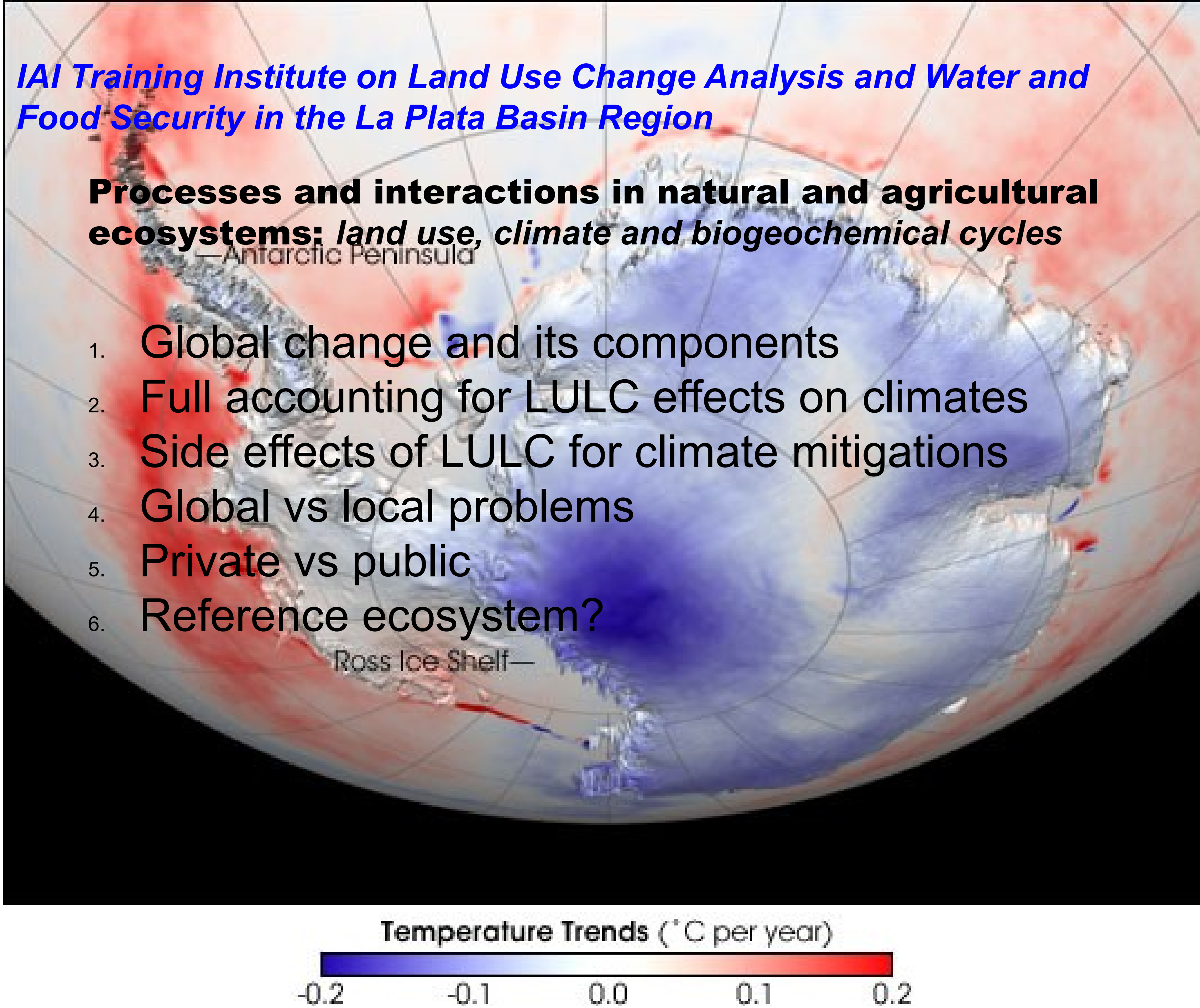
IAI Training Institute on Land Use Change Analysis and Water and Food Security in the La Plata Basin Region

Processes and interactions in natural and agricultural ecosystems: ***land use, climate and biogeochemical cycles***

1. Global change and its components
2. Full accounting for LULC effects on climates
3. Side effects of LULC for climate mitigations
4. Global vs local problems
5. Private vs public
6. Reference ecosystem?



