1 Project Title, Project Number, Principal Investigator, Key Words

LAND USE CHANGE IN THE *RIO DE LA PLATA* BASIN:
LINKING BIOPHYSICAL AND HUMAN FACTORS TO UNDERSTAND TRENDS, ASSESS IMPACTS, AND SUPPORT VIABLE STRATEGIES FOR THE FUTURE

CRN 2031

PI: Esteban Jobbágy
KEYWORDS: land use / land cover, Plata Basin, South America, ecohydrology, carbon cycling, social impacts and drivers.
WEBPAGE: http://platabasin.unsl.edu.ar

2 Project Funding

The CRN team has presented proposals related to the Plata Basin project goals to several funding agencies of national and international scope (Table 1). During year 2 of the project the team has received ~500.000 USD from the following agencies: Agencia-SECyT (Argentina), National Science Foundation and National Geographic Society (U.S.), International Development Research Center (Canada). A small yet qualitatively important source of funds derived from recent agreements with individual farmers and farmer associations such as AACREA in Argentina for in-farm research carried by CoPIs Noellemeyer and Jobbágy. During year 2, grants obtained in the previous year were still providing funds, including the "SENSOR" project from the European Commission, which has it execution period extended until mid 2009. Funds obtained during year one (900 K) and year two (500 K) had already surpassed the amount provided by the CRN grant.

Table 1. Additional funding obtained by CRN 2031 CoPIs in year 2 (2007-2008)

Granting Institutions	Grant type	Grant code	Starting date	Ending date	CRN members involved	Role	Amount (USD)(*)
National Science Foundation (US)	Division of Environmental Biology	NSF 717191	sep-07	sep-10	Jackson (with Jobbagy)	PI	150000
National Science Foundation (US)	Coupled Natural and Human Systems	NSF 709681	sep-07	sep-10	Podesta	PI	75000
National Geographic Society (US)	Research and Exploration Grants	NGS 8277-07	nov-07	oct-08	Jobbagy	PI	15000
Secretaria de Cs & Tecnica - La Agencia (Arg)	FONCyT - PICT (2006)	PICT	mar-08	mar-11	Piñeiro G	PI	10000
Secretaria de Cs & Tecnica - La Agencia (Arg)	FONCyT - PICT (2006)	PICT	mar-08	mar-11	Noellemeyer	CoPI	8500
Secretaria de Cs & Tecnica - La Agencia (Arg)	FONCyT - PICT (2006)	PICT	mar-08	mar-11	Fernandez (with Jobbagy)	PI	95000

International Development Research Center (Canada)	IDRC seed grant through IAI	IAI-IDRC	mar-08	mar-10	Jobbágy	CoPI	103000
International Development Research Center (Canada)	IDRC seed grant through IAI	IAI-IDRC	mar-08	mar-10	Meirelles	CoPI	61000
Funds from farmers associations and individual farms in collaborative projects	Collaborative projects and agreements		1 to 3 year-long agreements		Noellemeyer, Jobbágy	PI s	12000
TOTAL							**529500**

* only the amount allocated to CRN members is indicated

3 Research Activities and Findings

This section is organized as follows: First we present a detailed list of the work performed in the frame of the research activities that were initially planned (3.1), finally we list all the collective events (meetings, workshops, etc) carried-on in the reported year (3.2). Readers are directed to http://platabasin.unsl.edu.ar for more details on the team members and the project scope and activities.

3.1. Detailed description of activities

GOAL A: Understand the drivers of land use changes in the Río de la Plata Basin
Activity 1 - Regional land use changes patterns:

We are progressing at two complementary scales: regional and continental. At the regional we are expanding work originally performed in 9 pilot areas distributed over the Rio de la Plata grasslands **(see Baldi & Paruelo, Ecology and Society - in press)** to new pilot areas in the Chaco and Cerrado. (CoPI Paruelo + student Baldi in collaboration with INTA Salta with José Volante, CoPI Meirelles + student Ferraz). The analysis allowed us to define transition probabilities between three groups of land covers (grasslands, annual crops and implanted forests) and to study their environmental controls across phytogeographic and political boundaries. We expect to achieve this stage in the Chaco during year 3.
Work along this line has yielded a new vegetation characterization for Uruguay based on functional attributes as part of a MSc dissertation program (student Baeza with CoPIs Altesor and Paruelo), the first products have been submitted **(Baeza et al. Submitted to Journal of Applied Vegetation Science)**. In EMBRAPA, progress with pilot areas based on MODIS has been made and the first results are published **(Johnatan et al. 2007 – Revista Brasileira do Cartografia**), these products will contribute the the continental level assessment of land use changes.

