El papel de los sistemas pastoriles en la regulación **hidrológica** de la llanura **chaco-pampenana**

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gea
grupo de estudios ambientales

IMASL
CONICET
UNSL

La **vegetación** es un fuerte determinante de la **hidrología**, especialmente en llanuras muy planas.

El retroceso de sistemas pastoriles (Pampa) y su transformación (Chaco) son una fuerza de cambio hidrológico

-- Contexto

-- Pampa

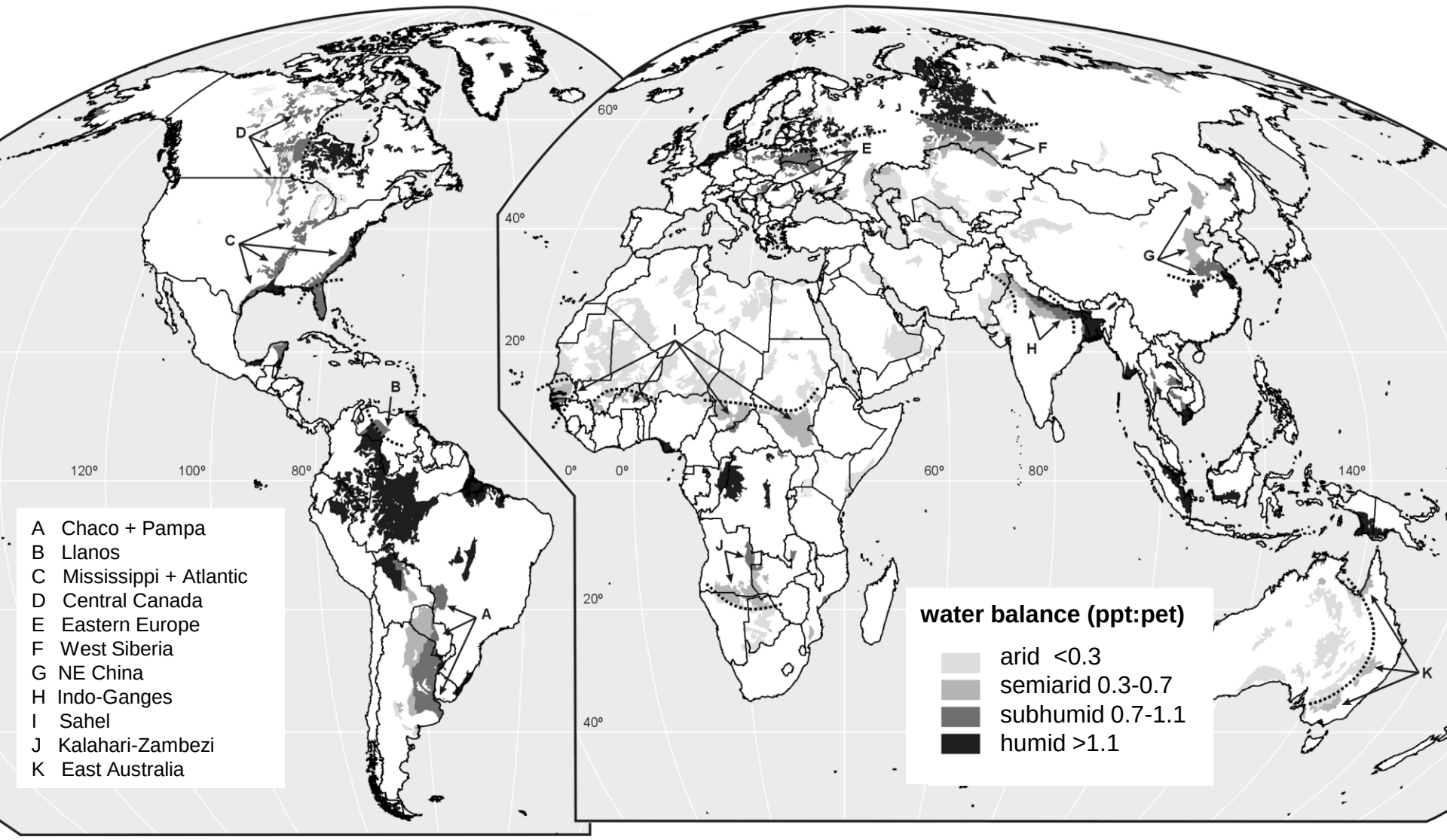
-- Chaco

-- Conclusión

1. **Hiperllanura**
   excesos hídricos – problema de largo plazo
   ahorrar agua no es la mejor opción (huella hídrica…)

2. **Agriculturización**
   progresiva retracción ganadera en la Pampa
   vegetación natural -> rotación -> agricultura contínua
   transformación ganadera en el Chaco
   vegetación natural -> pasturas -> cultivos anuales

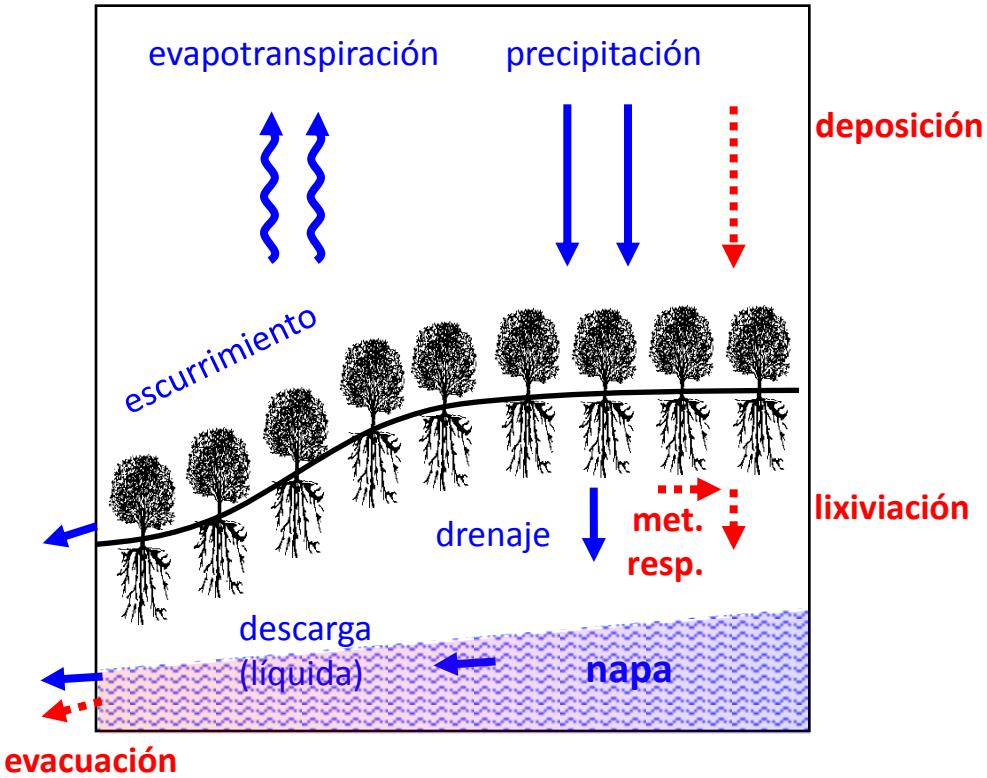
3. **Extensificación / Simplificación**
   hacia mínimos costos y estructura, máxima escala
   plazos cortos – menor diversidad -Ganadería “acorralada



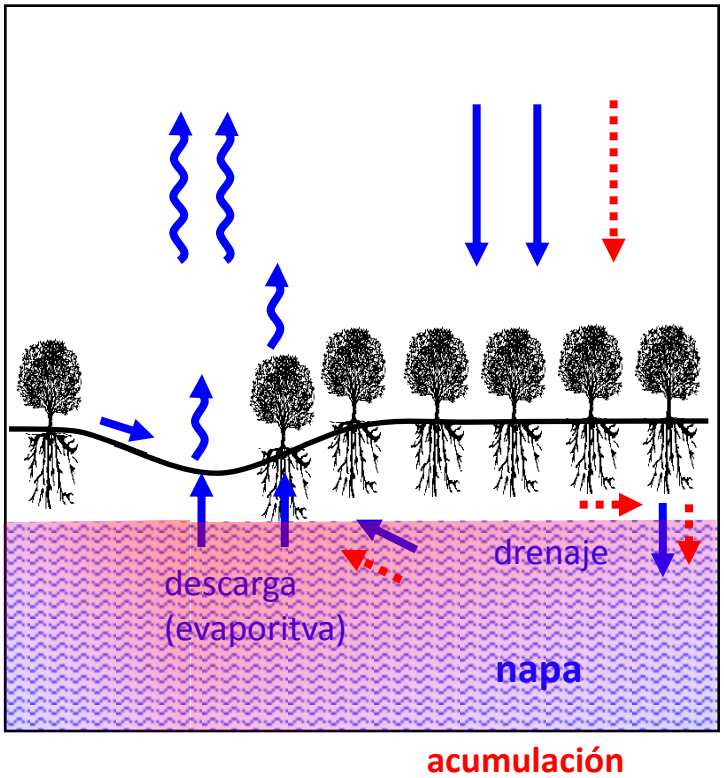
hiperllanuras (regional slope < 0.1 % - based on Space Shuttle DEM, 8km^2 kernel)

Jobbágy et al 2008 – Ecología Austral

libro de texto



hiperllanura



Vegetación

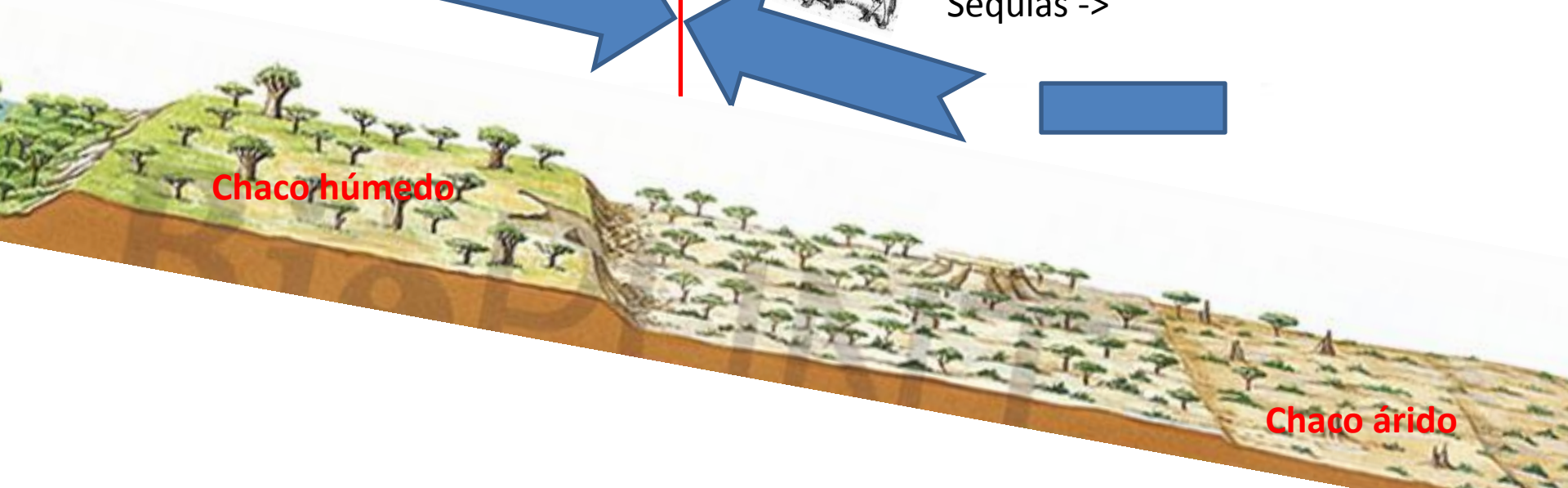
↙

Hidrología

Hidrología ↔ Vegetación

Precio internacional del grano ->
Cargas fiscales al grano <-
Precio insumos <-
Expansión alquiler ->
Concentración ->?
Simplificación ->?

Trabas a exportación carne/leche ->
Pérdida de infraestructura ganadera ->
Sequías ->

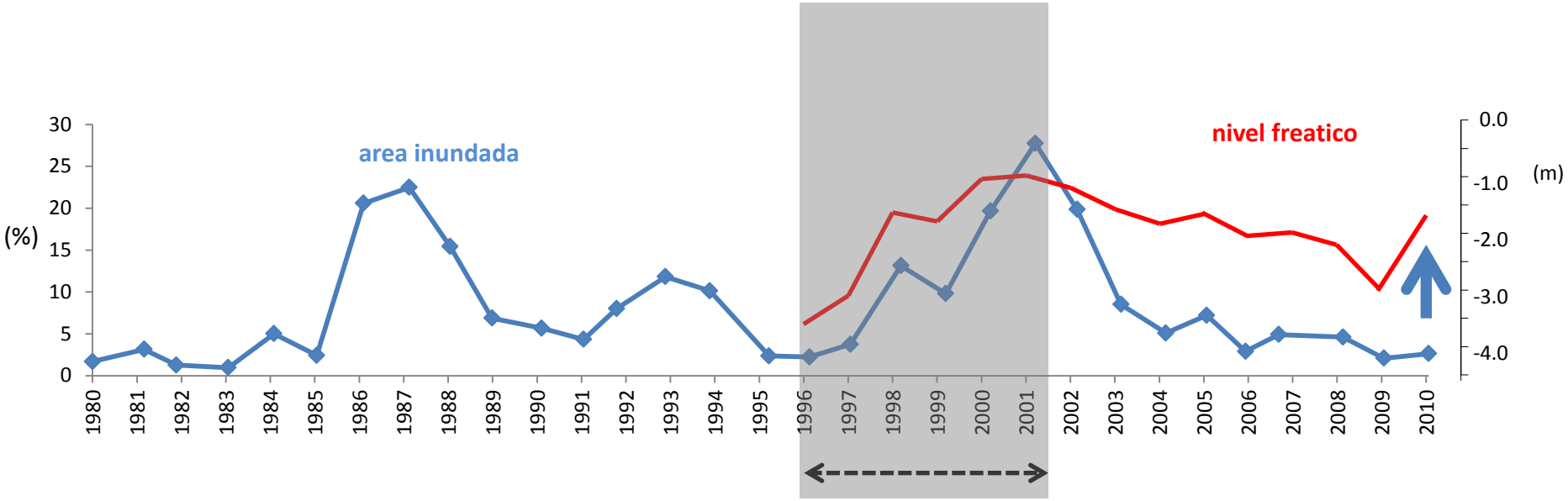


-- Contexto

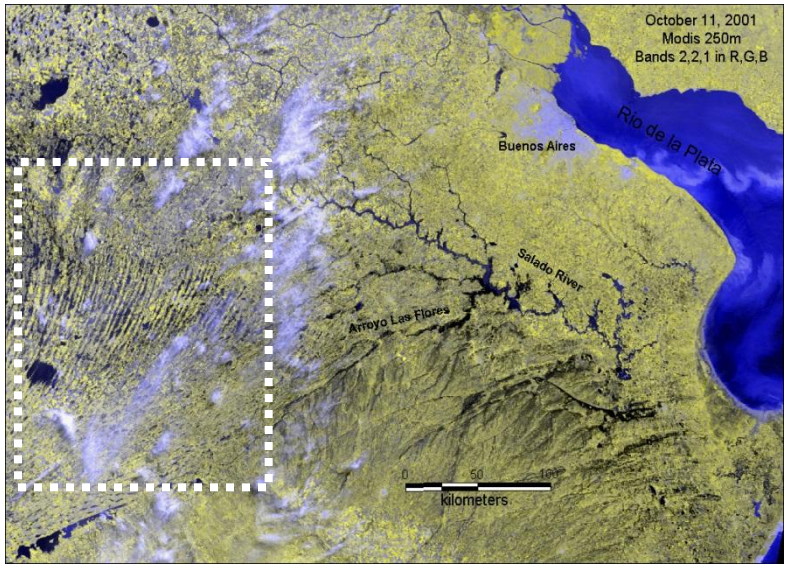
-- Pampa

-- Chaco

-- Conclusiones



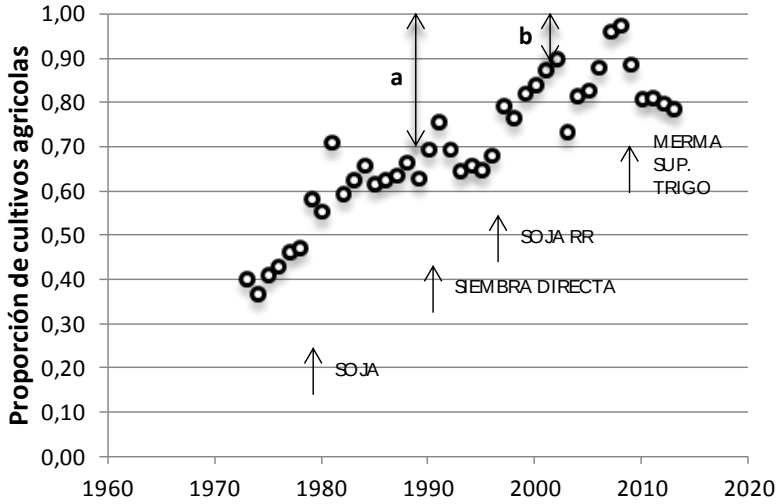
1996 – 2001 (+20% lluvia)