Cambio *Ambiental* Global

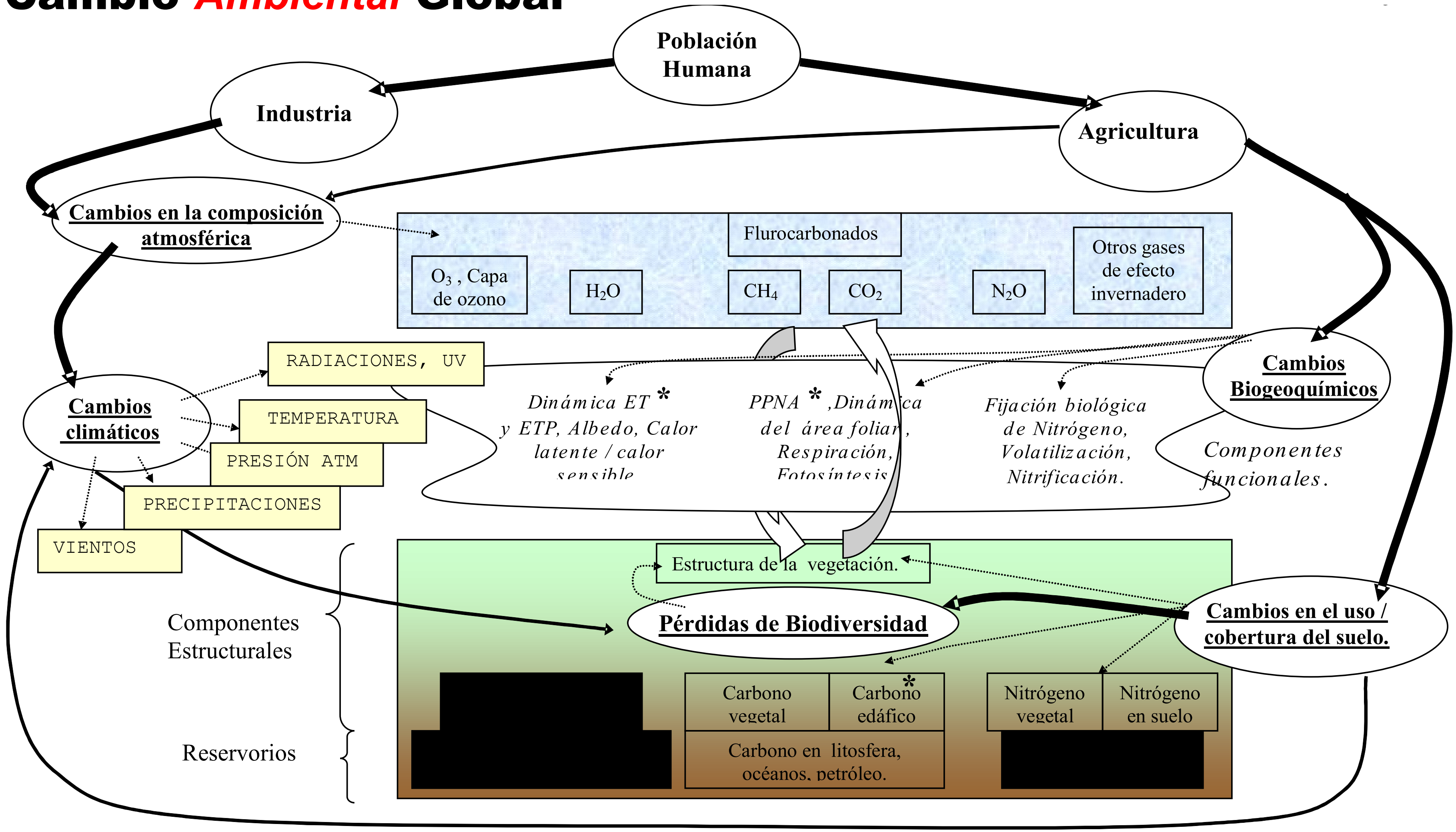
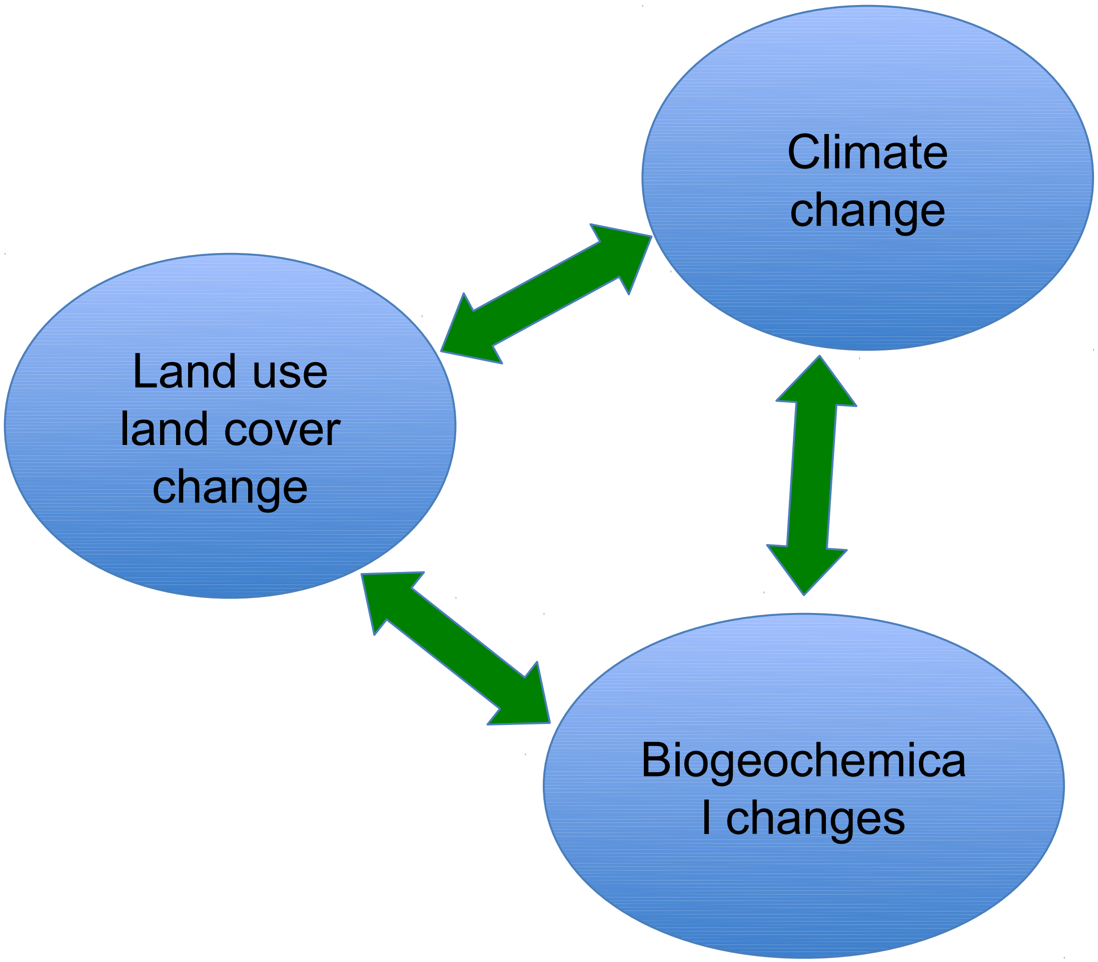


