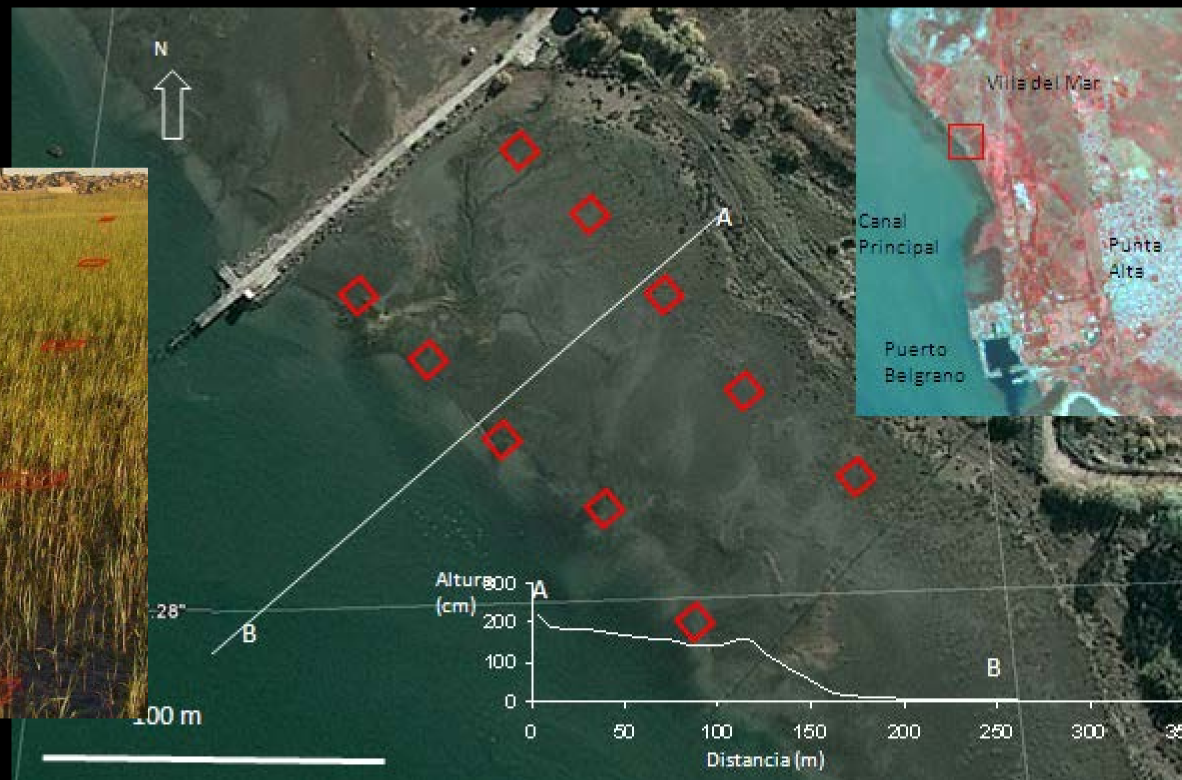




• *Measured in permanent sample plots (10 cm side)*

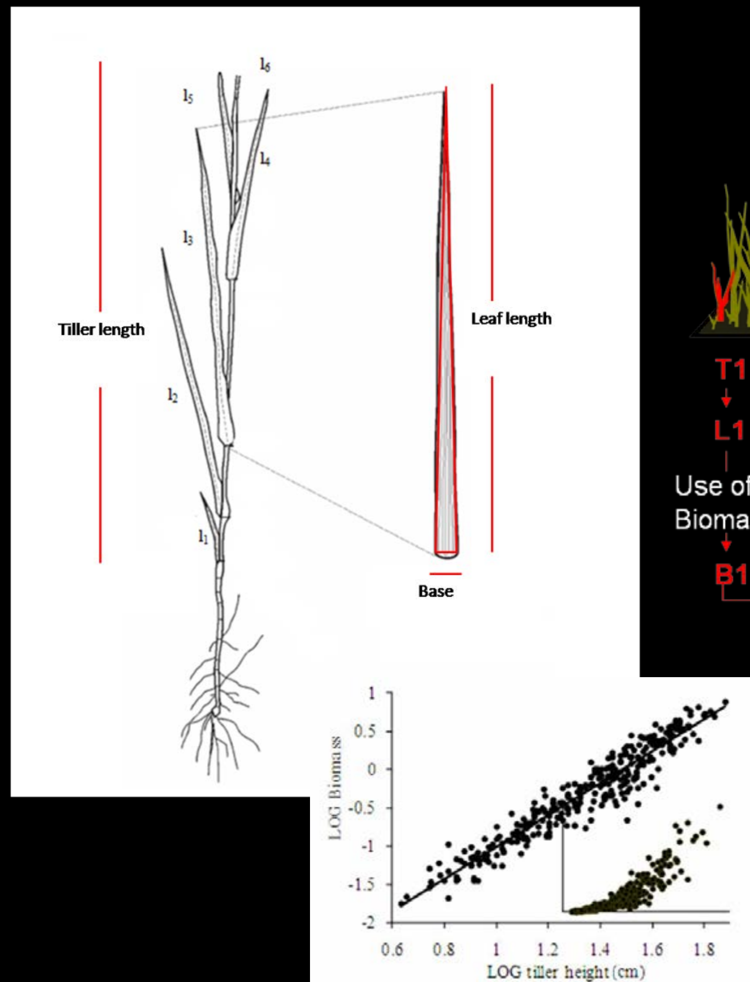
Field Biomass and LAI data of *S. alterniflora*. (LAI_{field} Bio_{field}).