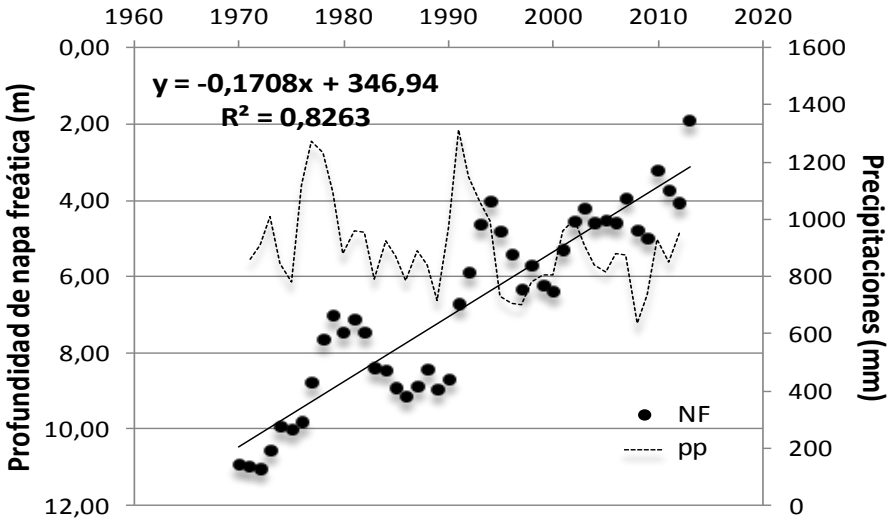


+ 500 mm napas
+ 300 mm lagunas

+ 800 mm TOTAL

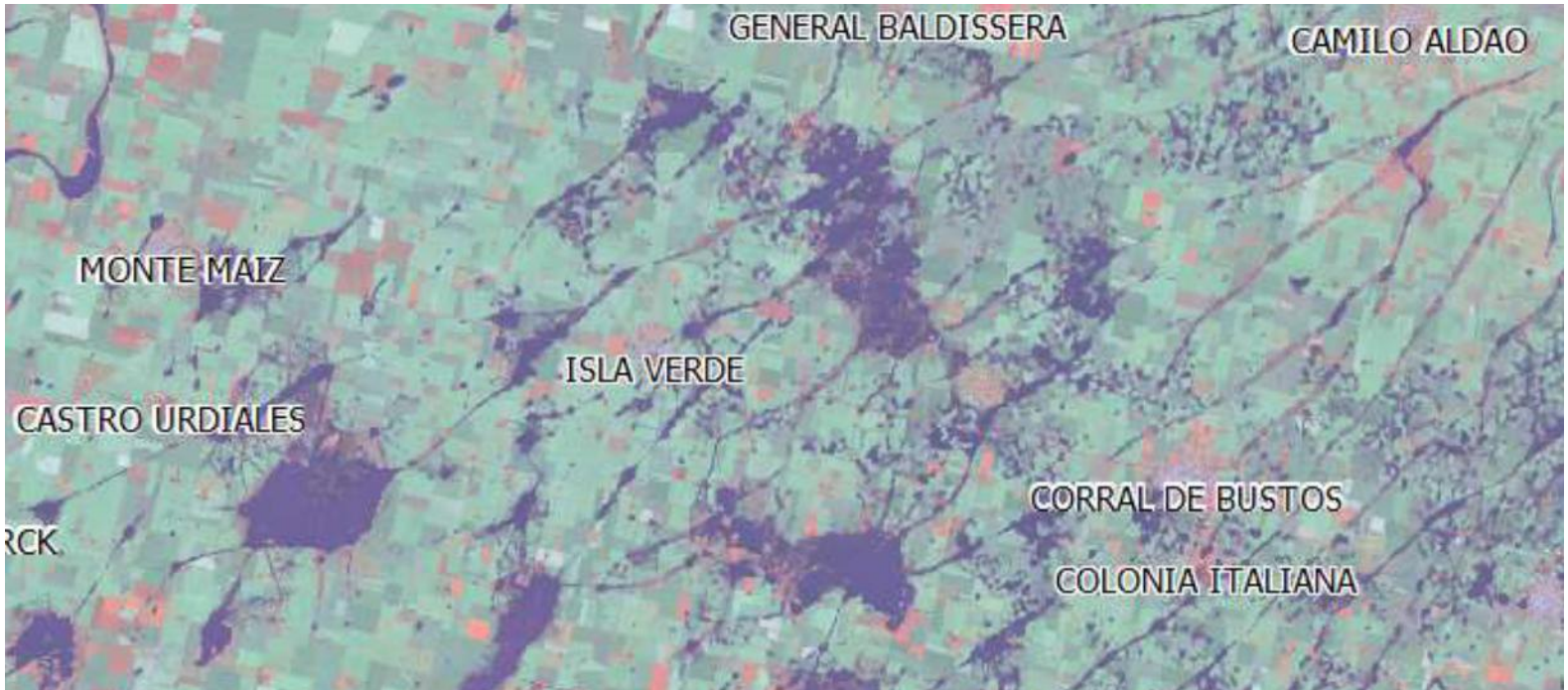
Aragón et al 2010 – Ecohydrology
Kuppel et al. 2015 - WRR



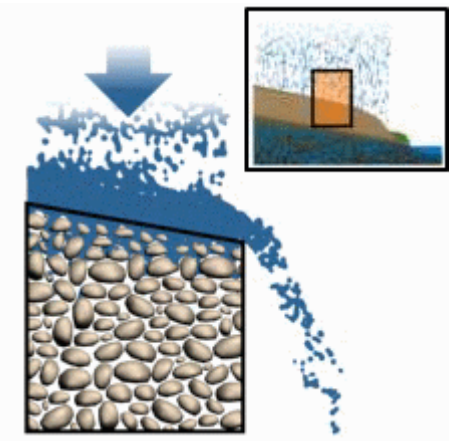


Betram & Chiacchiera 2013. Reporte INTA

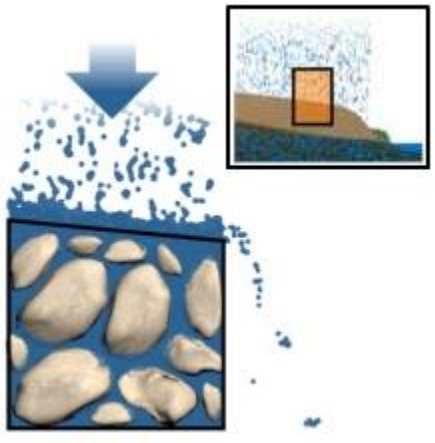
- Marcos Juarez



Tipo I: exceso de infiltración



Tipo II: exceso de saturación



Con napas superficiales aparece el “tipo II” de inundación

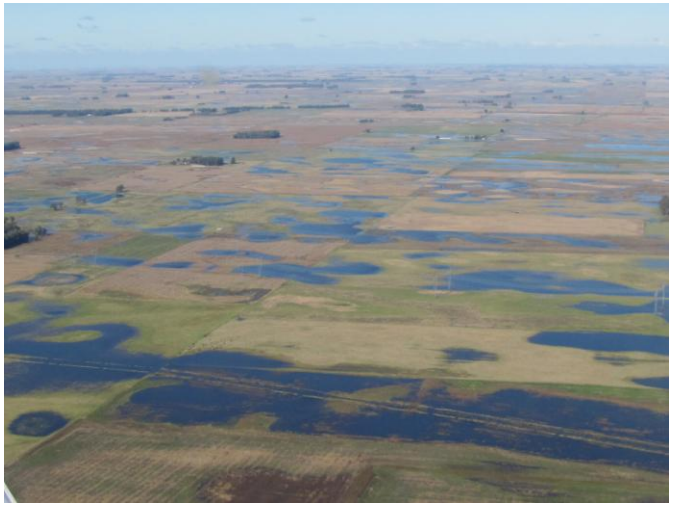
Dura mucho tiempo

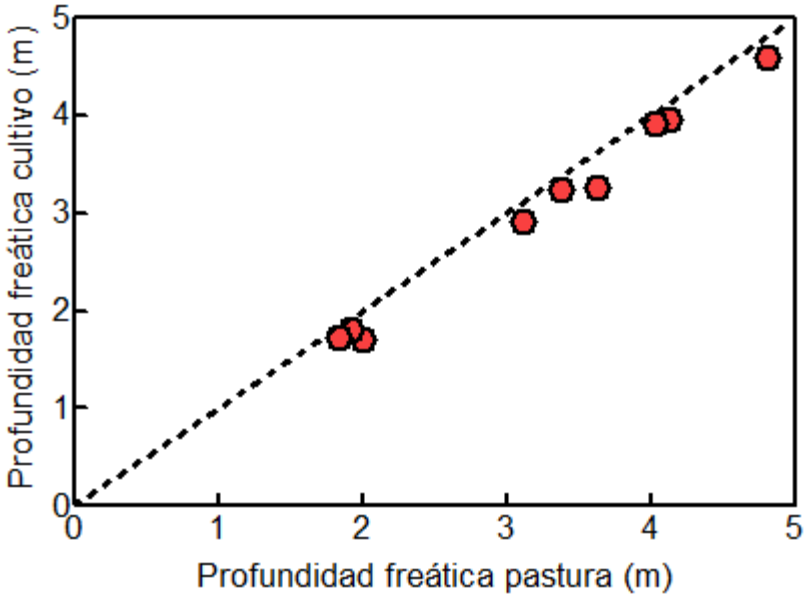
Vehiculiza sales

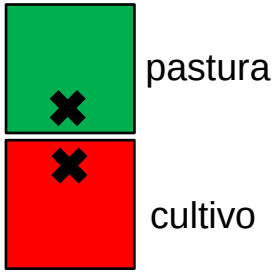
Profundidad freática en sitios pareados

(9 pares cultivo-pastura)

- Trenque Lauquen



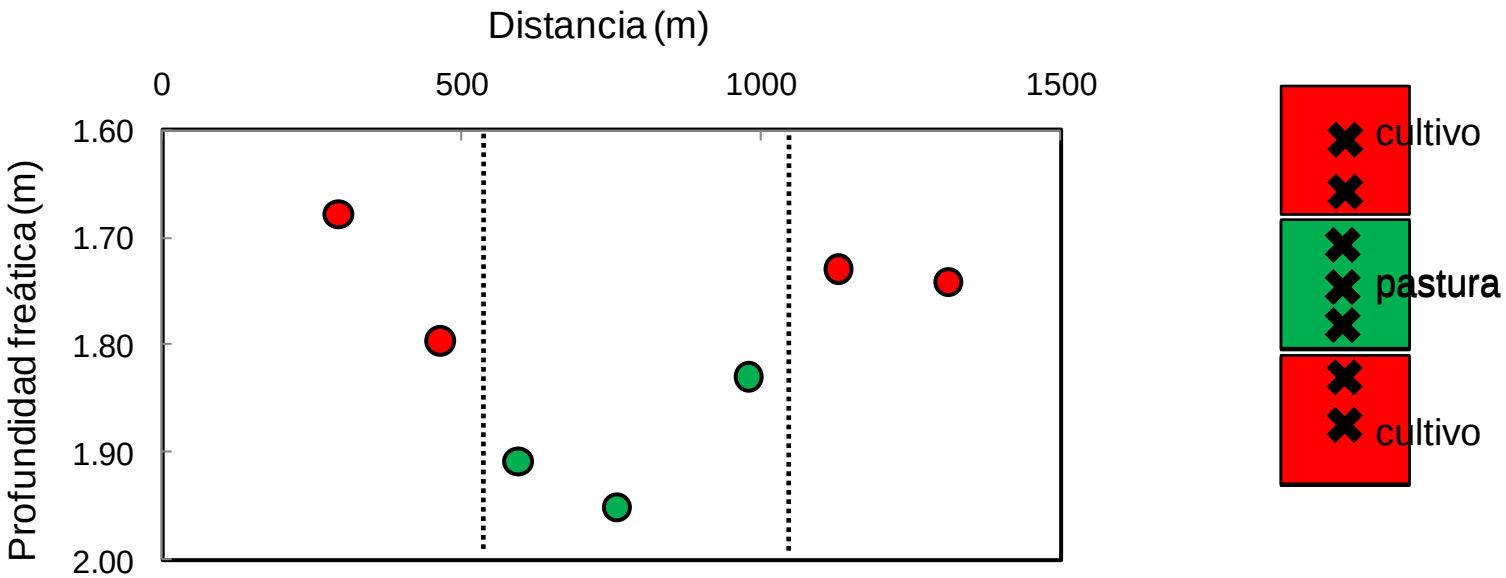


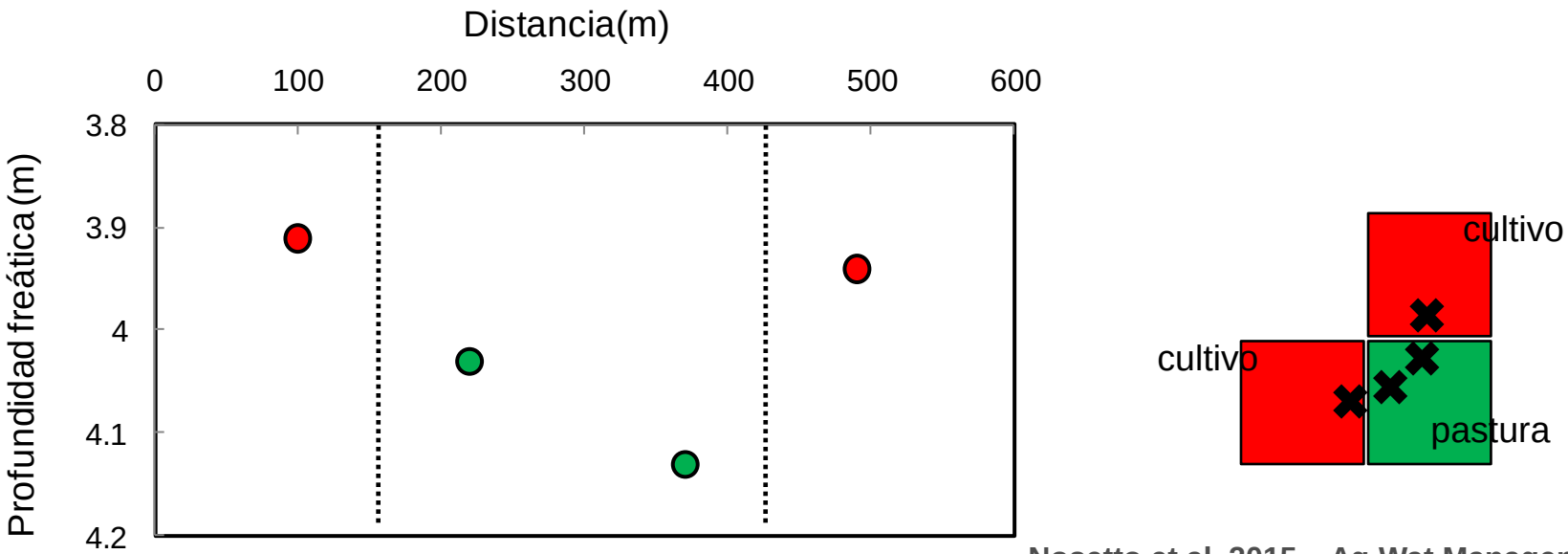


En todos los sitios --> más profundo en pasturas (20 cm en promedio)