Figura 1: Diagrama de los principales componentes del Cambio Global y su relación con los ciclos de los nutrientes a escala planetaria. Se muestran también los principales componentes estructurales (imprenta) y funcionales (cursiva) de los ecosistemas. Las flechas gruesa señalan efectos dominantes entre los componentes del cambio global ambiental (dentro de óvalos y subrayados) y las flechas finas efectos menores (Adaptado de Vitousek 1994). Las flechas punteadas muestran la influencia de los componentes del cambio global en los ecosistemas y la atmósfera. Los asteriscos señalan las variables funcionales y estructurales de los ecosistemas que se analizarán en el proyecto. *(ET- evapotranspiración real, ETP- evapotranspiración potencial, PPNA- productividad primaria neta aérea).*

Procesos interrelacionados

Piñeiro, 2001

Interrelated processes

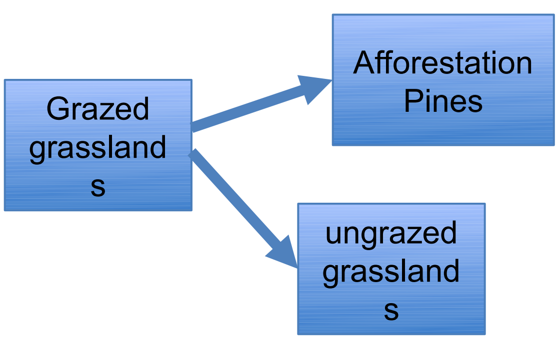


Climate forcing of LULC change

Changes in C stocks

Nosetto et al.,2006

LULC	Carbon
Afforestation	SOC and biomass changes



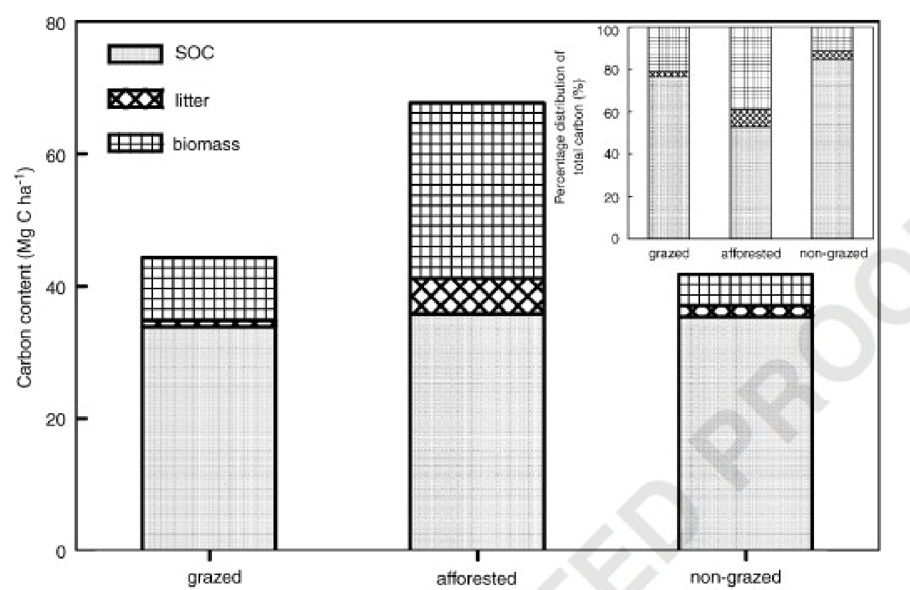
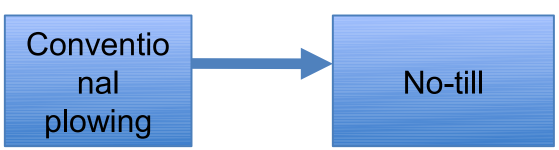


Fig. 2. Carbon distribution (Mg C ha^{-1}) among soil organic carbon (SOC), litter and biomass in grazed, non-grazed and afforested stands. Bars correspond to the average value of five sites (grazed and afforested stands) and three sites (non-grazed stands). The inset graphic represents the percentage carbon distribution among the same pools.

Climate forcing of LULC change

Changes other GHG emissions

LULC	Carbon	GHG
No till vs plowing	SOC and biomass changes	N20, CH4



Steinbach y Alvarez, 2006

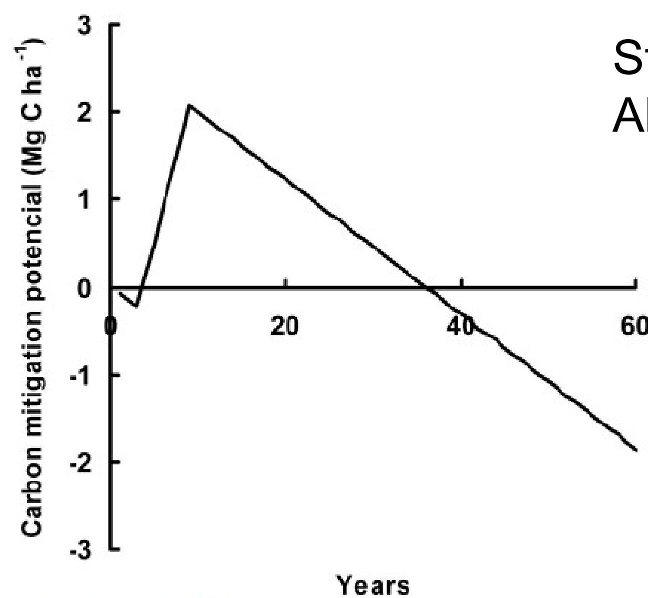


Fig. 9. Carbon mitigation potential under no-till in the Argentine Pampa Region. Estimations were performed assuming a C sequestration of 460 kg C ha^{-1} yr^{-1} under no-till between Years 4 to 9