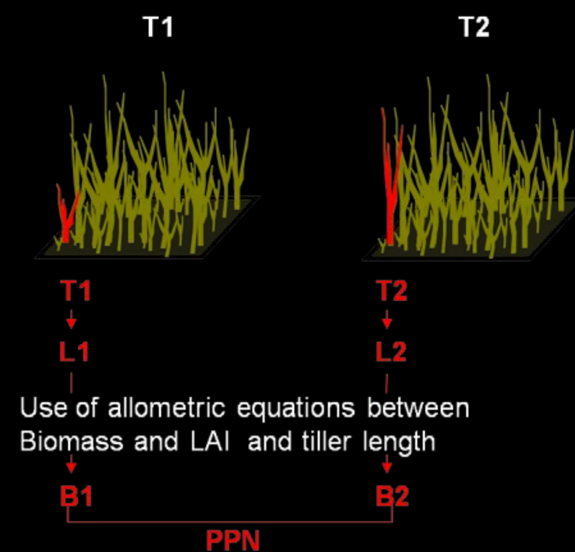
Tagging and following tillers in permanent sample plots

Use of allometric regressions

Measurements every 2 months.

Study period: 2005-2007: 2 growing seasons.



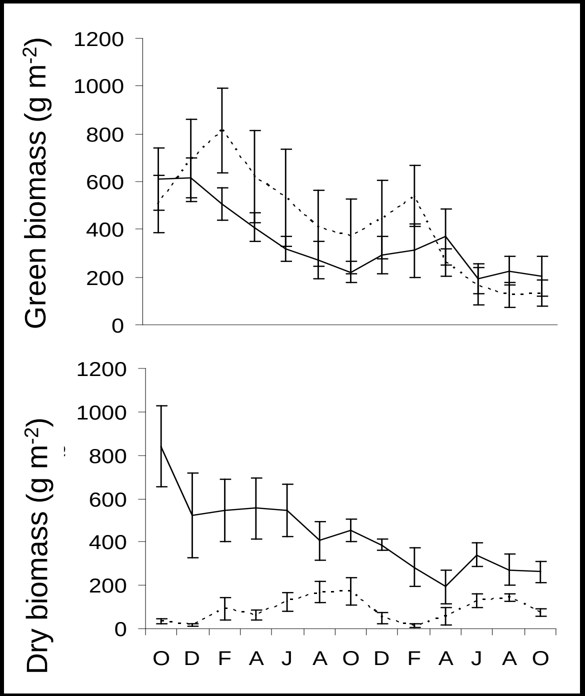


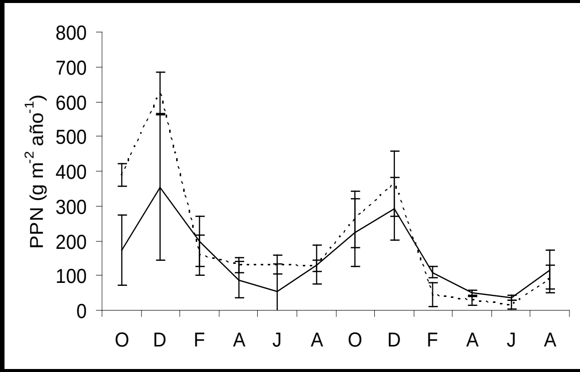
•González Trilla G, Schivo F, Borro M, Morandeira N, Kandus P, Marcovecchio J. Allometric scaling of dry weight and leaf area for Spartina densiflora and Spartina alterniflora in two south-west Atlantic saltmarshes. Journal of Coastal Research. In press.

Field Biomass and LAI data of *S. alterniflora*. (LAI_{field} Bio_{field}).

Aboveground primary productivity is around 628 ± 327 g m^{-2} $year^{-1}$.