Nosetto et al. 2015 – Ag Wat Management

Profundidad freática en transectas

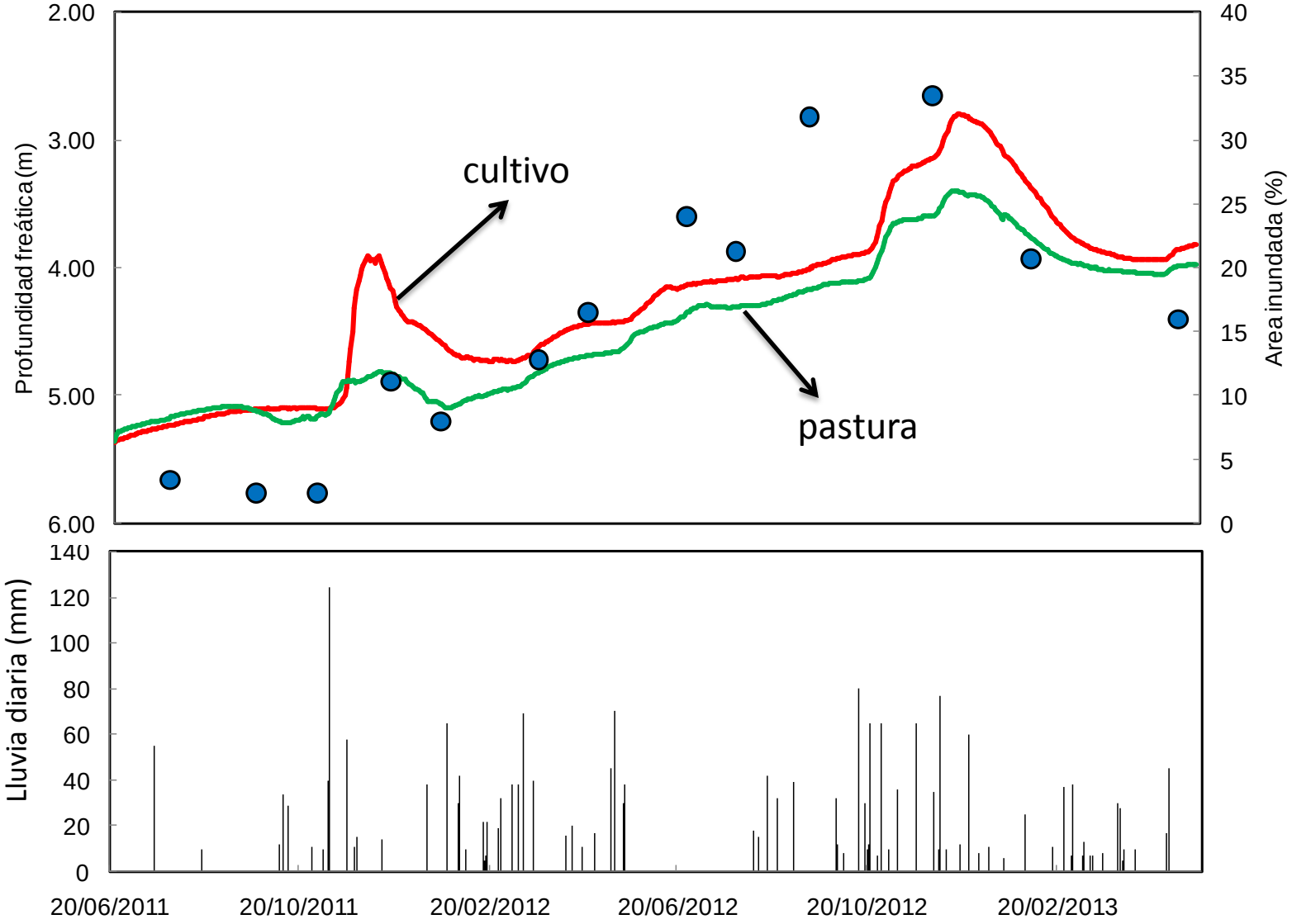




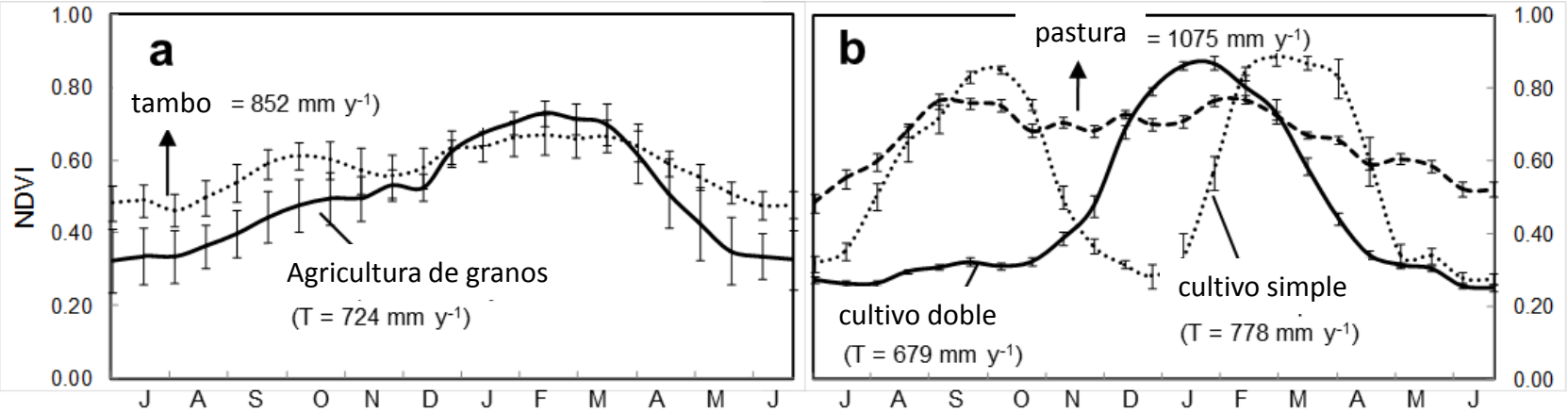
Nosetto et al. 2015 – Ag Wat Management

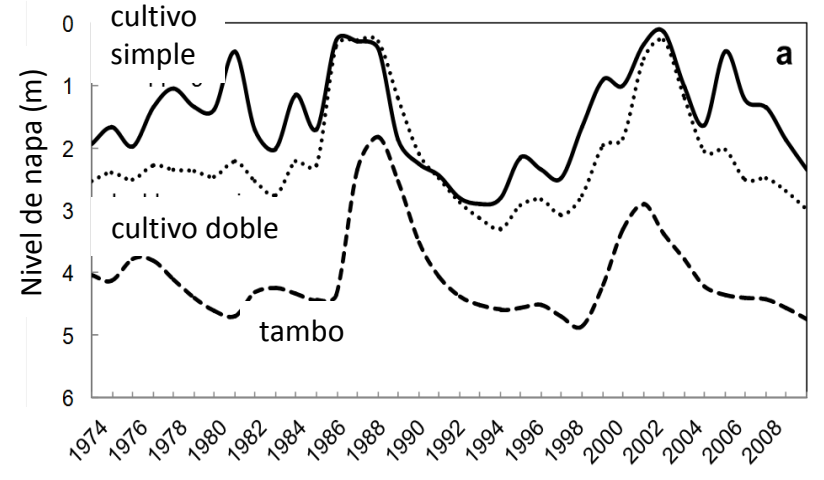
Dinámica del nivel freático

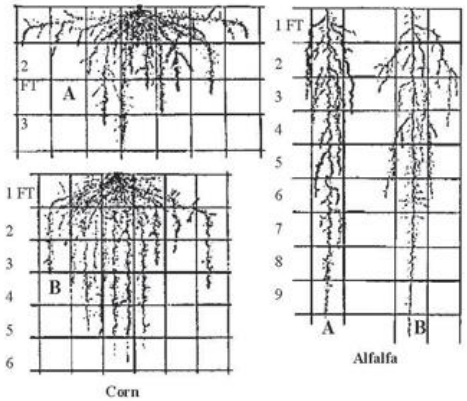
(efectos sobre la recarga)



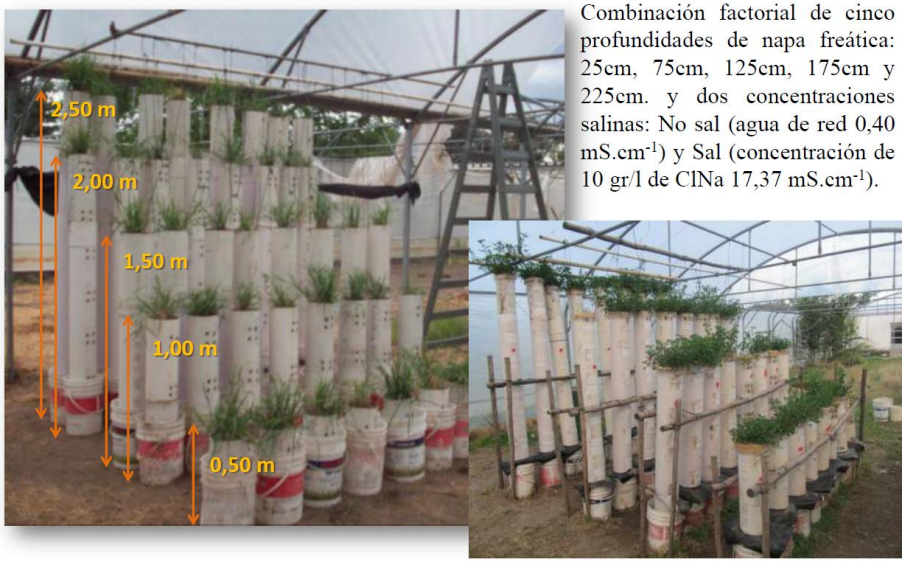
Nosetto et al. 2015 – Ag Wat Management



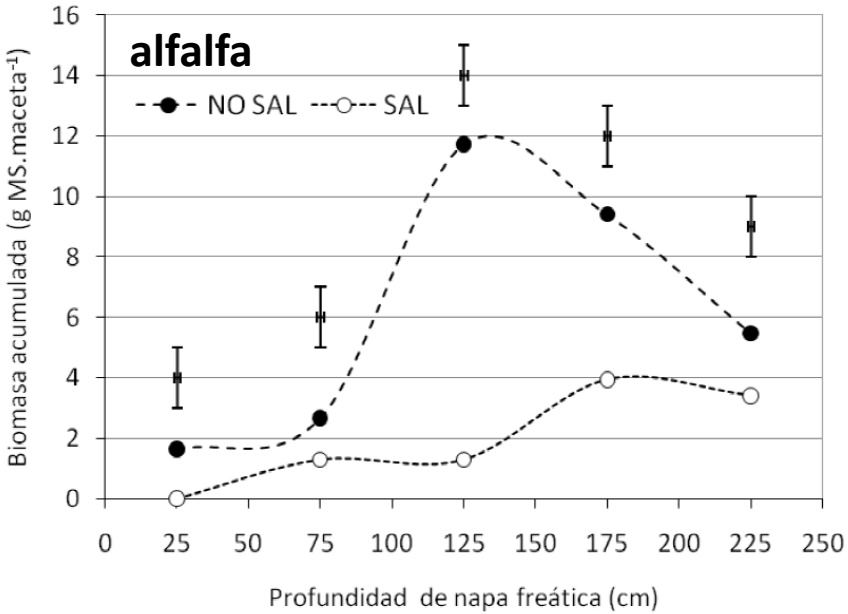


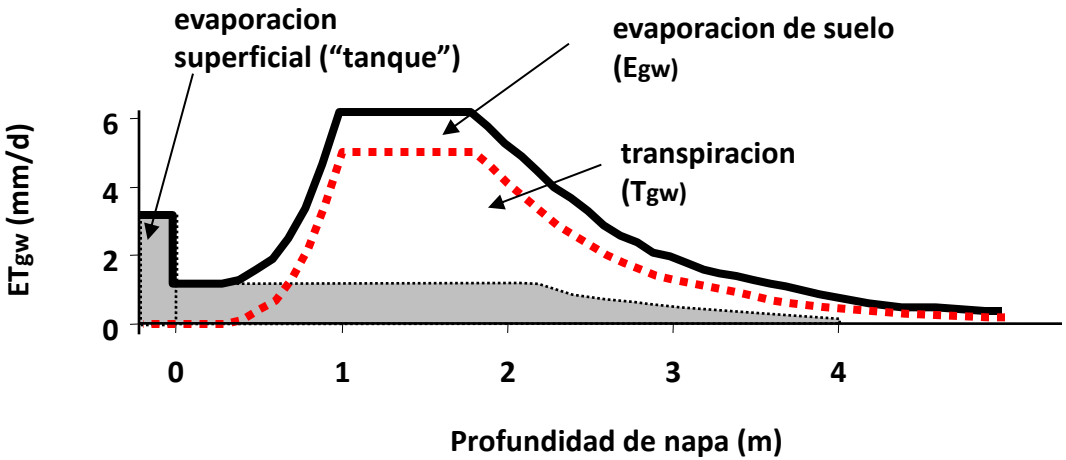


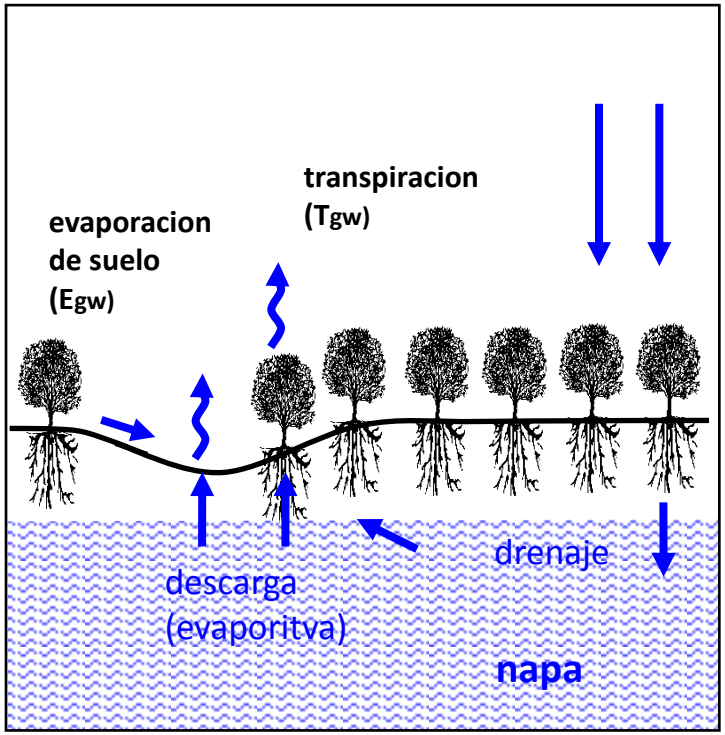
Nosetto et al. 2015 – Ag Wat Management



Combinación factorial de cinco profundidades de napa freática: 25cm, 75cm, 125cm, 175cm y 225cm. y dos concentraciones salinas: No sal (agua de red 0,40 $mS.cm^{-1}$) y Sal (concentración de 10 gr/l de ClNa 17,37 $mS.cm^{-1}$).