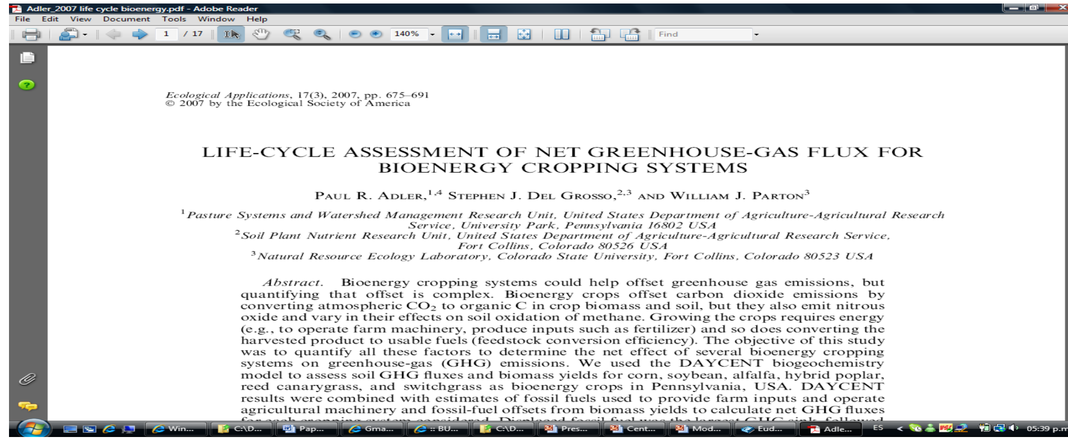
Climate forcing of LULC change

Changes in fossil fuel use and CO2 emissions

LULC	Carbon	GHG	Full life cycle
Biofuels	SOC and biomass changes	N2O, CH4	Fossil Energy Use Farming Transportation Industry Etc..

- **Estimación de emisiones de gases de efecto invernadero (CO2, CH4, N20).**

- **Biocombustibles**



Ecological Applications, 17(3), 2007, pp. 675–691

LIFE-CYCLE ASSESSMENT OF NET GREENHOUSE-GAS FLUX FOR BIOENERGY CROPPING SYSTEMS

PAUL R. ADLER,[1,4] STEPHEN J. DEL GROSSO,[2,3] AND WILLIAM J. PARTON[3]

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[2] *Soil Plant Nutrient Research Unit, United States Department of Agriculture-Agricultural Research Service, Fort Collins, Colorado 80526 USA*
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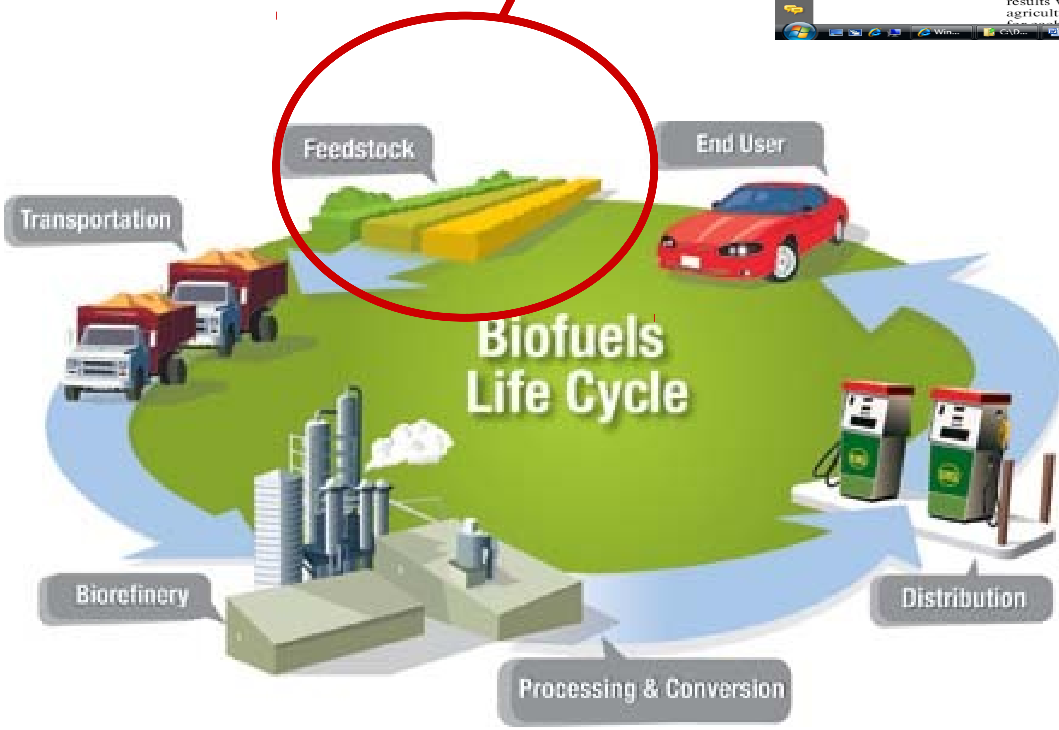
Abstract. Bioenergy cropping systems could help offset greenhouse gas emissions, but quantifying that offset is complex. Bioenergy crops offset carbon dioxide emissions by converting atmospheric CO_2 to organic C in crop biomass and soil, but they also emit nitrous oxide and vary in their effects on soil oxidation of methane. Growing the crops requires energy (e.g., to operate farm machinery, produce inputs such as fertilizer) and so does converting the harvested product to usable fuels (feedstock conversion efficiency). The objective of this study was to quantify all these factors to determine the net effect of several bioenergy cropping systems on greenhouse-gas (GHG) emissions. We used the DAYCENT biogeochemistry model to assess soil GHG fluxes and biomass yields for corn, soybean, alfalfa, hybrid poplar, reed canarygrass, and switchgrass as bioenergy crops in Pennsylvania, USA. DAYCENT results were combined with estimates of fossil fuels used to provide farm inputs and operate agricultural machinery and fossil-fuel offsets from biomass yields to calculate net GHG fluxes