Total Biomass was estimated as 655.75 ± 120 g m^{-2}

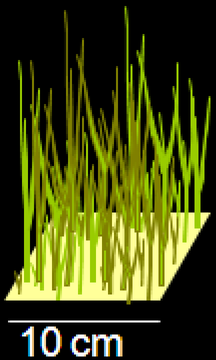




•González Trilla, G., Kandus, P., Negrin, V. and Marcovecchio, J. 2009. Tiller dynamic and production on a SW Atlantic *Spartina Alterniflora* marsh. Estuarine, Coastal and Shelf Science. 85:1 (126-133).

•González Trilla, G., De Marco, S., Marcovecchio, J., Vicari, R. and Kandus, P. 2010. Net Primary productivity of *Spartina densiflora brong* in a SW atlantic coastal salt marsh. Estuaries and Coasts. 33 (4): 953-962.

DEVELOPMENT

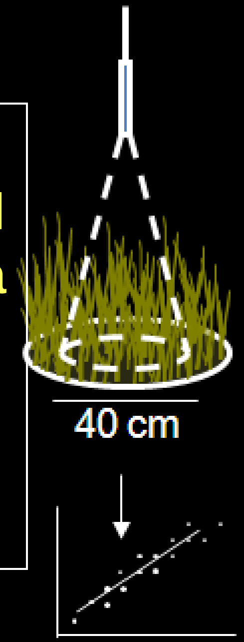


Field Biomass and LAI data of *S. alterniflora*. (LAI_{field} Bio_{field}).

Down/Up scaling

Regression models between Biomass and LAI and Field radiometer data (Eq_{rad}).

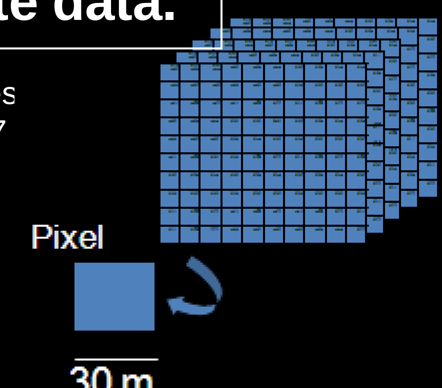
Reflectance measured in circular plots (40 cm diameter). Biomass and LAI between $NDVI_{rad}$ and $MSAVI_{rad}$ regression equations were generated.



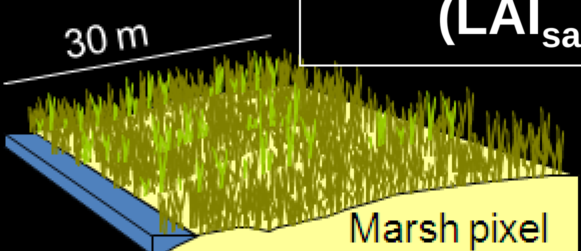
Up scaling

Satellite data.

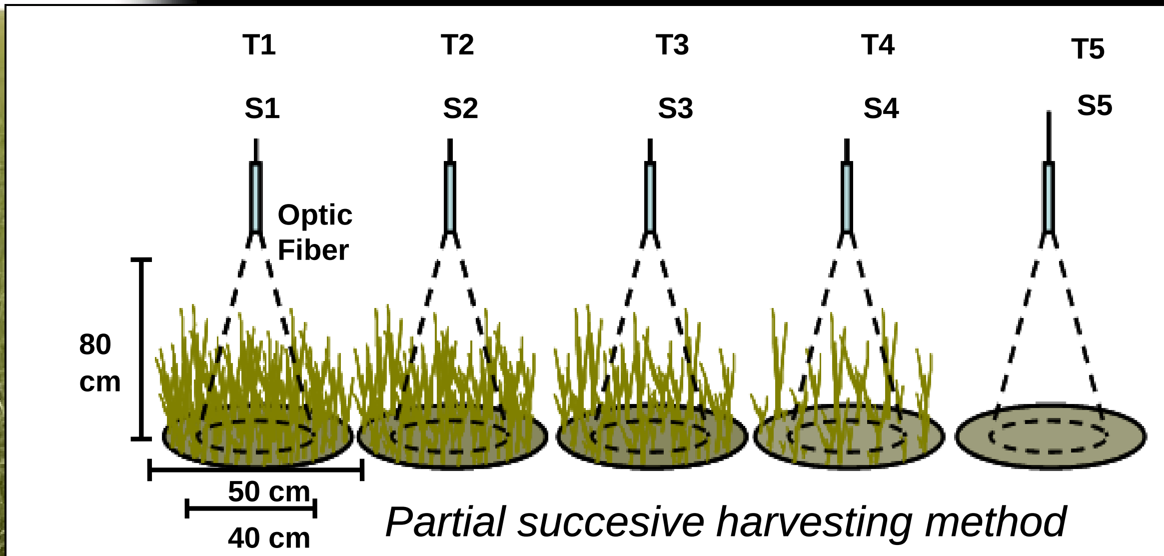
Time series 2005-2007 period



Biomass and LAI estimation based on satellite data (LAI_{sat} Bio_{sat}).