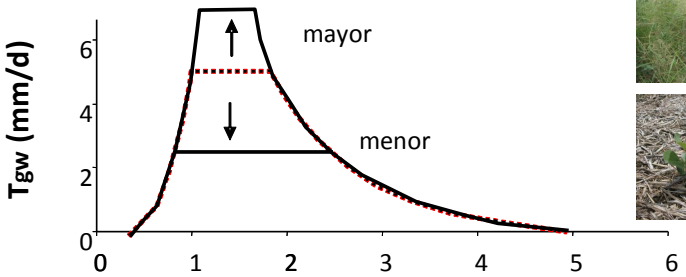


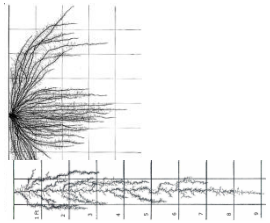
MODELO UPFLOW
transporte capilar y anegamiento

Raes et al. 2003 – Plant and Soil

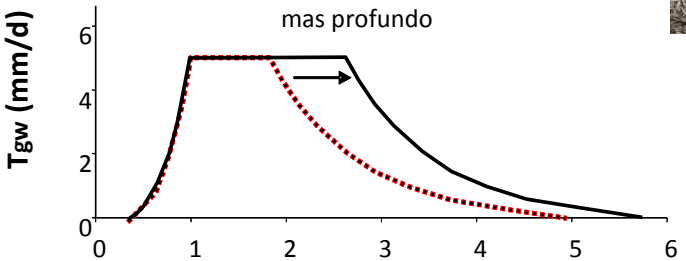
Jobbagy et al. 2009 – EOS

área foliar

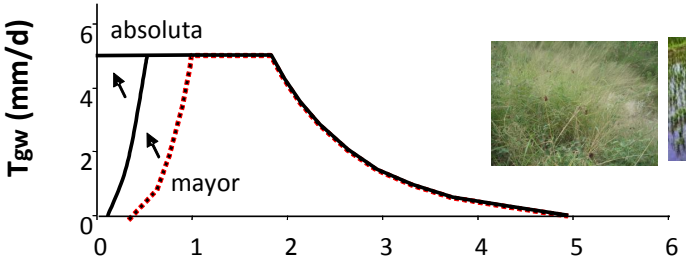




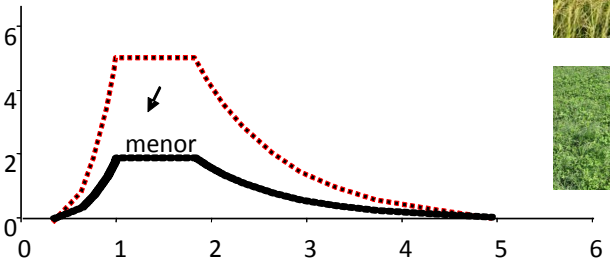
raíces



tolerancia anegamiento



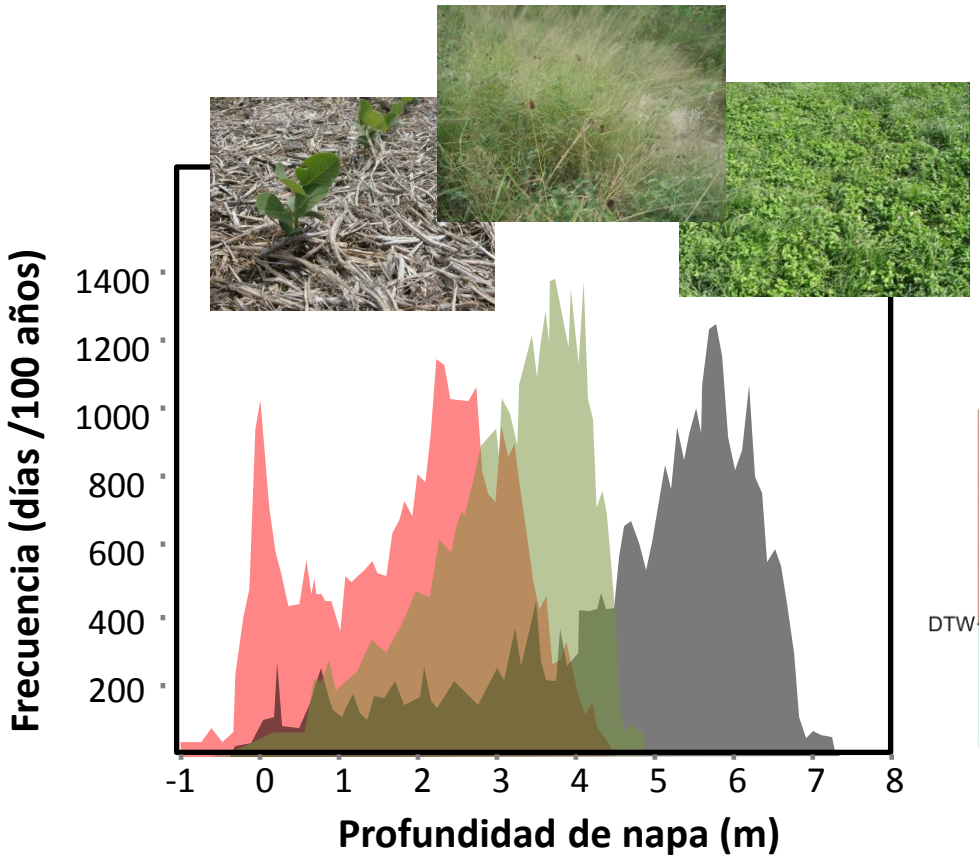
tolerancia salinidad

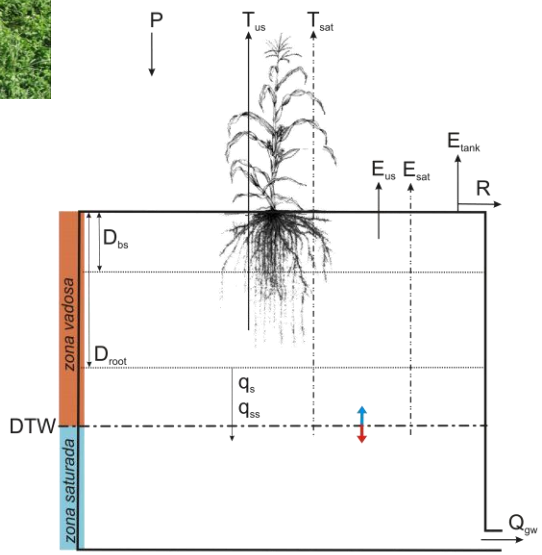


ECOSISTEMA

SIMULACION

HIDROLOGIA

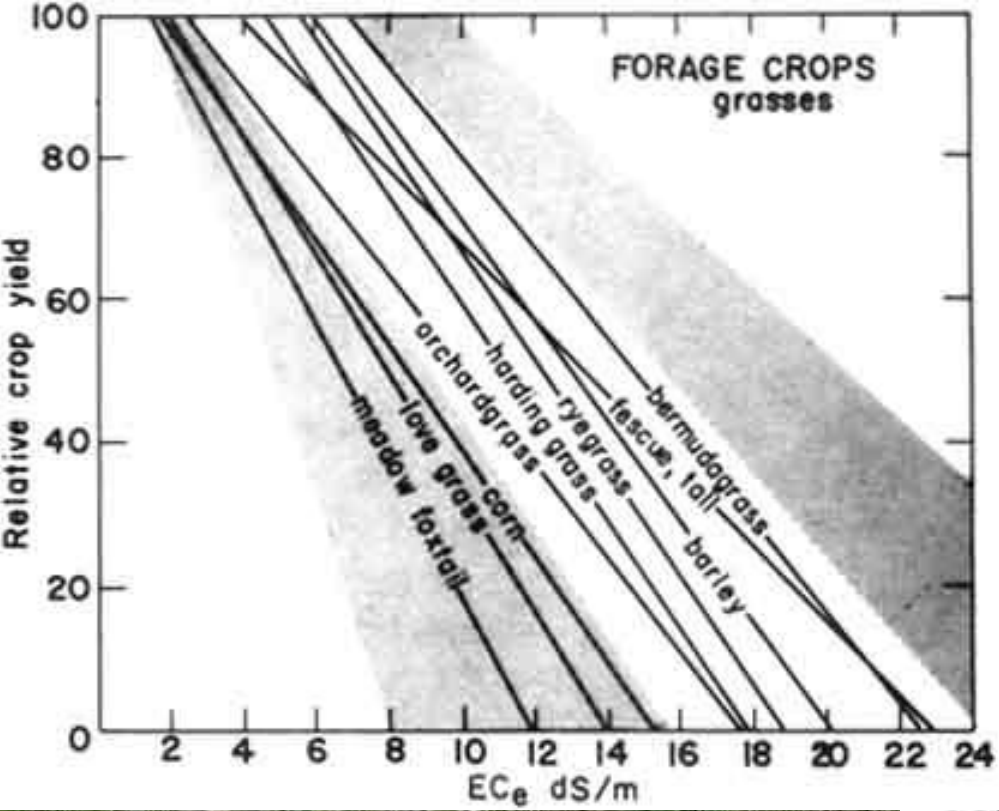


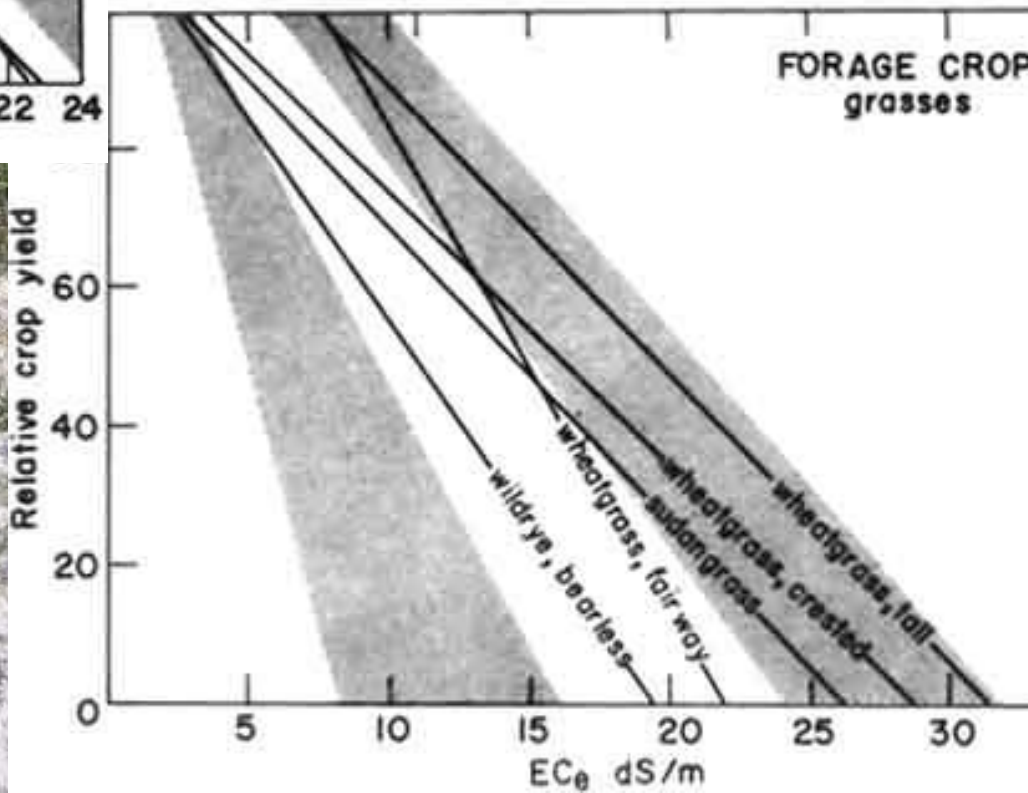


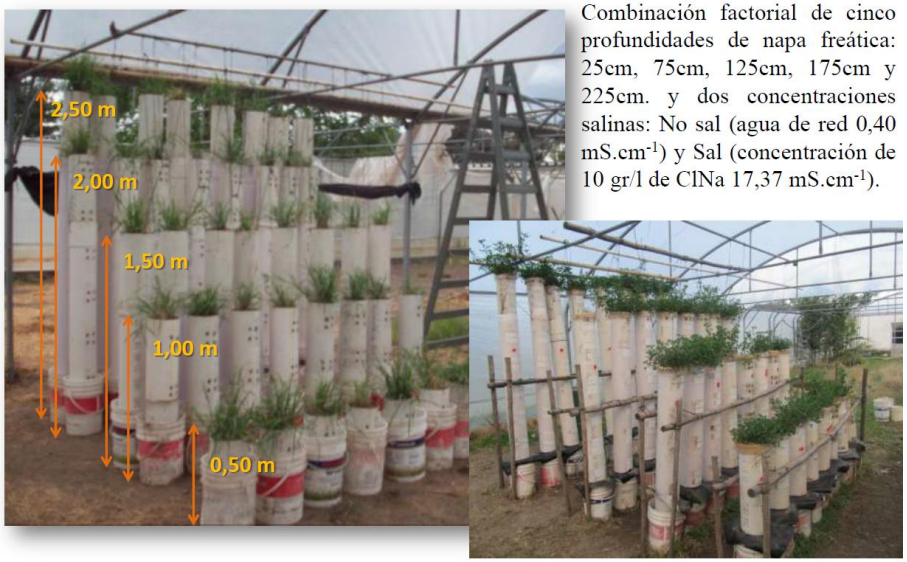
MODELO "VEG-NAP"
SW de Córdoba
clima 1908-2008 +20% PPT
agua freática **NO** salina

	raíces	*tolerancia anegamiento*	*ET*
Pastizal	**3 m**	**SI**	**950 mm**
Pastura de alfalfa	**5 m**	**NO**	**1100 mm**
Agricultura (maiz-trigo-soja)	**2 m**	**NO**	**850 mm**

Contreras et al. AGU 2008


FORAGE CROPS
grasses
Relative crop yield
100
80
60
40
20
0
2
4
6
8
10
12
14
16
18
20
22
24
ECe dS/m
bermudagrass
fescue, tall
barley
ryegrass
harding grass
orchardgrass
corn
love grass
meadow foxtail