At the continental scale we revised existing long term satellite data sets of NDVI to compare their ability to detect relevant land use changes. Among three different datasets, FASIR proved to be the most sensitive and accurate tool at the continental level. We have submitted to published the first results of this analysis **(Baldi et al. Submitted to Sensors)** and our team is making this progress available to the scientific community through our LechuSA site (see activity 12). A new long term datasets (LTDR) has been recently released by NASA and extends NDVI series to the present warranting a good overlap of NOAA and MODIS data. Our team is already working with these data and plans a joint

efforts during August – October 2008 at FAUBA based on the temporary settlement of Dr. Alcaraz (CoPI Epstein´s posdoc) working in collaboration with several CoPIs (Meirelles through student Ferraz, Jobbágy, Paruelo, Di Bella). Common nomenclature of land cover types has been ellabroated by Alcaraz and Caride-Paruelo.

Activity 2 – Historical socioeconomic context of key land use changes:

This activity has been focused is being started in the Uruguaian territory in its first stage. The role of the globalization process and the transformations in the role of the national state are being explored as part of a series of integrated thesis in UDELAR (CoPI Piñeiro + student Carambula and others). Our plan is to use this first experience as a basis to compare Brazil-Argentina-Uruguay.

Activity 3 – Spatial and temporal controls of land use changes:

The analysis of land cover allowed us to define transition probabilities between three groups of land covers (grasslands, annual crops and implanted forests) and to study their environmental controls across phytogeographic and political boundaries. These results were summarized as a set of Markov models at a resolution of 8x8 km over the total area cover by the Landsat scenes. We presented the analysis of the models and scenarios of land use and land cover changes based on the study of the eigenvalues of the markovian models (Vega et al. 2007). A first version of a MS presenting these results will be submitted in 2008. To model patterns and drivers of land use change Ernesto Vega has been working with José Paruelo, Alice Altesor and Esteban Jobbagy on developing a spatially explicit simulation model of Land Use Change (LUC). A first version of the model has been presented in a meeting in Berlin in 2008 (Vega et al. 2008).

GOAL B: Evaluate their impacts on ecosystems and societies

Activity 4 – Socioeconomic impacts

The first land use change focused for this activity is the expansion of afforestation in grasslands. CoPI Piñeiro´s team has included five grad and undergrad students documenting and understanding the consequences of this land use shift on the labor market and life quality. Interviews to local actors and stakeholders had provided the first assessment of the perception of local societies on the landscape transformation of Uruguaian grasslands becoming afforested. Four undergraduate dissertation works had yielded information and new human capacity on rural sociology (see capacity building). A MSc student in the group is studying the generation and action of social movements triggered by the establishment of paper mills in the area. Researchers working in this line had established links with those in the SCENARIO – SGP-HD project leaded by JF Tourrand. Results from the "afforestation experience" had contributed to a recent book **(Moraes & Piñeiro – in press)**

Activity 5 – Carbon uptake

Work is being conducted at the continental scale. We are centering on the dynamics of NDVI as a surrogate of fPAR, the main control of carbon gains (CoPI Epstein + Paruelo, student Alcaraz). The processing of the MODIS NDVI 16-day 250x250 m time-series from 2000 to 2006 for the entire basin has been completed. Details about the processing can be found at: http://stipae.ebd.csic.es/stipaewiki/doku.php/proyectos:cuencadelplata. In cooperation with the University of Almería and the Doñana Biological Station of the Spanish Council for Research we have created Stipae, a platform for the exchange of data, procedures, and other information between different partners, including the IAI participants of University of Virginia, University of Buenos Aires, University of San Luís and Universidad de la República de Uruguay. Stipae is composed by a wiki, a forum and a data exchange folder. Its contents and details are accessible at: http://stipae.ebd.csic.es. e to the lack of confidence on the current AVHRR long time series (PAL, GIMMS and FASIR) (see activity 1), we decided to start processing the new time series of AVHRR/NDVI, the LTDR (Land Long Term Data Record).The analysis of an accurate long term time series of satellite images is essential to evaluate the temporal changes that occurred in La Plata basin during the last three decades. LTDR is a 5x5 km daily dataset of AVHRR images of the whole world from 1981 to 1999 and, soon, up to 2007. Processing such amount of information is the current challenge of the team and it is involving a lot of effort from many people. In this sense, Alcaraz will spend a couple of months in Argentina. Based on MODIS and LTDR datasets we are now working on a multiscale and multitemporal definition of Ecosystem Functional Types to be used in the whole-basin land use classification schemes **(Alcaraz et al. in preparation)**.