Regression models between Biomass /LAI and Field radiometer data (Eq_{rad}).

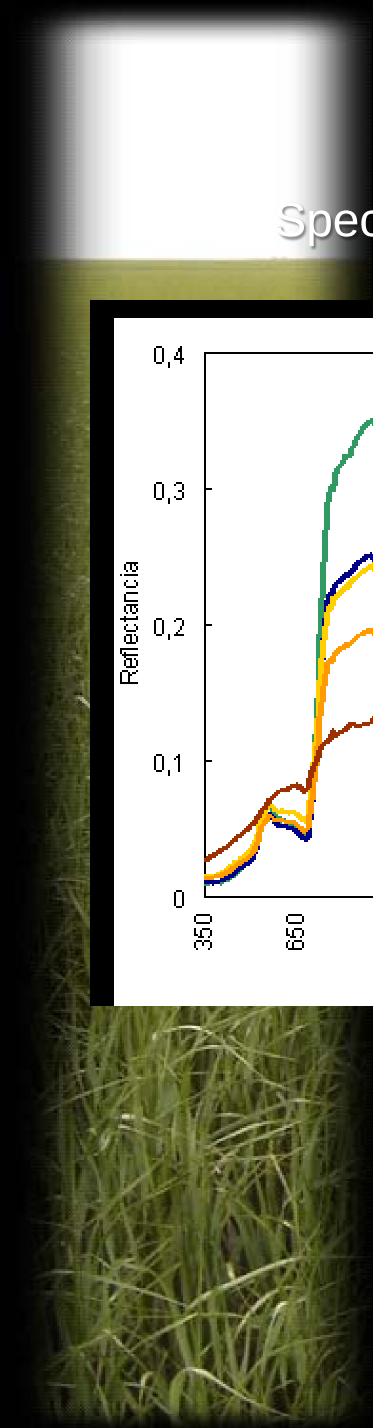


Reflectance was measured in circular plots (40 cm diameter) with a *FieldSpec* Radiometer.

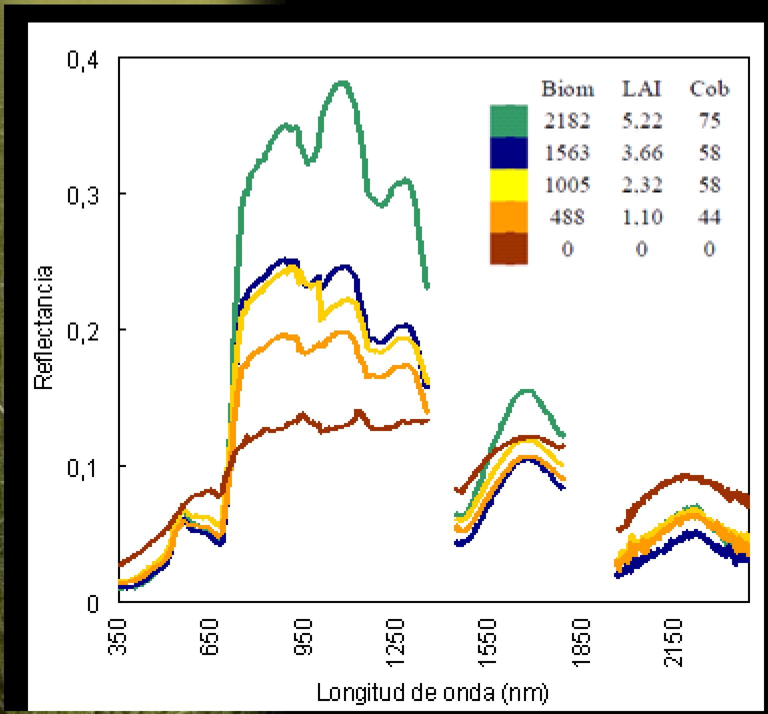
Field measurements

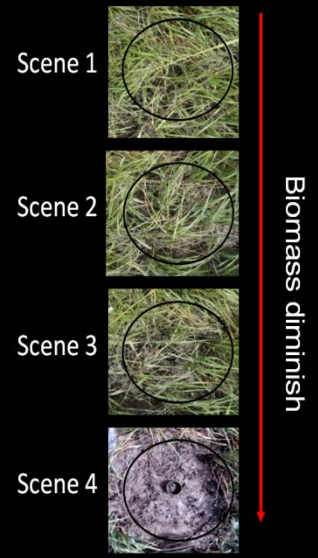
- Low tide
- around Noon
- during summer
- 24 sites

Regression models between Biomass /LAI and Field radiometer data (Eq_{rad}).