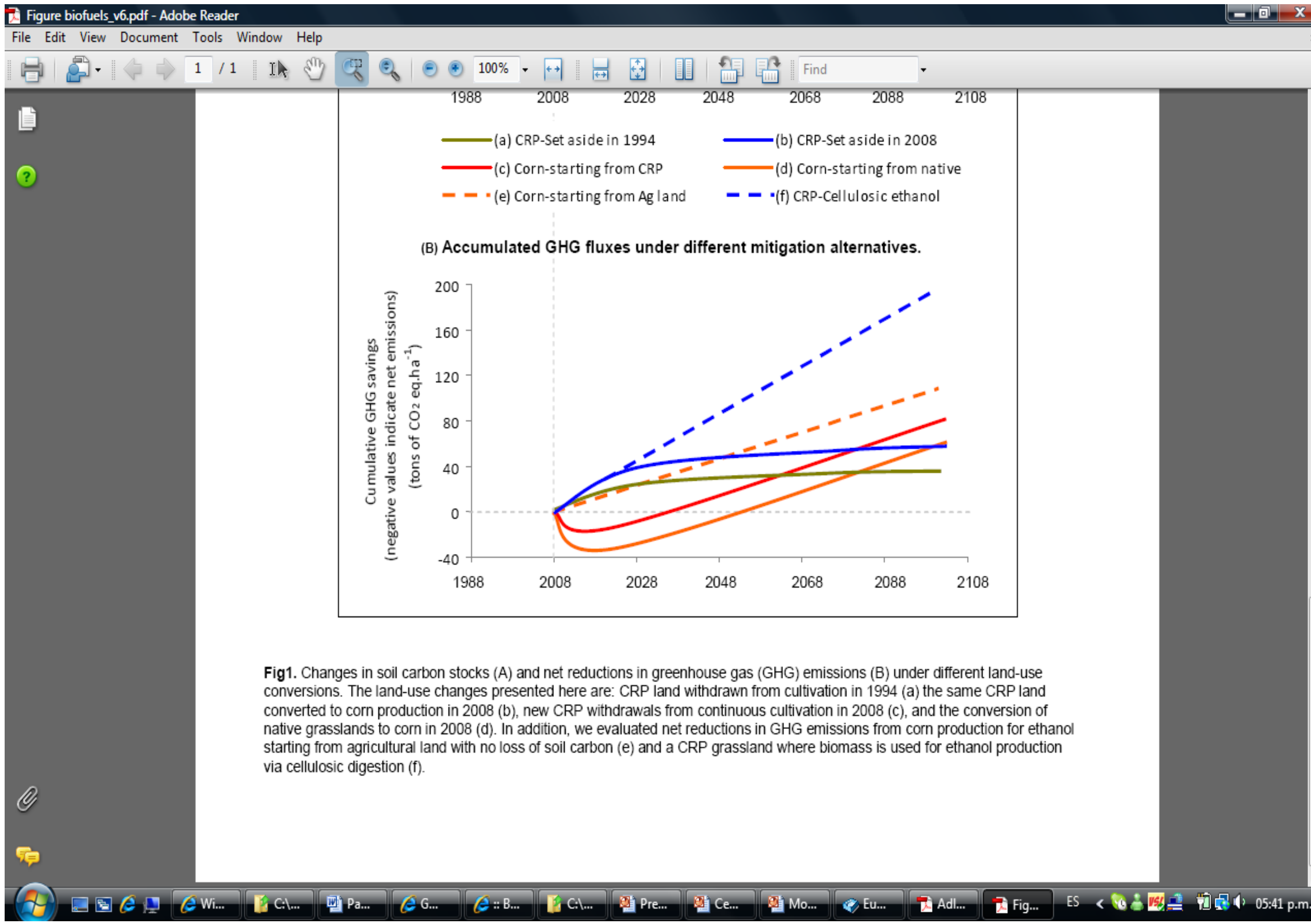


Datos tomados de Hill et al. (2006)

		Etanol Maíz
Rendimiento (kg/ha)		9312
Conversión grano en Etanol (L/kg)		0,39
Litros de Etanol/ha		3632
MJ/litro de Etanol		21,26
Producción de energía MJ/ha		77216
Subsidios de energía (MJ/ha)		
Uso energía en planta de producción *	0,50	38454
Trabajo en planta/industria *	0,006	463
Construccción planta industrial *	0,002	154
Transporte		3243
Uso de energía en almacenamiento		3552
Producción de maquinaria de campo		618
Fertilizantes y pesticidas		7876
Gasoil para labores y aplicaciones		7027
Semillas (híbridas o variedades)		154
Total de subsidio (MJ/ha)		61541
Producción neta de energía (MJ/ha.año)		15675
Energía en subsidio/energía neta producida		**0.25**

Total de emisiones en life cycle (gCO2 eq/MJ)	gasoline	96.9
Desplaz de combustibles fosiles por ethanol (%)		0.25 a 0.20
GEI no emitidos al usar ethaol (g CO2 eq/MJ)		19.67
Emisiones de N2O en chacra (g CO2 eq/MJ)		5.6
Emisiones de CH4 en chacra (g CO2 eq/MJ)		0.434
Emisiones de CO2 (encalado)(g CO2 eq/MJ)		2.48
Ahorro total de emisiones de GEI (g CO2 eq/MJ)		**12.02**
Ahorro total de emisiones de GEI (%)		12.4

Si incluimos cambios en el carbono del suelo en distintas trayectorias de uso del suelo.



Piñeiro et al. 2009. Ecological Applications.

Climate forcing of LULC change

Other changes in land use

LULC	Carbon	GHG	Full life cycle	Land use displacement
Biofuels	SOC and biomass changes	N_2O CH_4	Fossil Energy Use Farming Transportation Industry Etc..	Land use change in other places

23. T. Searchinger *et al.*, *Science* **319**, 1238 (2008).
24. R. Hammerschlag, *Environ. Sci. Technol.* **40**, 1744 (2006).
25. B. D. Solomon, J. R. Barnes, K. E. Halvorsen, *Biomass Bioenergy* **31**, 416 (2007).

Renewable Energy and the Environment, NSF grant no. DEB0620652, Princeton Environmental Institute, and the Bush Foundation. We thank T. Searchinger for valuable comments and insights and J. Herkert for providing references.

Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change

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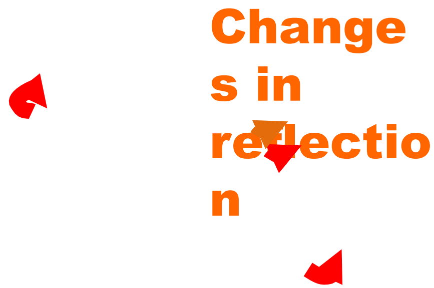
Most prior studies have found that substituting biofuels for gasoline will reduce greenhouse gases because biofuels sequester carbon through the growth of the feedstock. These analyses have failed to count the carbon emissions that occur as farmers worldwide respond to higher prices and convert forest and grassland to new cropland to replace the grain (or cropland) diverted to biofuels. By using a worldwide agricultural model to estimate emissions from land-use change, we found that corn-based ethanol, instead of producing a 20% savings, nearly doubles greenhouse emissions over 30 years and increases greenhouse gases for 167 years. Biofuels from switchgrass, if grown on U.S. corn lands, increase emissions by 50%. This result raises concerns about large biofuel mandates and highlights the value of using waste products.

Climate forcing of LULC change



LULC examples	Carbon	GHG	Full life cycle	Land use displacement	Albedo

Climate forcing of LULC change

Change s in energy exchang e

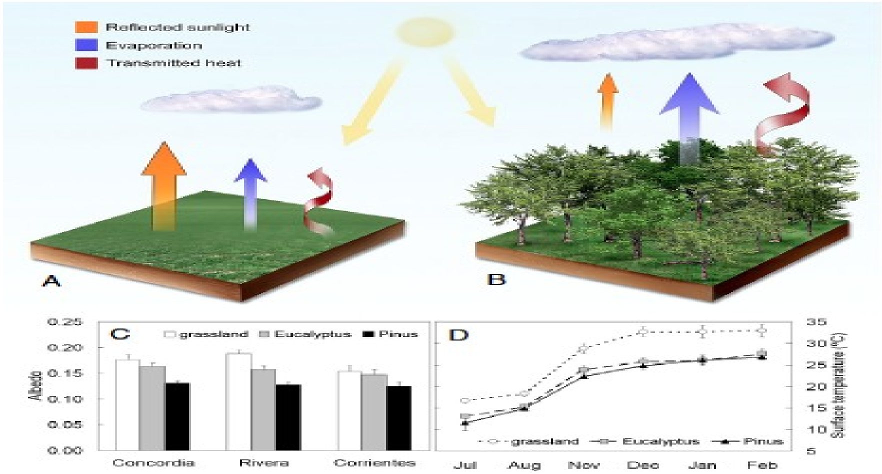


Figure 1. Examples of various biophysical factors in a grassland or cropland (A) and forest (B). Because of a grassland or cropland's higher reflectivity (albedo), it typically reflects more sunlight than the forest does, cooling surface air temperatures relatively more. In contrast, the forest often evaporates more water and transmits more heat to the atmosphere (latent and sensible heat, respectively), cooling it locally compared to the grassland or unirrigated cropland. More water vapor in the atmosphere can lead to a greater number and height of clouds as well as to increased convective rainfall. In addition, the forest has a more uneven canopy (surface roughness) that increases mixing and upwelling of air. ((C) and (D)) Comparison of shortwave albedo and surface skin temperature for 215 grassland and forest stands across Argentina and Uruguay. The satellite data were assessed using 180 km × 180 km Landsat images (2000–2005) on seven dates for the Corrientes and Concordia regions of Argentina and three dates for the Rivera region of Uruguay. The Landsat scenes were geometrically and atmospherically corrected and correspond to images 226/80 (path and row) for Corrientes, 225/82 for Concordia, and 223/82 for Rivera. In general, measurements at sites within a region compared adjacent grassland, pine, and eucalypt stands.

LULC	Carbo n	GH G	Full life cycl e	Land use displacement	Albed o	Full Energy balance of the surface

Jackson et al., 2008

Climate forcing of LULC change

Changes in energy exchange and ATM

LULC	Carbon	GHG	Full life cycle	Land use displacement	Albedo	Full Energy balance of the surface	Full energy balance of the surface and Atm Aerosols ?

Climate forcing of LULC change

Changes in energy exchange and ATM

LULC examples	Carbon	GHG	Full life cycle	Land use displacement	Albedo	Full Energy balance of the surface	Full energy balance of the surface and Atm Aerosols?	Is there more…. probably yes!

SIDE effects of LULC changes for climate mitigations

LULC	Ecosystem Services					Social	Economical
	Water	Water quality	Nutrients	Air quality	Biodiversity	Labor	Incomes
Afforestation							
No till vs plowing							
Biofuels				Vocs, NOx PM2.5			