FORAGE CROP
grasses
Relative crop yield
60
40
20
0
5
10
15
20
25
30
ECe dS/m
wheatgrass, fall
wheatgrass, crested
sudangrass
wheatgrass, fairway
wildrye, beardless



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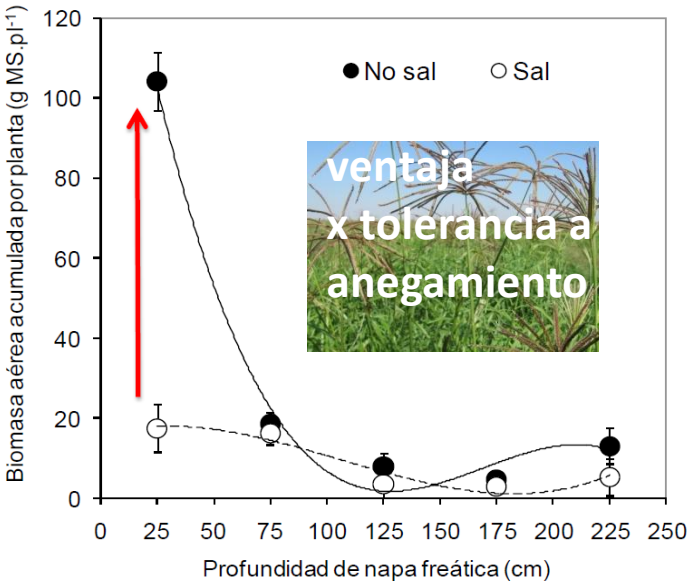
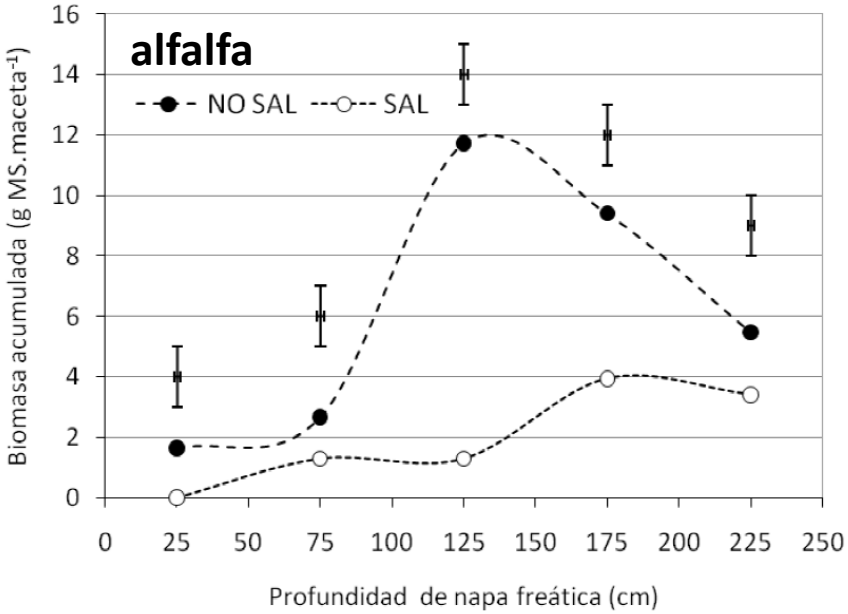
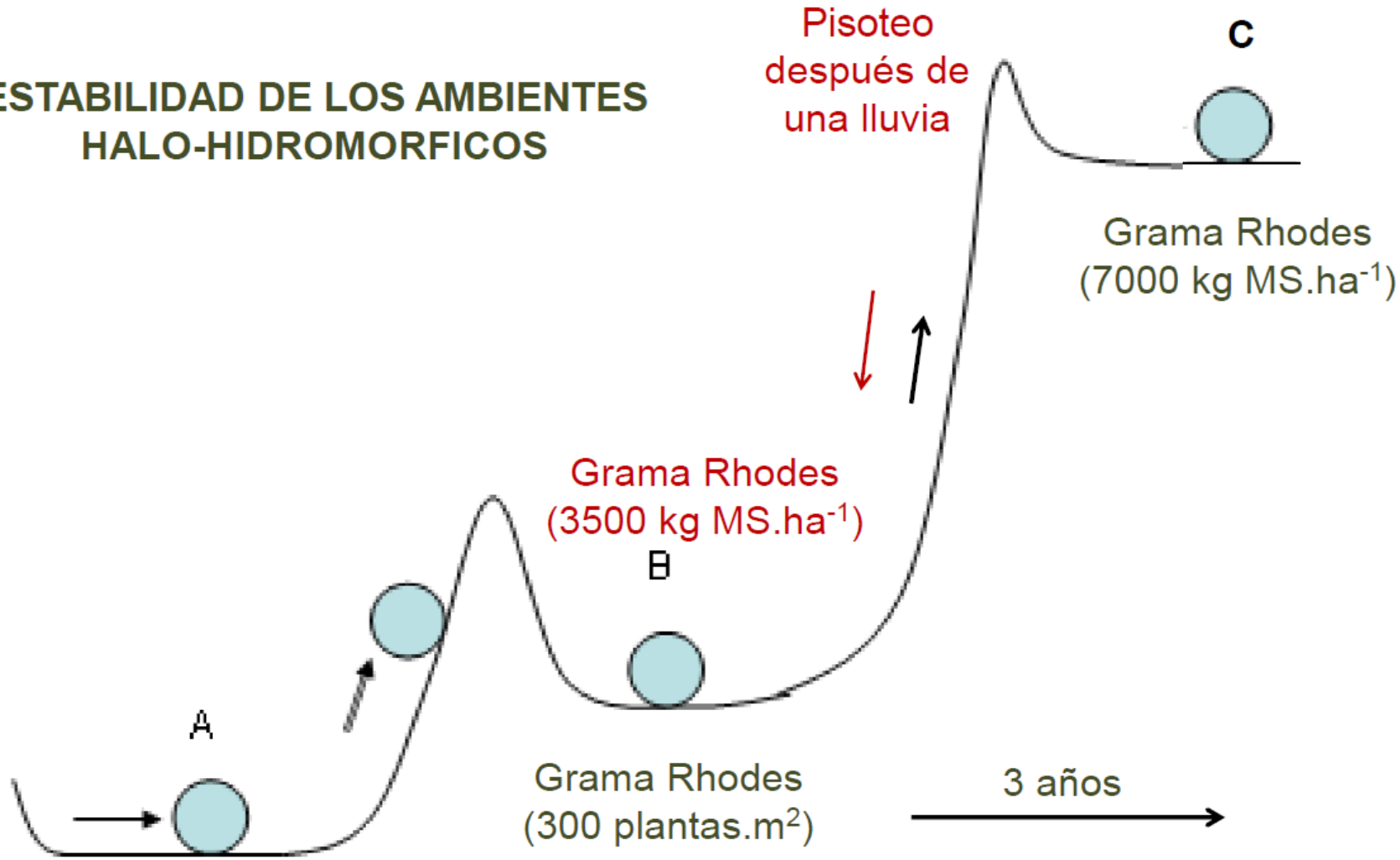
grama rhodes





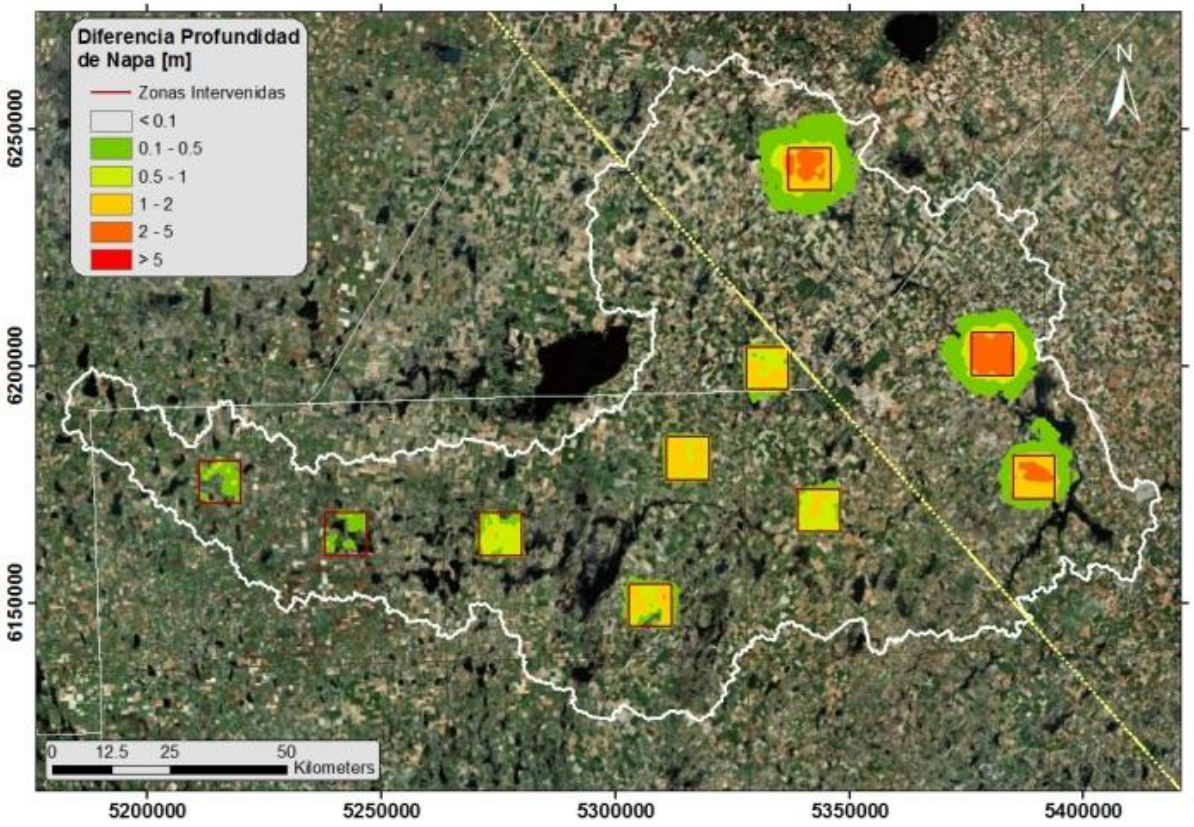
agropiro...

ESTABILIDAD DE LOS AMBIENTES HALO-HIDROMORFICOS



Pasto natural
(gramon – pelo de chancho – salicornia)

- NO BA + S Santa Fe



Garcia et al – MS envíado a J Hydrology
Mercau et al. 2014 – Agronomía y Ambiente

PAMPA

El aumento de inundaciones y anegamientos y su impacto, favorecidos por el abandono de sistemas pastoriles

3 atributos clave de la vegetación

1. Estacionalidad/intensidad de la demanda de agua
2. Profundidad de raíces
3. Tolerancia a anegamiento/salinidad

El agua conecta el paisaje

Una fracción del paisaje puede generar beneficios/perjuicios a otra
Difícil balance y acuerdo entre actores del territorio

Debemos revisar los nichos para NUEVOS sistemas pastoriles

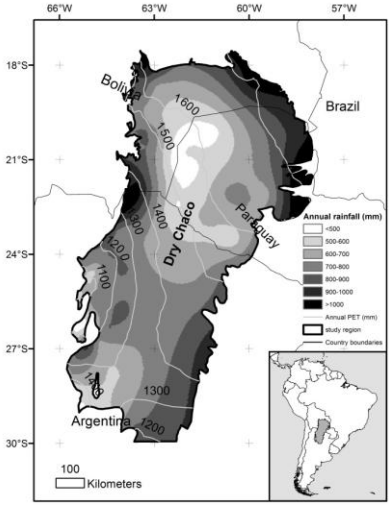
Ambientes **extremos** (bajos –tolerancia aneg/sal!, lomas muy arenosas –raíz!)
Adiós rotación con pasturas, Hola **pasturas oportunistas/adaptativas**
Oferta de forraje espacial/temporalmente **fragmentada** ¿transporte hacia el animal?
Relación **volátil** de quien produce con la tierra ¿Hacia alquiler forrajero?