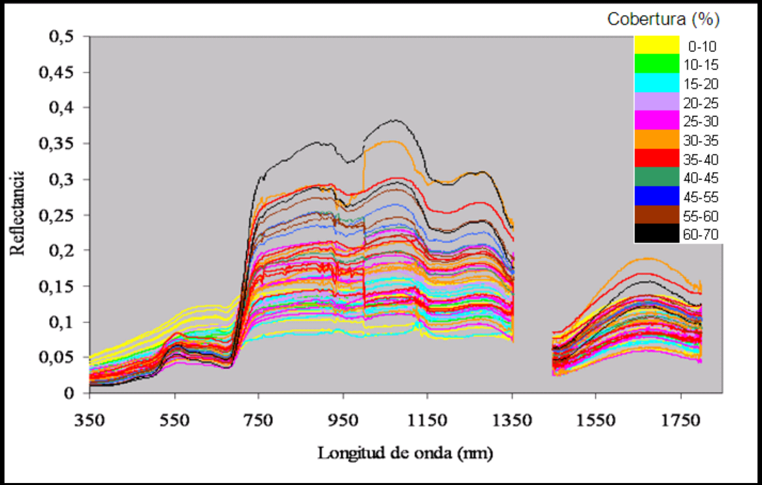
Spectral signatures for different partial succesive harvesting biomass levels





Plots biomass were highly correlated with LAI (r=0.91) and cover (r=0.82).

Spectral signatures for all sites and harvesting



Regression models between Biomass /LAI and Field radiometer data (Eq_{rad}).

Spectral indices

Nombre	Ecuación	Cita
$NDVI_{Rouse}$	(ρ864 - ρ671)/(ρ864 + ρ671).	
$NDVI_{NOAA}$	(Pr (ρ720-1100) - Pr(ρ580-680)) / (Pr (ρ720-1100) + Pr(ρ580-680))	Kriegler et al. (1969), Rouse et al. (1974)
$NDVI_{Landsat}$	(Pr ρ760-900 - Prρ630-690) / (Pr ρ760-900 + Prρ630-690)	
$NDVI_{Modis}$	(Pr ρ841-876 - Prρ620-670) / (Pr ρ841-876 + Prρ620-670)	
$GNDVI_1$	(ρ800 - ρ550)/(ρ800 + ρ550)	Gitelson et al., 1996
$GNDVI_2$	(ρ780 - ρ550)/(ρ780 + ρ550)	Gitelson et al., 1996
GRDIrange	(Pr ρ545-565 – Prρ660-680)/ (Prρ545-565 + Prρ660-680)	
IRI	ρ740 / ρ730	Reusch (1997)
VARIgreen	(Pr ρ545-565 – Prρ660-680)/ (Pr ρ545-565 + Prρ660-680- Prρ470-490)	Gitelson et al., 2002
PRI 1	(ρ529 – ρ569)/(ρ529 + ρ569).	Gamon et al. (1992)
PRI 2	(ρ570 – ρ531)/(ρ570 + ρ531).	Gamon et al. (1992)
WBI	ρ900 / ρ970	
MCARI1	(ρ700 - ρ670) - 0.2 (ρ700 - ρ550) (ρ700 / ρ670)	Daughtry et al. (2000)
TCARI	3 ((ρ700 - ρ670) - 0.2 (ρ700 - ρ550) (ρ700 / ρ670))	Haboudane et al. (2002)
MSAVI	$0.5 (2\rho800 + 1 - \sqrt{((2\rho800+1)^2 - 8 (\rho800 - \rho670))})$	Qi et al. (1994)
ρ695/ρ420	ρ695/ρ420	Carter (1994)
ρ695/ρ760	ρ695/ρ760	Carter et al. (1996)
ρ800/ρ550	ρ800/ρ550	(Buschman y Nagel, 1993
REIP	700 + 40 ((ρ670 + ρ780)/2 - ρ700) / (ρ740 - ρ700)	Guyot y Baret, 1988).
OSAVI	(1 + 0.16).(ρ800 – ρ670)/(ρ800)	Rondeaux et al. (1996)
SR	ρ800 / ρ670	Jordan (1969); Rouse et al. (1974)