Climate change and health costs of air emissions from biofuels and gasoline

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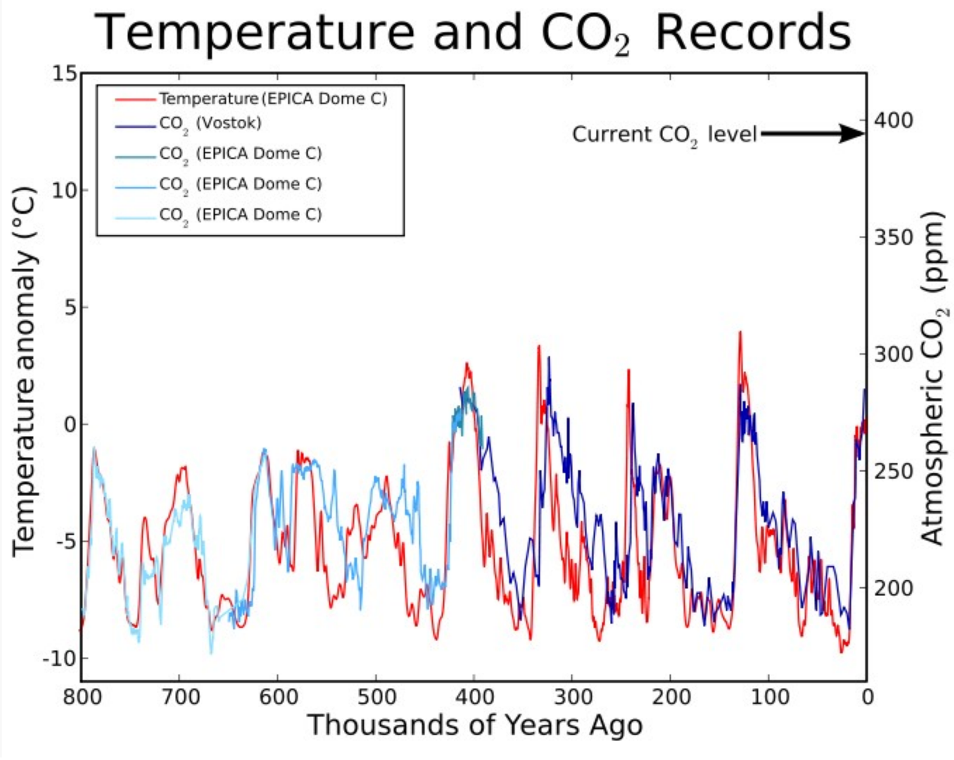
[a]Department of Applied Economics, [b]Department of Ecology, Evolution, and Behavior, University of Minnesota, St. Paul, MN 55108; [c]Department of Biology and Natural Capital Project, Woods Institute for the Environment, Stanford University, Stanford, CA 94305; [d]Argonne National Laboratory, Argonne, IL 60439; and [e]Industrial Economics, Cambridge, MA 02140

Contributed by David Tilman, December 16, 2008 (sent for review August 14, 2008)

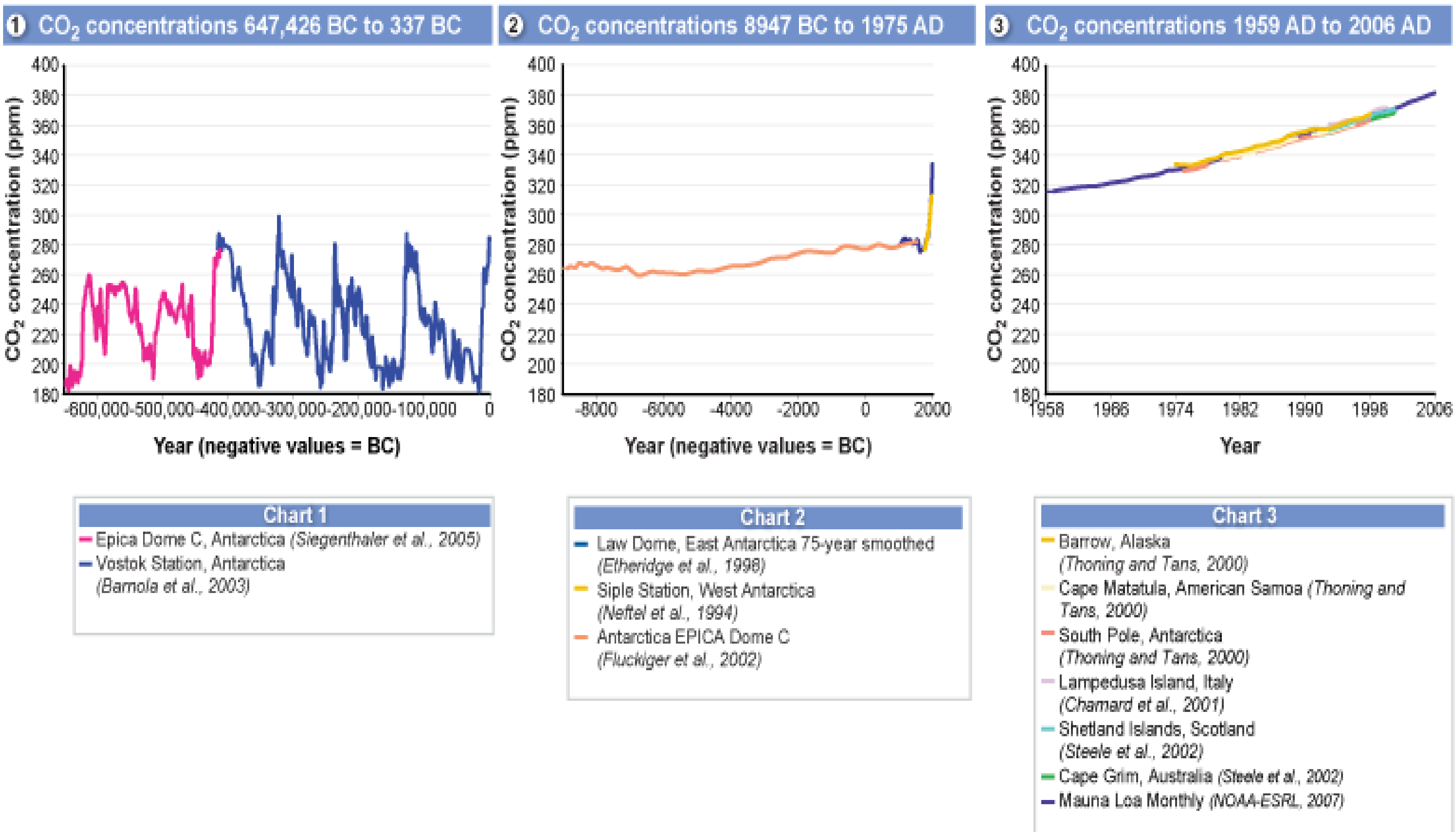
Global vs local problems
Private vs public

Reference ecosystem

Fundamental Assumption:
The biosphere worked well without human activities and maintained the earth climate



Energy and resource capture, information, evolution, fitness of ecosystems,
Resilience theory