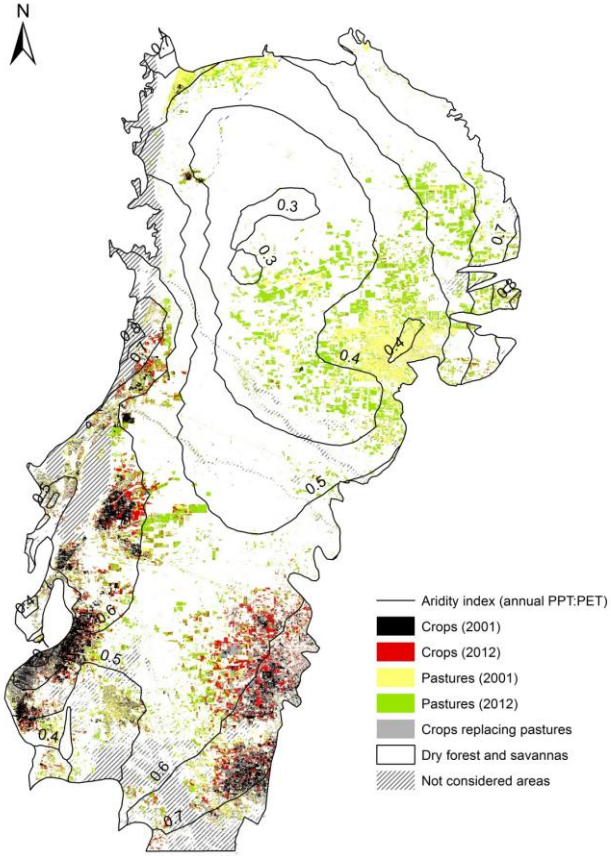
-- Contexto

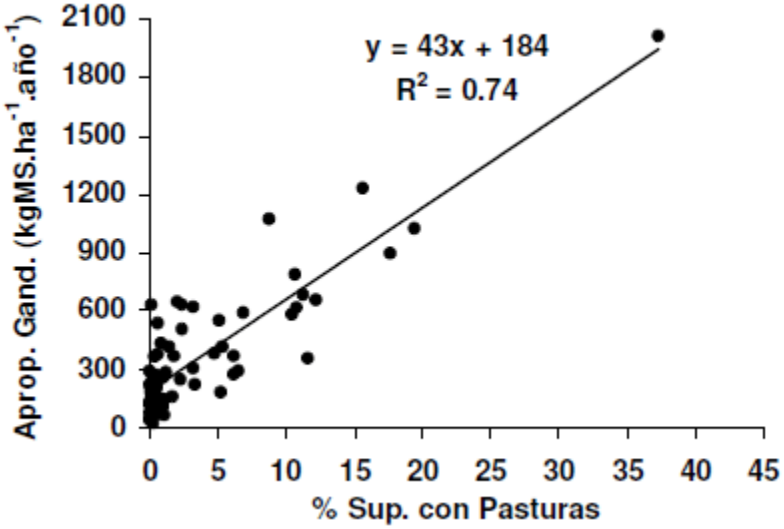
-- Pampa

-- Chaco

-- Conclusiones





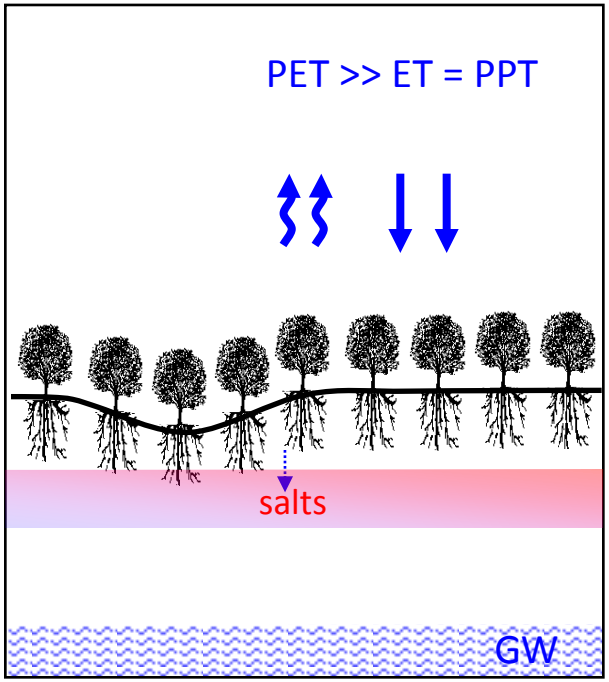


Houspanossian et al. – en preparación

Rueda et al. 2013 – Ecología Austral

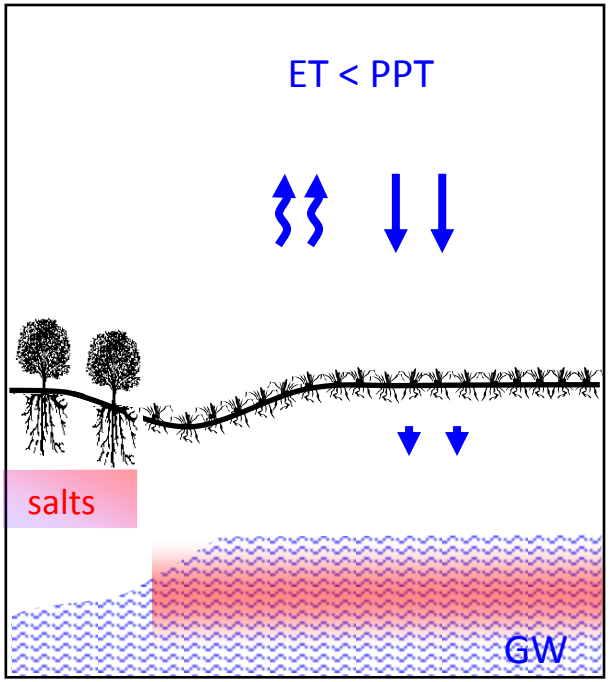
Monte

Australia, Sahel, High Plains, Chaco



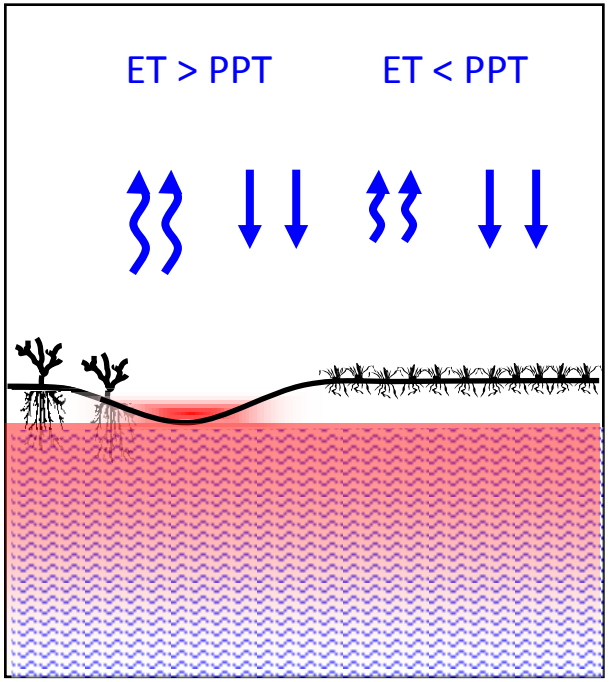
Cultivo (primeras décadas)

Australia, Sahel, High Plains, Chaco

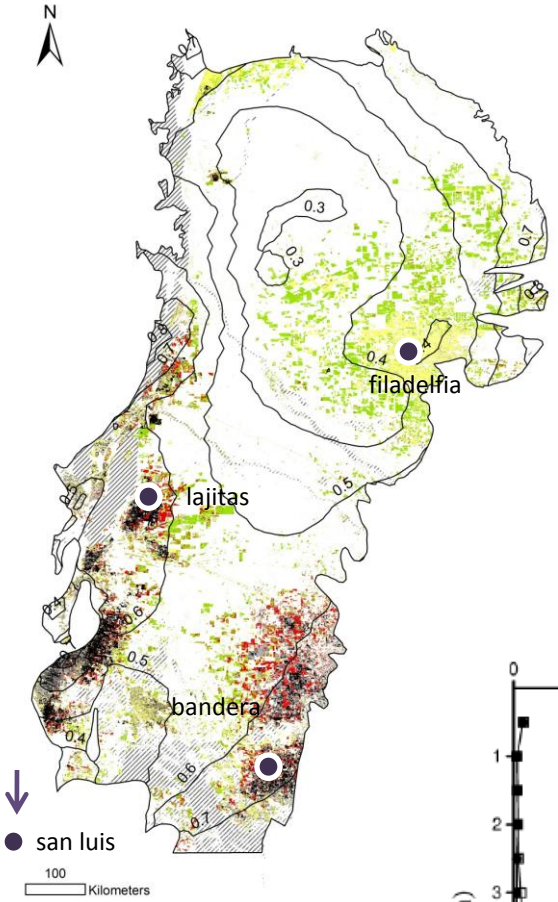


Cultivo (estado avanzado)

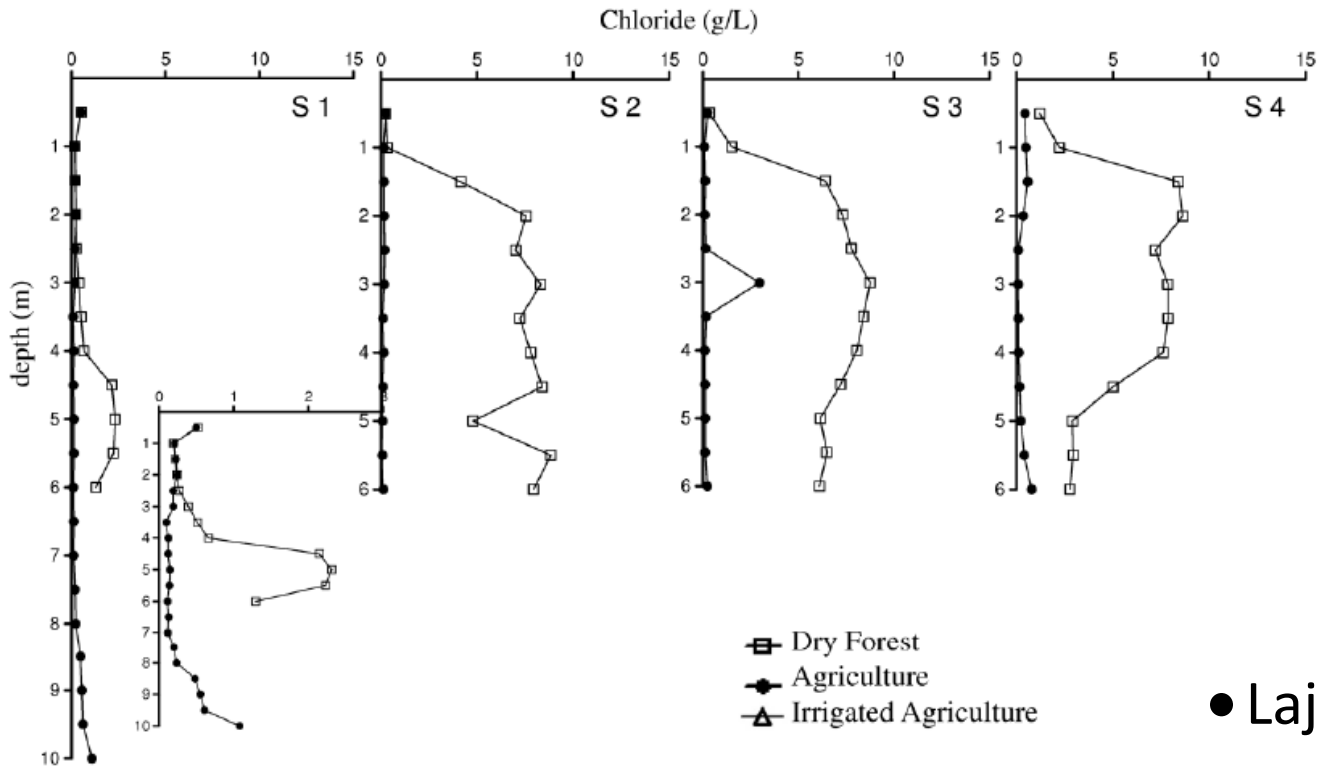
Australia, Sahel…. (Chaco ?)



Santoni et al. 2010 – WRR
Jayawickreme et al. 2011 – Ecological Applications
Contreras et al. 2012 – Ecohydrology
Amdan et al. 2014 – WRR
Gimenez et al. in preparation

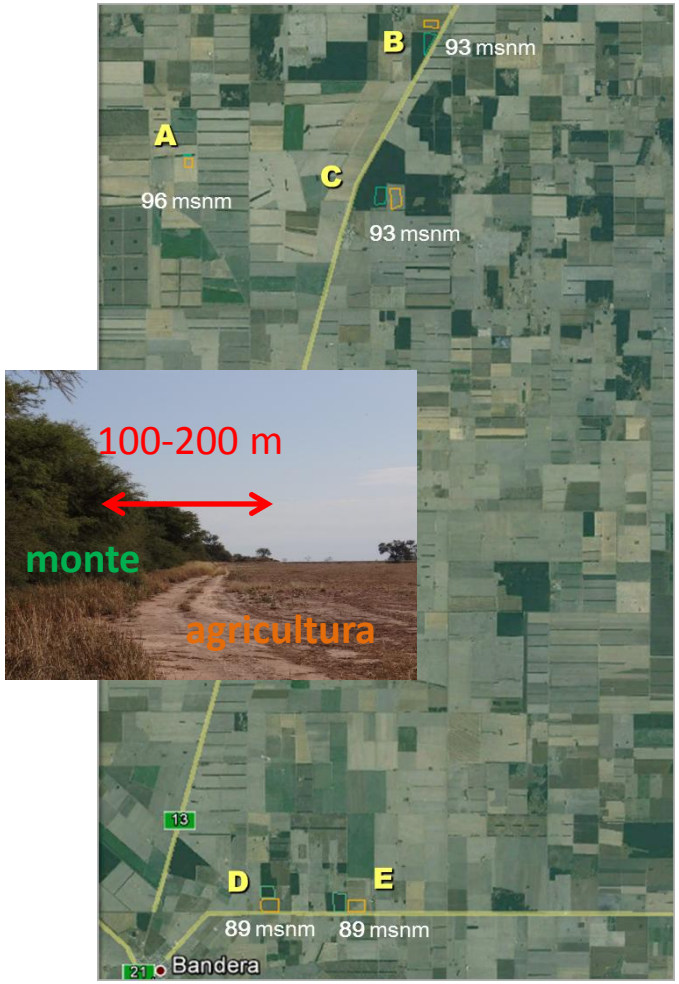


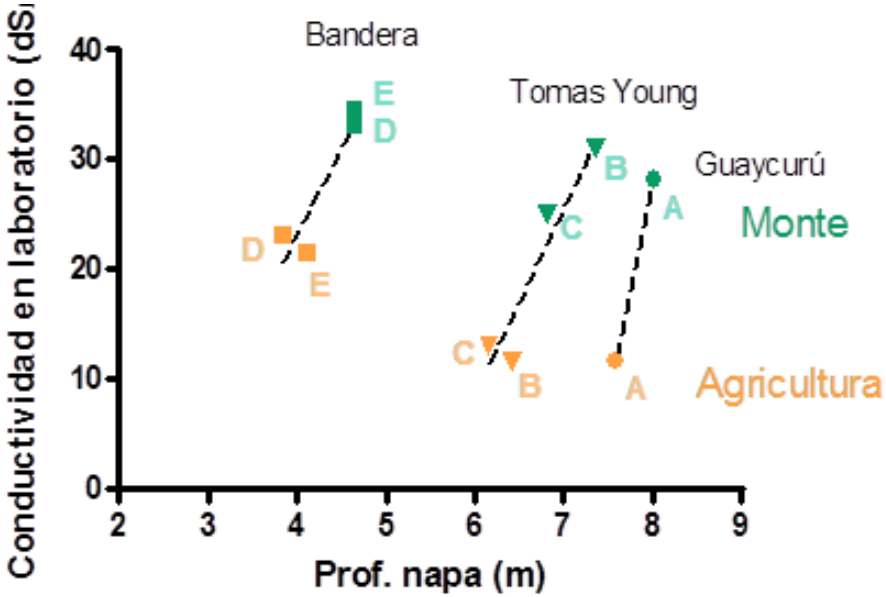
	Lluvia (mm/yr)	Prof freat (m)	stock natural de Cl (kg/m^2)	Recarga bajo cultivo (mm/yr)
San Luis	600	> 20	0.2-9 Kg/m2	5 to 20
Filadelfia	800	> 10	> 10 Kg/m2	?
Lajitas	850	> 20	6-13 Kg/m2	30 to 50
Bandera	950	> 8	10-12 Kg/m2	30 to 50