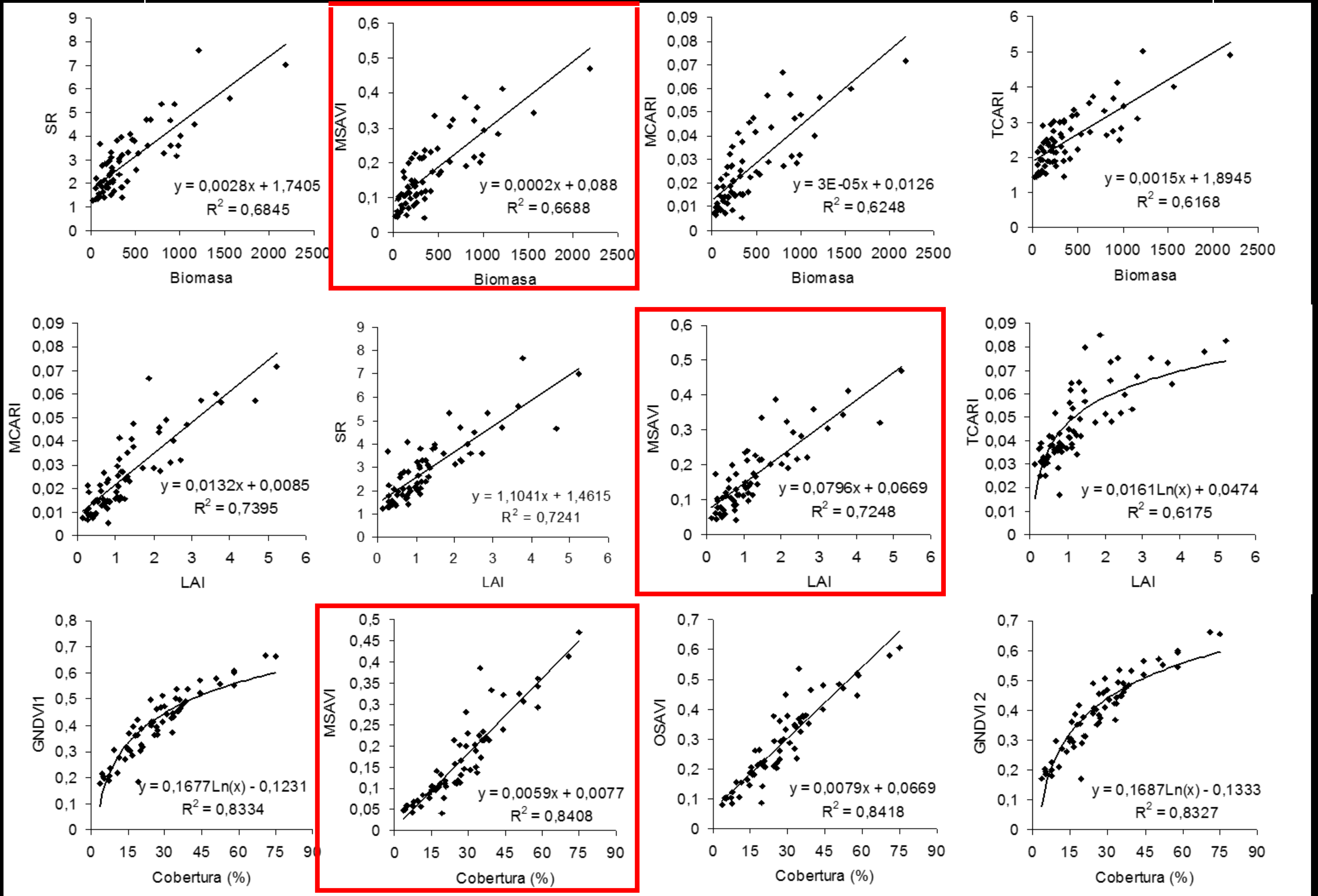
Spectral indices were calculated from spectrometer data for all sites and scenes.

Correlation analysis were performed between Bio and LAI (from plots) and spectral indices.

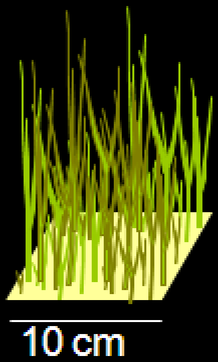
NDVI was not as good as expected and it saturates at high coverage

• González Trilla G, Pratolongo P, Beget ME, Kandus P, Marcovecchio J, Di Bella C. Relating biophysical parameters of coastal marshes in the Bahia Blanca Estuary, Argentina, to hyperspectral reflectance data. Journal of coastal Research. In press.

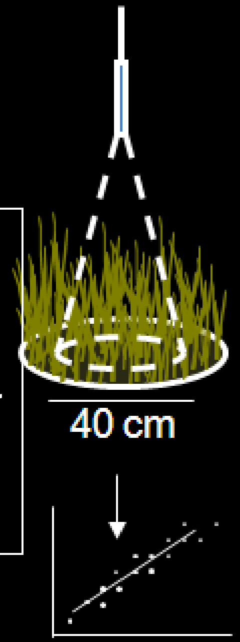
Regression models between Biomass /LAI and Field radiometer data (Eq_{rad}).



DEVELOPMENT



Field Biomass and LAI data of *S. alterniflora.* (LAI_{field} Bio_{field}).



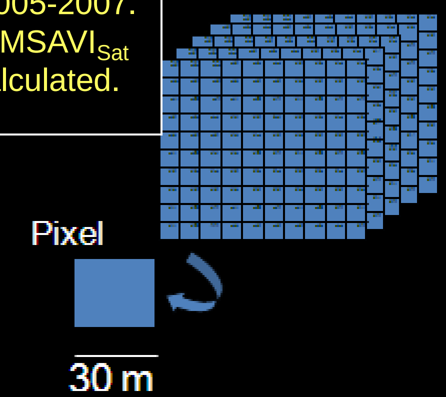
Regression models between Biomass and LAI and Field radiometer data (Eq_{rad}).