1 CO_2 concentrations 647,426 BC to 337 BC
2 CO_2 concentrations 8947 BC to 1975 AD
3 CO_2 concentrations 1959 AD to 2006 AD
CO_2 concentration (ppm)
400
380
360
340
320
300
280
260
240
220
200
180
-600,000 -500,000 -400,000 -300,000 -200,000 -100,000 0
Year (negative values = BC)
-8000 -6000 -4000 -2000 0 2000
Year (negative values = BC)
1958 1966 1974 1982 1990 1998 2006
Year
Chart 1
Epica Dome C, Antarctica *(Siegenthaler et al., 2005)*
Vostok Station, Antarctica *(Barnola et al., 2003)*
Chart 2
Law Dome, East Antarctica 75-year smoothed *(Etheridge et al., 1998)*
Siple Station, West Antarctica *(Neftel et al., 1994)*
Antarctica EPICA Dome C *(Fluckiger et al., 2002)*
Chart 3
Barrow, Alaska *(Thoning and Tans, 2000)*
Cape Matatula, American Samoa *(Thoning and Tans, 2000)*
South Pole, Antarctica *(Thoning and Tans, 2000)*
Lampedusa Island, Italy *(Chamard et al., 2001)*
Shetland Islands, Scotland *(Steele et al., 2002)*
Cape Grim, Australia *(Steele et al., 2002)*
Mauna Loa Monthly *(NOAA-ESRL, 2007)*

FIN

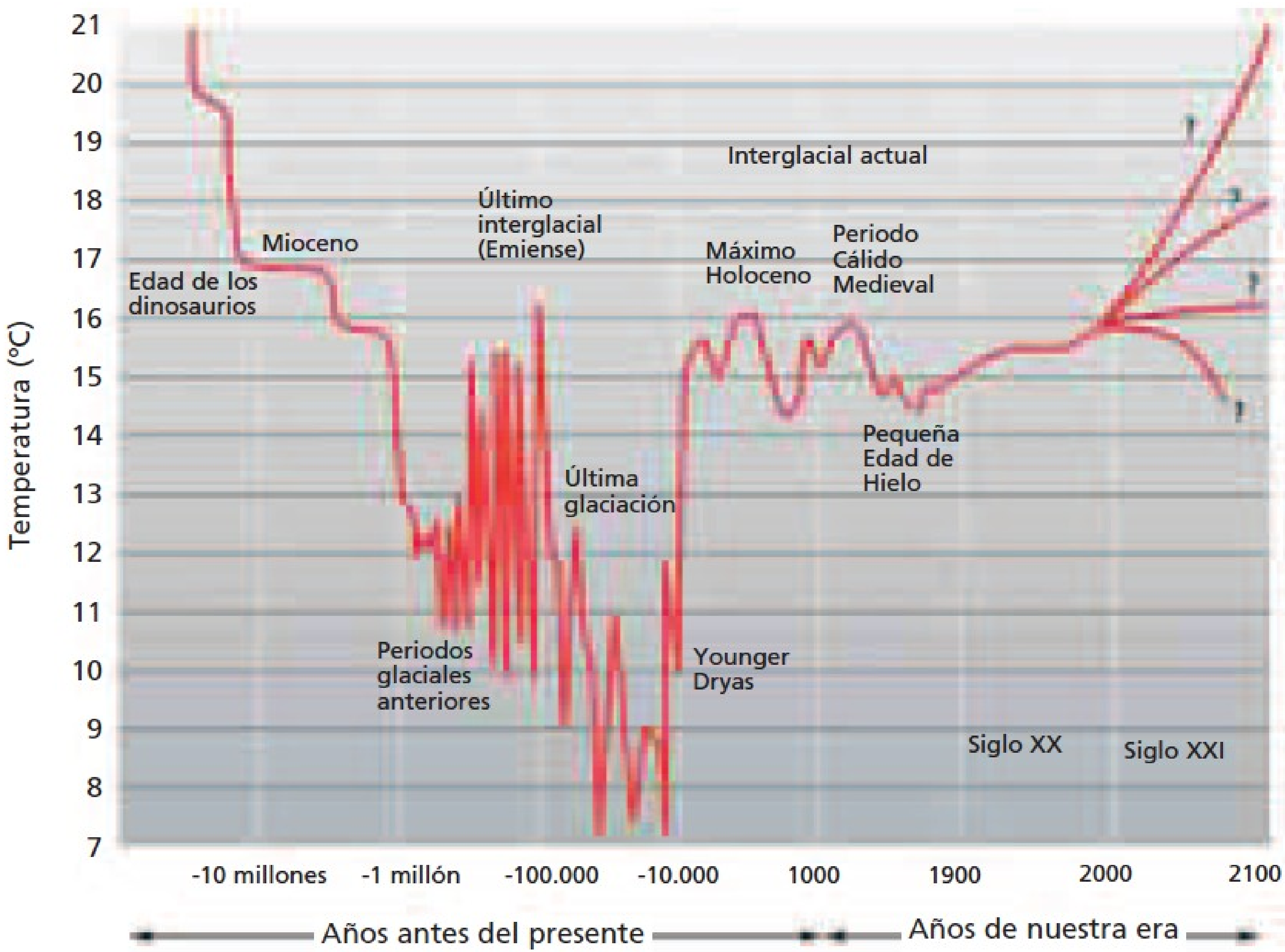
Energy and resource capture, information, evolution, fitness of systems,
Resilience theory

Paper group 2

Message 1. LULC for climate mitigation include full energy accounting
Message 2. LULC effects on climate modeling
Message 3. LULC local climate effects vs global climate effects
Message 4. LULC local vs global Side effects

Paper group 1

Justificación: modelo de agentes, toma de decisiones
Global drivers y su mask o defromacin de regional and local drivers…
Stakeholders (agente) ven el global driver deformado por drivers a escalas menores



Temperatura (ºC)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
Interglacial actual
Último interglacial (Emiense)
Mioceno
Edad de los dinosaurios
Máximo Holoceno
Periodo Cálido Medieval
Pequeña Edad de Hielo
Última glaciación
Periodos glaciales anteriores
Younger Dryas
Siglo XX
Siglo XXI
-10 millones
-1 millón
-100.000
-10.000
1000
1900
2000
2100
Años antes del presente
Años de nuestra era