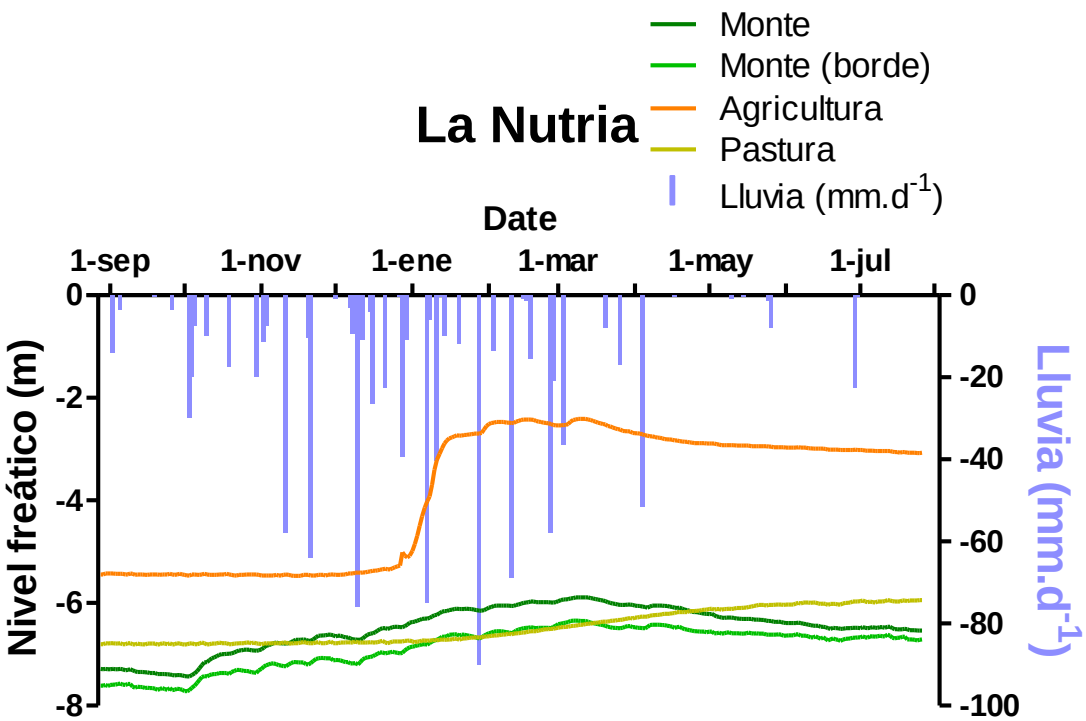


• Lajitas

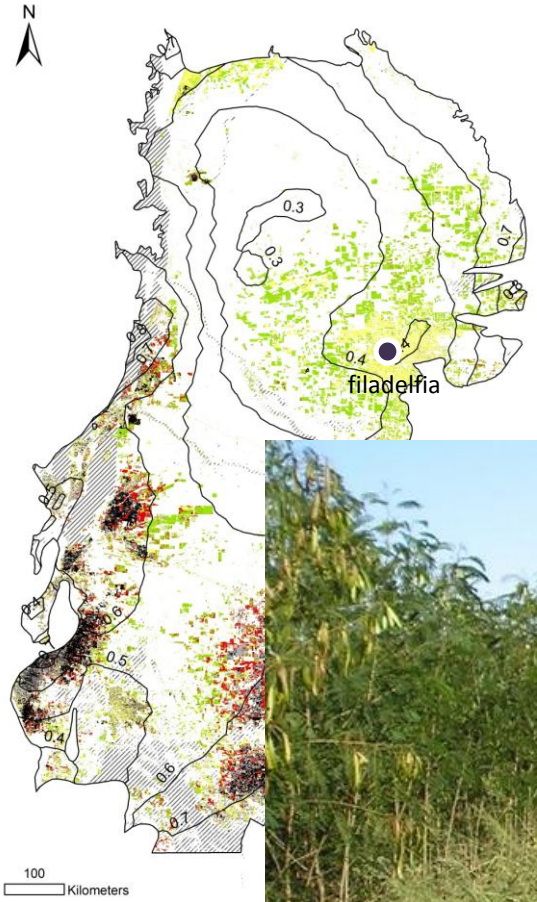
- Bandera


B
93 msnm
A
96 msnm
C
93 msnm
100-200 m
monte
agricultura
13
D
E
89 msnm
89 msnm
21
Bandera


Conductividad en laboratorio (dS
Prof. napa (m)
Bandera
Tomas Young
Guaycurú
Monte
Agricultura
E
D
D
E
B
C
A
C
B
A
0
10
20
30
40
2
3
4
5
6
7
8
9



Giménez et al. en preparación


N
0.3
0.3
0.7
0.4
filadelfia
0.5
0.4
0.6
0.7
100
Kilometers

Muzzarella
TREBOL
Leche
TREBOL

CHACO

La deforestación agrícola dispara el ascenso freático y moviliza el gran stock de sales existente. Existen condiciones para anegamiento y salinización de gran escala.

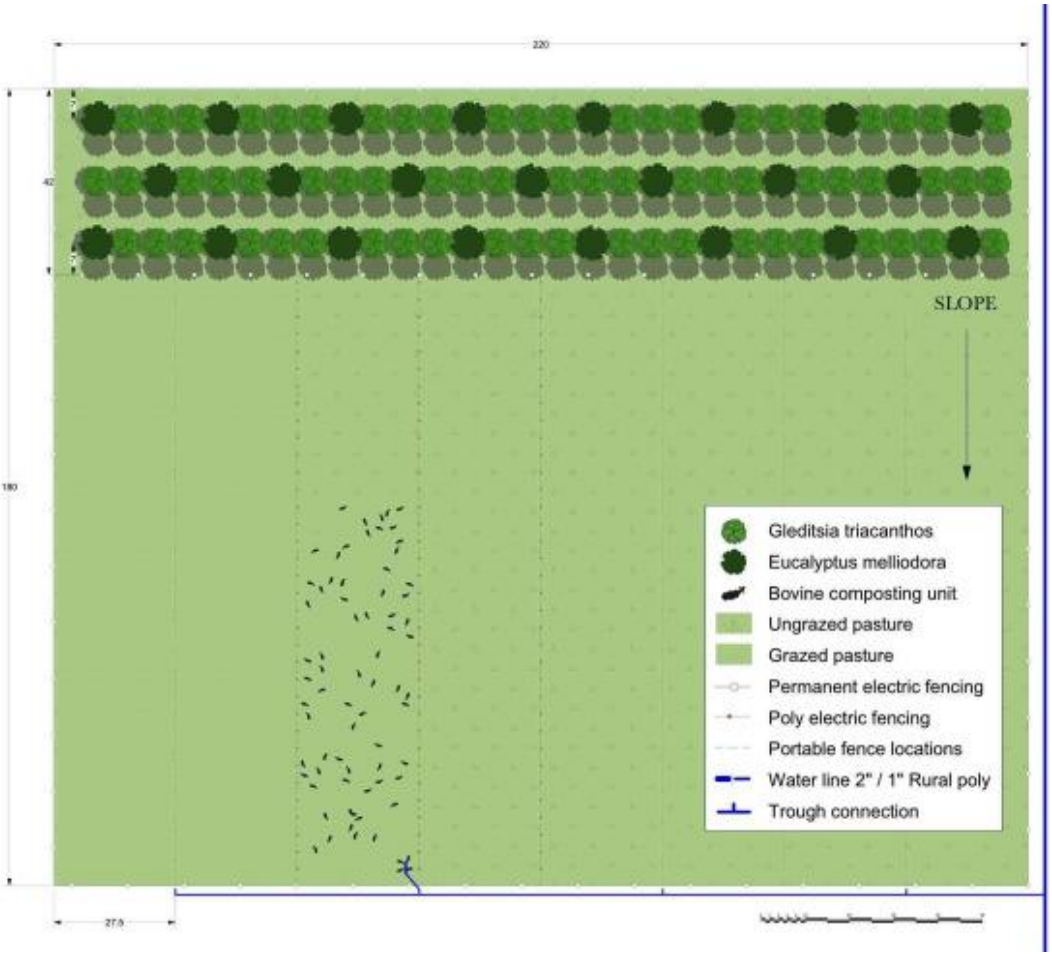
Las pasturas tienen un impacto mucho menor que los cultivos anuales
No está claro como responderán al ascensos de napas y sales

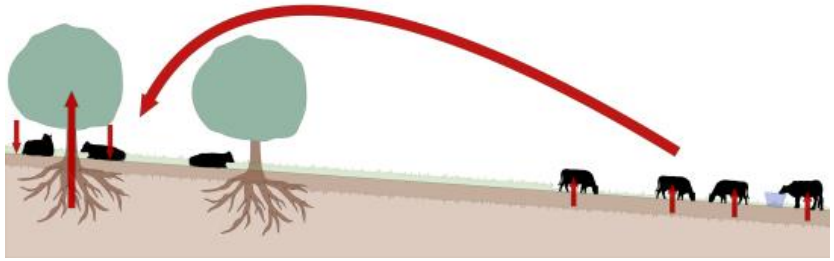
Debemos revisar los nichos para NUEVOS sistemas pastoriles
Las pasturas como destino final y no como “parada” previa a la agricultura
Agricultura subsidiaria de la ganadería (+maíz!)
Raíces profundas de “rescate” de agua en rotación con cultivos
Oportunidad en tierras degradadas
Tolerancia a la salinidad será cada vez más importante
Fijación de nitrógeno con el paso del tiempo y el abandono de soja

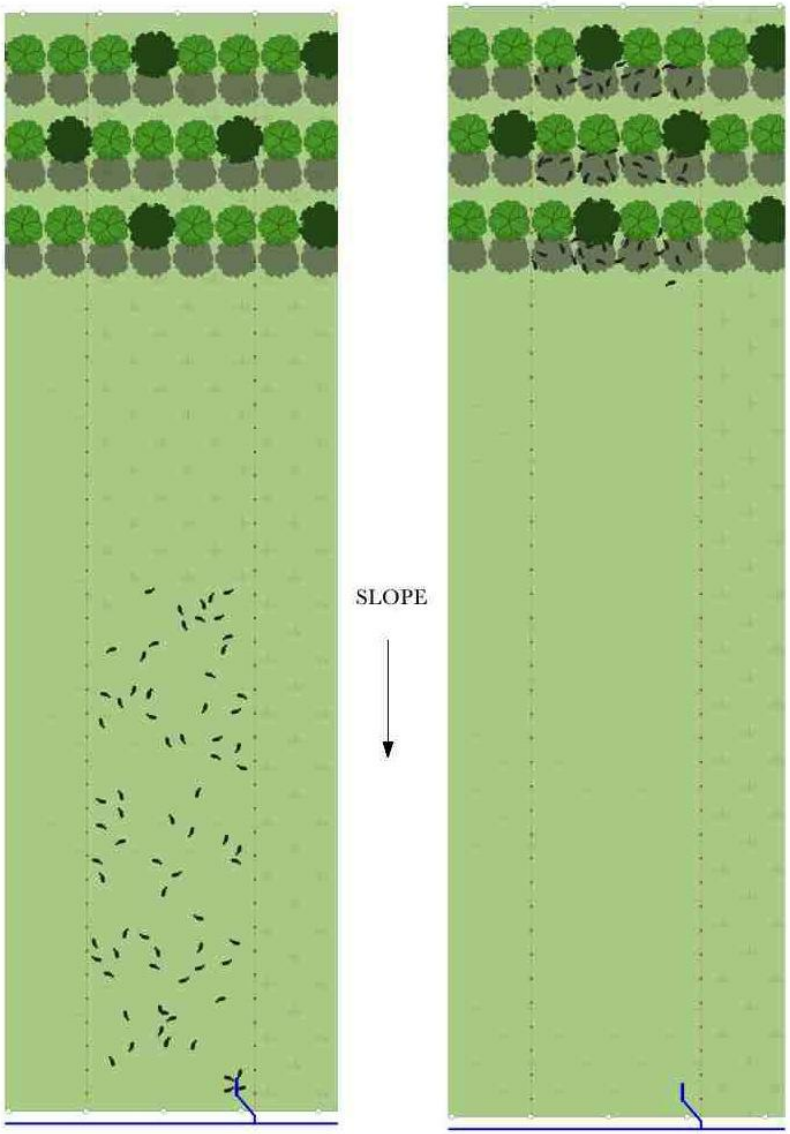
¿Estamos listos para recibir la “expansión ganadera 2.0”?

Volcar grano al animal

Habilitar nuevos nichos pastoriles

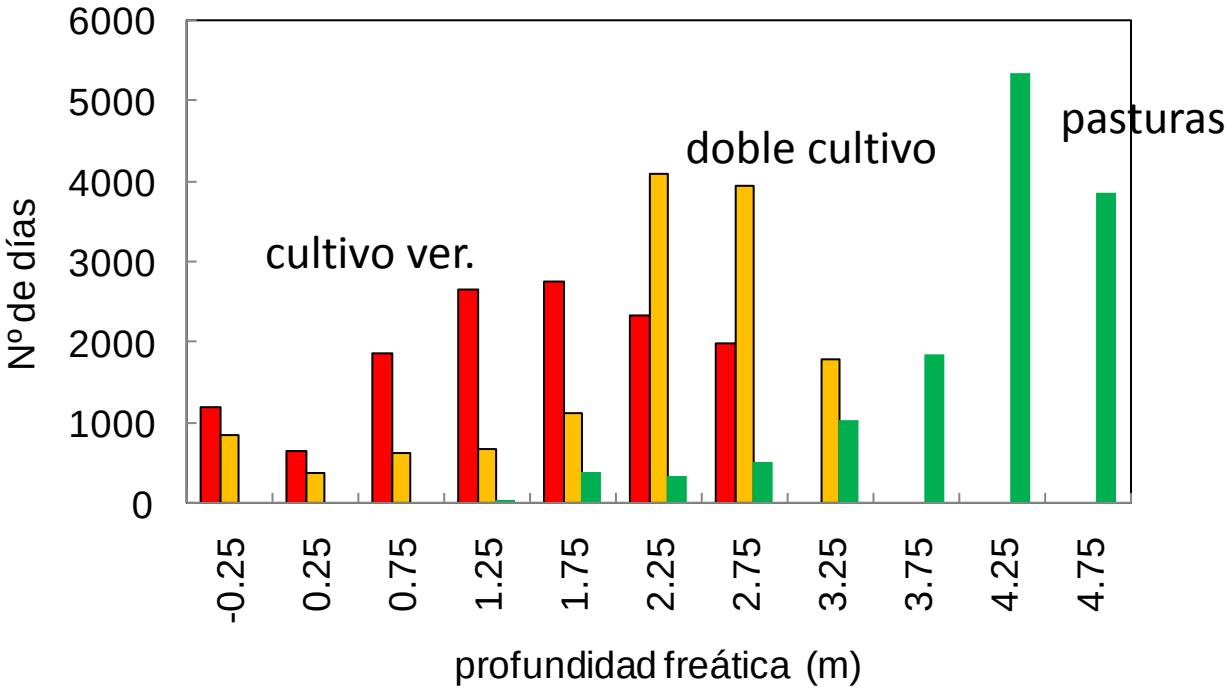

220
42
180
27.5
SLOPE
Gleditsia triacanthos
Eucalyptus melliodora
Bovine composting unit
Ungrazed pasture
Grazed pasture
Permanent electric fencing
Poly electric fencing
Portable fence locations
Water line 2" / 1" Rural poly
Trough connection



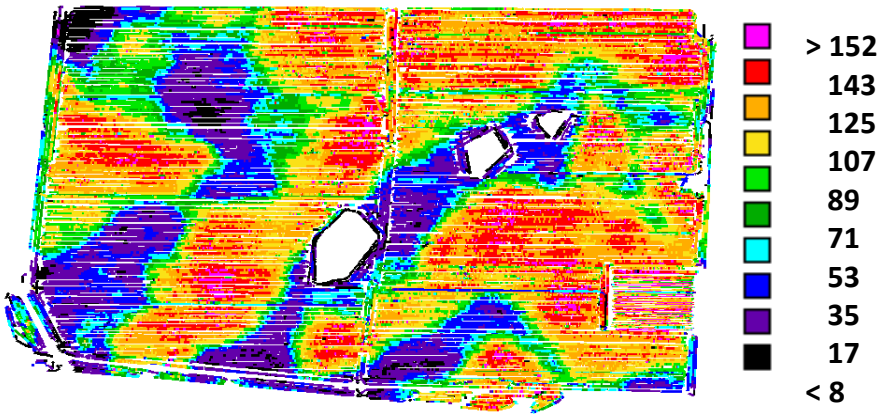

SLOPE

Modelado Hidrológico

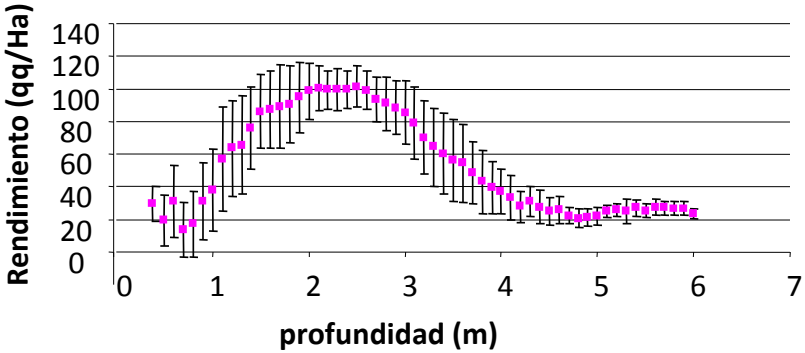
(Dinámica freática)