Down/Up scaling

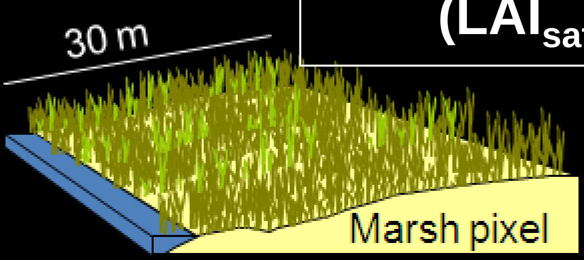
Up scaling

Satellite data.

14 Landsat TM 2005-2007. The $NDVI_{sat}$ and $MSAVI_{Sat}$ indexes were calculated.



Biomass and LAI estimation based on satellite data (LAI_{sat} Bio_{sat}).



Satellite data.

14 Landsat 5 TM scenes (226/87) were acquired between 2005 and 2007.

Images

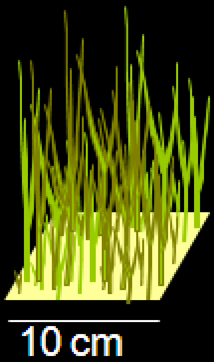
• geometricaly corrected and registered

• surface reflectance were calculated considering a model of Raighley distribution (Stumptf 1992)

• The $MSAVI_{Sat}$ was calculated.

• Pixel samples were taken from the same places where the two years fieldwork was performed.

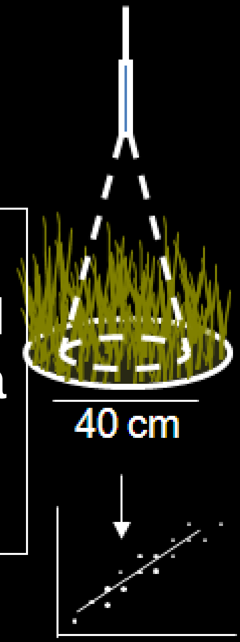
DEVELOPMENT



Field Biomass and LAI data. (LAI_{field} Bio_{field}).

Down/Up scaling

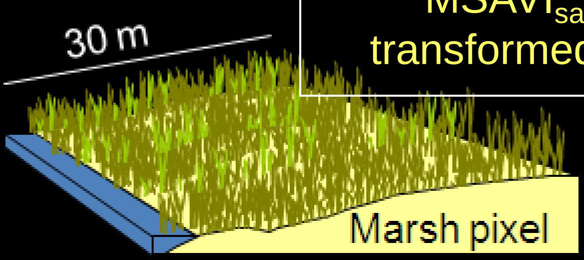
Regression models between Biomass and LAI and Field radiometer data (Eq_{rad}).



Up scaling

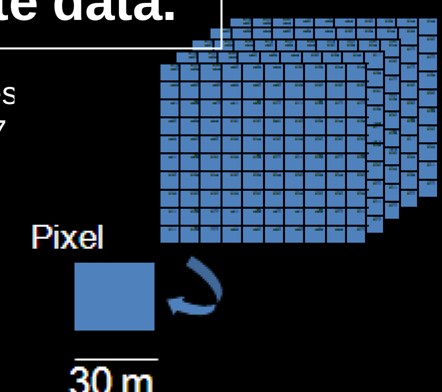
Biomass and LAI estimation based on satellite data (LAI_{sat} Bio_{sat}).

$MSAVI_{sat}$ data were transformed using **Ecu_{rad}**

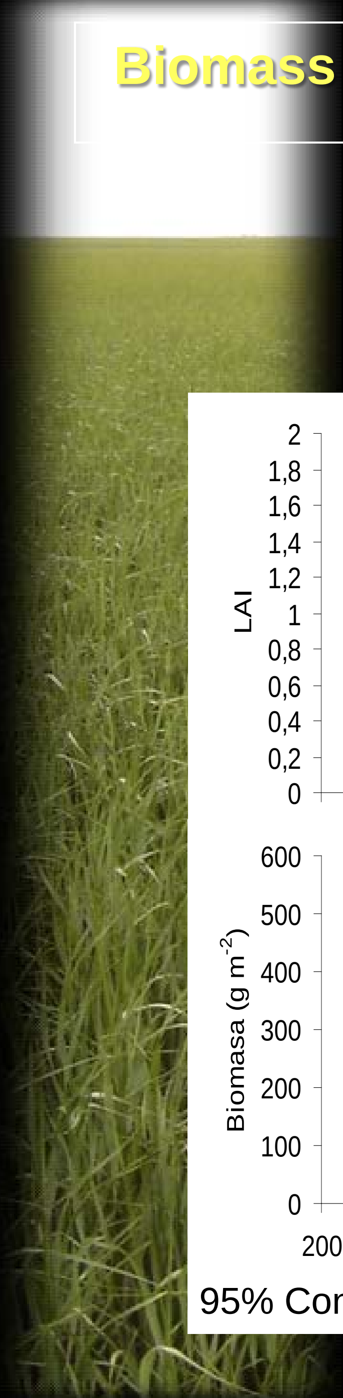


Satellite data.