- V. Mackenna CBA

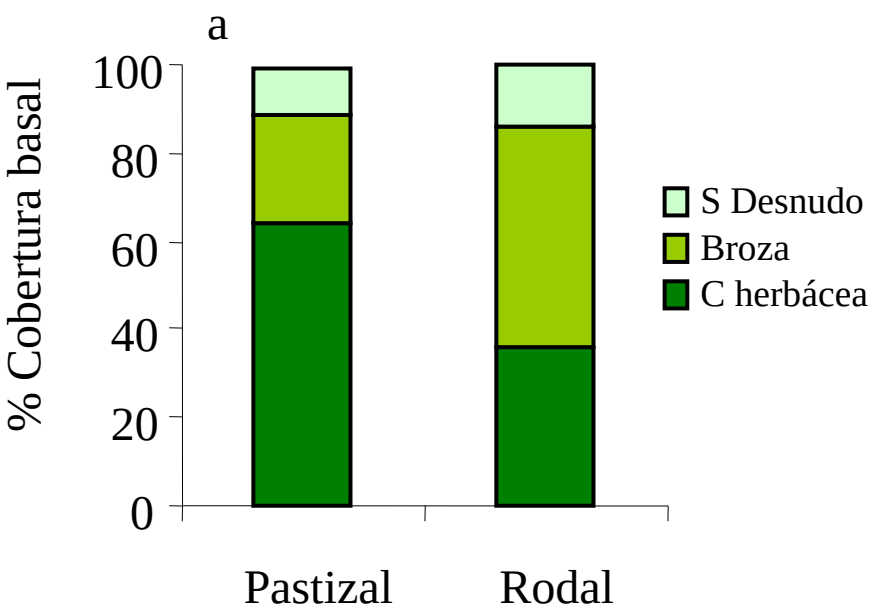


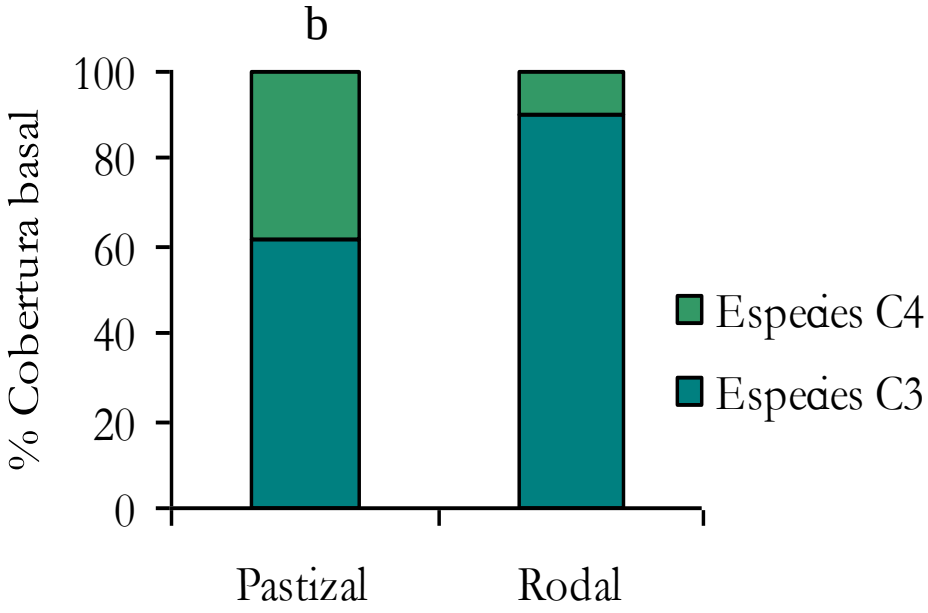
Maiz 2005-2006 (qq/Ha)



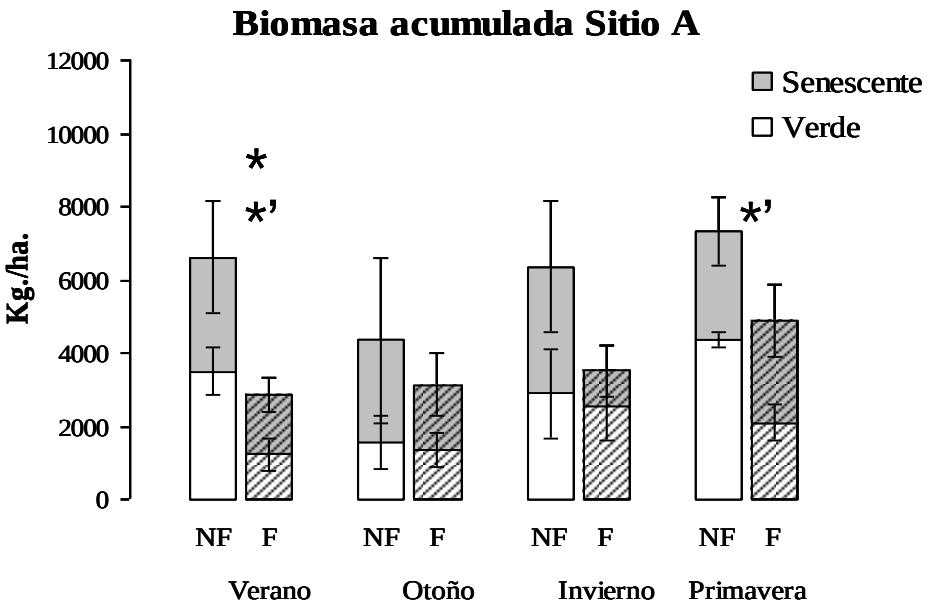
7/7/2013
Image © 2014 DigitalGlobe

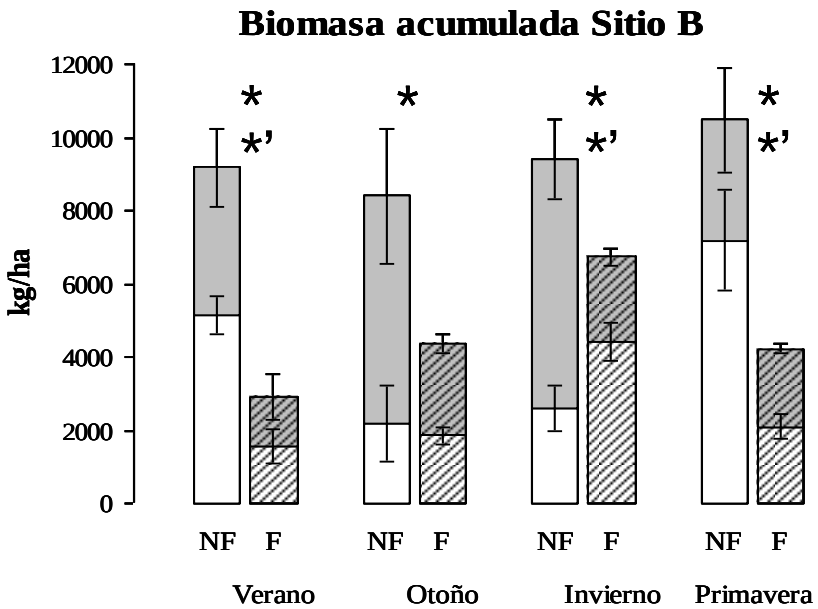
Clavijo et al. 2005 – Rangeland Ecology & Management



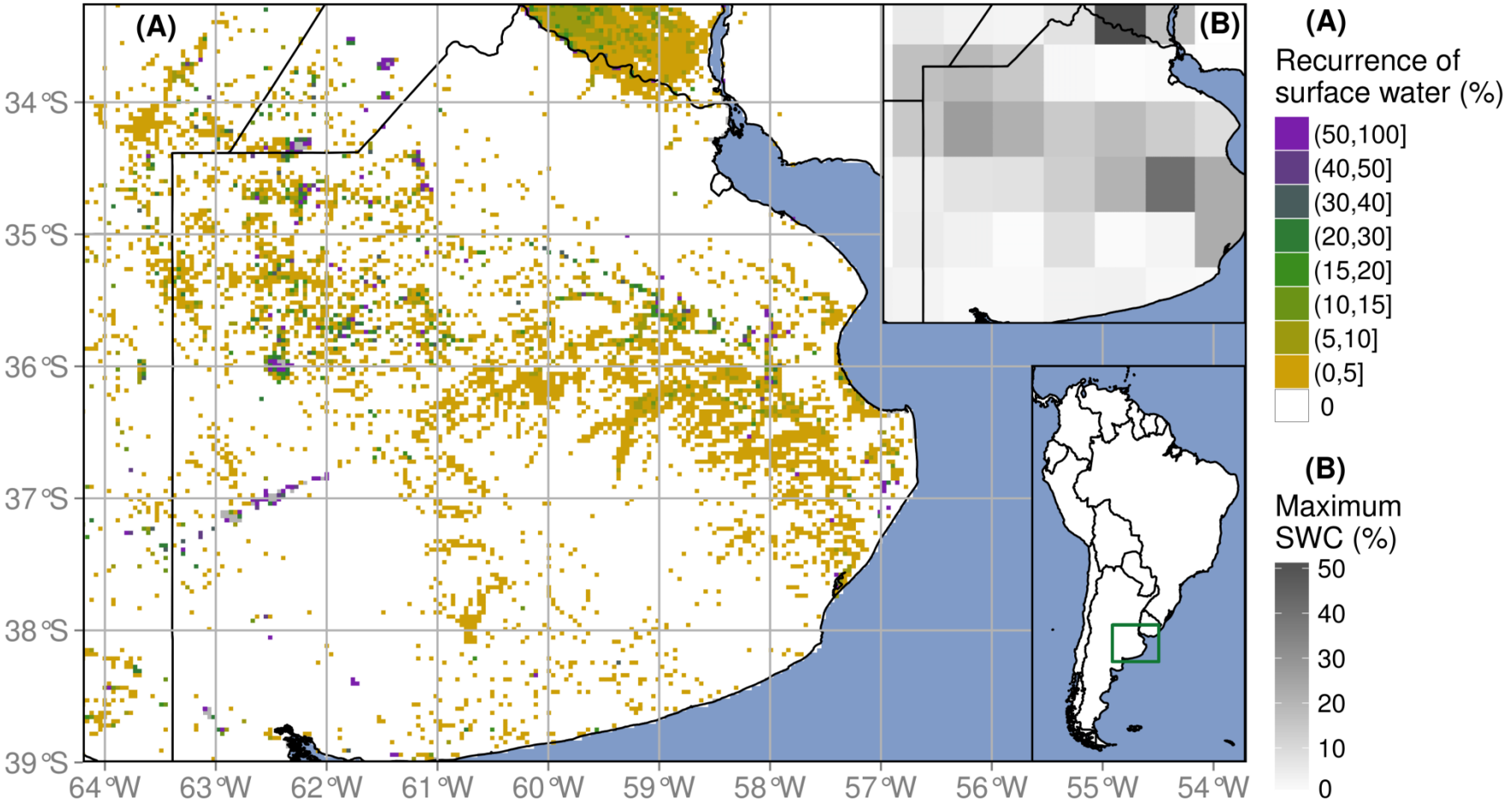


Nordenstahl et al. 2012 – Agroforestry Systems





Cobertura de agua regional 2000-2013



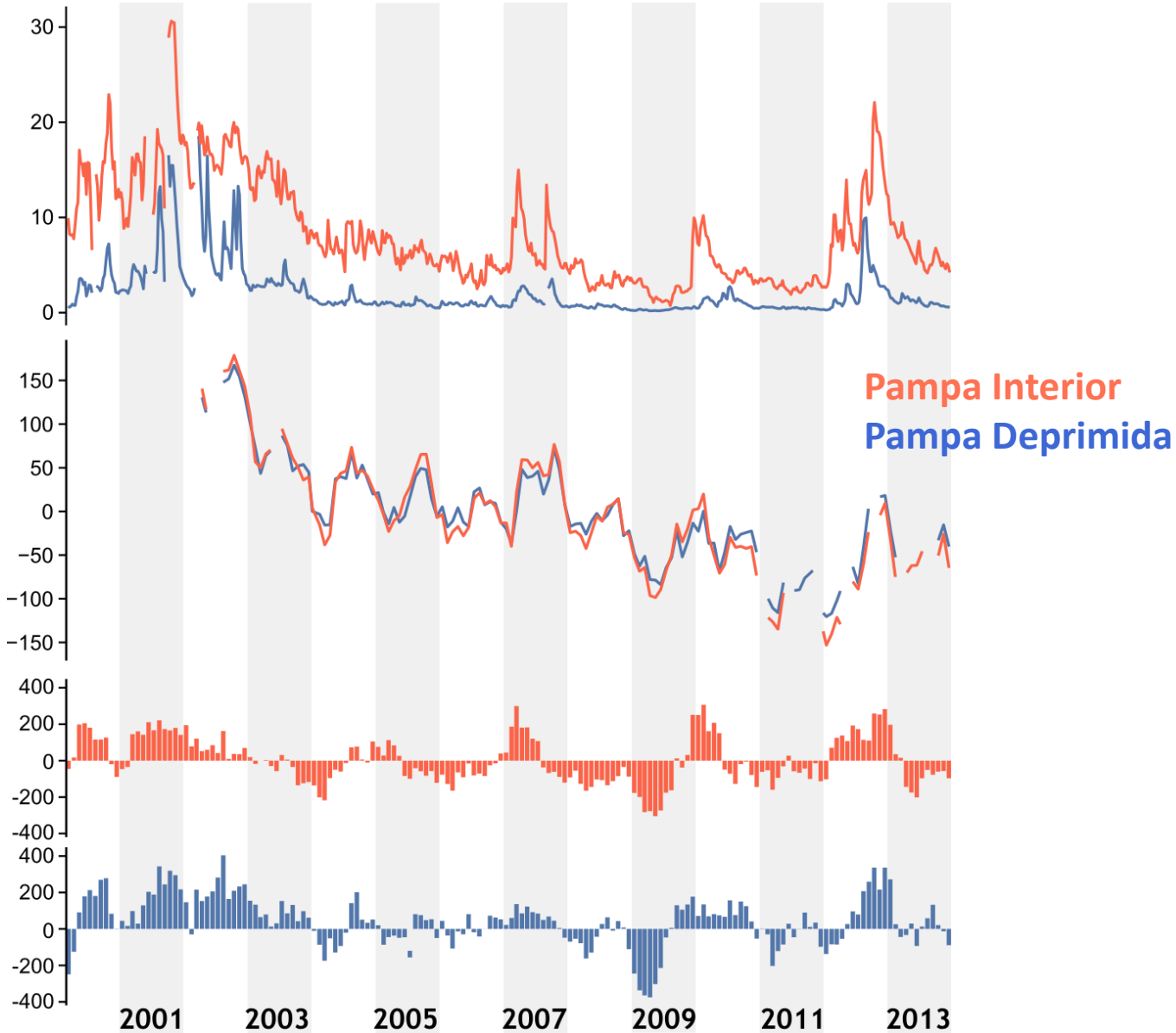
Deteccion de agua usando albedo —> MODIS (500x500m, 8 days)

Area Inundada (%)

MODIS

Stock de agua total (mm)

GRACE
(Swenson et al., 2006;
Landerer et al., 2012)

Anomalía de Lluvias (mm)

TRMM
(Kummerow et al., 1998)