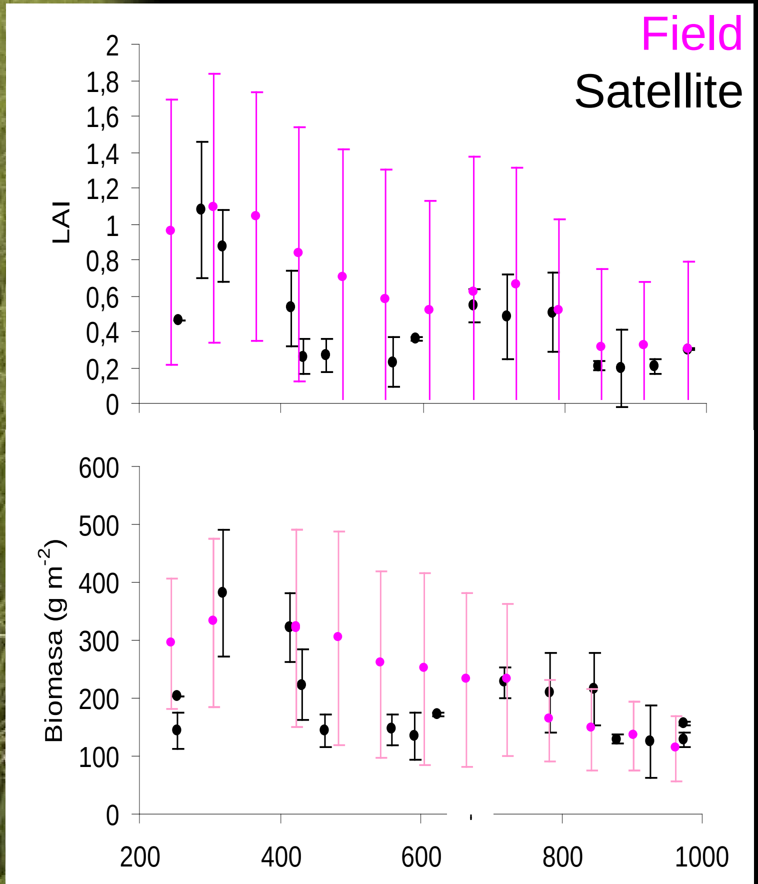
Time series 2005-2007 period



Biomass and LAI (Bio_{sat} LAI_{sat}) estimations based on satellite data



- **Bio_{sat} and LAI_{sat}** were estimated from $MSAVI_{sat}$ using **Eq_{rad}**
- Satellite and field time series data were comapred.



95% Confidence interval

LAI_{sat}-LAI_{field}

correlations between series $r^2 = 0.79$.

Underestimated	70 (42- 96) %
Overestimated	114 (108 – 118) %

BIO_{sat}-BIO_{field}

correlations between series $r^2 = 0.43$.

Underestimated	72.83 (44- 97) %
Overestimated	160 (104 – 212) %

LAI showed better estimations

Biomass (Bio_{sat}) estimation based on satellite data

Biomass map made from Landsat 5 TM (226/87) February 2008

Biomass sat	Biomass field		
654 (591 - 718)	639 (416-833.3)	102.3	NS
345 (11 - 679)	469.5 (303.5-635.5)	73.4	NS
707 (501 – 913)	647 (403.3-890.3)	91.5	NS
787 (159 – 1416)	920 (430.5 - 1410)	116.8	NS
794 (613 – 976)	856.5 (406 - 1307)	107.87	NS

Final Remarks

Field data of Biomass and LAI of *Spartina alterniflora* show high variability at site scale, and seasonal and interannual as well. Additional source of variability is the tide condition (*we only consider low tide situations*).

Field radiometer observations were faithful in identifying changes in biomass and LAI.

In order to monitoring *Spartina alterniflora* biomass and LAI, MSAVI show a good performance, much better than NDVI: We obtained a fitting model (RM) between biomass and LAI (field) and MSAVI (radiometer) data.

The aplication of RM model (Eq_{rad}) on MSAVI derived from a time series of Landsat observations, brings a quite accurate estimation of biomass and LAI mean values.

We obtained a map of biomass distribution for Bahia Blanca marshes which shows a good fit between observed and field values.

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Muchas gracias!!