Activity 6 – Carbon storage and turnover

The initial targeted land use change has been grassland afforestation. In this year we completed work on tow additional and important land use aspects controlling soil organic matter: Grazing and Agriculture. Work performed on a large set of grazing exclosures evaluating the effects of grazing on C storage and its interaction with the N cycle has been recently concluded **(Piñeiro et al. Submitted to Global Biogeochemical Cycles).** This work opens new perspectives on the long term effects of grazing in the Plata Basin and on the interactions between ecosystem services and grazing in grassland ecosystems. A theoretical framework to assess grazing effects on C cycling has been proposed **(Piñeiro et al. Submitted to Rangeland Ecology and Management)** and the evaluation of its net impacts on grassland C and N storage for the region has been concluded **(Paruelo et la. Submitted to Rangeland Ecology and Management)**

The other key issue targeted by the team is C cycling and its response to agriculture. We are approached the issue from several perspective. The first one evaluates net C losses with agriculture in the context of grassland to cron for ethanol conversion. Our results suggest that under most scenarios the introduction of corn as a biofuel crop in grasslands offsets fossil fuel savings by enhanced soil carbon outputs and/or declining inputs, as indicated by a complete life cycle assessment **(Piñeiro et al. Submitted to Ecological Applications)**. In semiarid systems the team has provided new figures on the response of soil carbon in different forms or fractions to different types of agricultural systems/practices **(Noellemeyer et al. 2007. Soil Tillage Research).** A related land transformation is being explored in the Parana River Delta by CoPIs Schlichter-Jobbágy and student Ceballos. In

this forestry oriented region its becoming more common to establish tree plantations on terrain that is previously drained and protected from river floods. As a result massive oxidation of organic matter takes place. We are assessing soil changes based on a chronosequence of drained and afforested sites. To account for volumetric changes (20% or more SOC is lost) total mineral particles are used as a constant mass indicator.

Our team is currently progressing on the use of stable isotopes connected with simple analyitical models to evaluate the turnover rates of soil carbon and elucidate the relative importance of two aspects of agriculture on the decline of soil organic carbon pools: Declining inputs, mainly through roots vs. Increaing respiration, mainly through tillage. A second line of work seeks to synthesize the dominant effects of major land use changes in the Basin on soil organic carbon. Recently Dr. Fabiano Baliero, from EMBRAPA has taken this task jointly with IAI posdocs Marcella Aboim and Gervasio Piñeiro. CoPIs Noellemeyer, Jackson, Jobbágy Coutinho and Panario support and guide this initiative.

Activity 7 – Biomass burning

We studied the relationship between fire occurrence and behavior (propagation, orientation, duration, disturb forms) vs. vegetation types, meteorological conditions, land use in the Chaco-Espinal semiarid region of Argentina. The ratio between precipitation and potential evapotranspiration influenced the total burned surface and the annual and monthly frequency of fire events. In addition, the spatial fire distribution was mainly influenced by three factors: climate, vegetation type and land use.

Fire behavior was variable according to the affected area and the date of fire events. The smaller and thinner fuels (grasslands) were able to burn quicker favoring the propagation and fire speed. The thicker fuels (forests), favored the permanency of fire flames on one place for a longer time. On the other hand, the bigger and longer fires mainly occurred on November and December, when the high temperatures and the fuel dryness promotes the propagation and duration of these disturbs. Fire directions detected were associated to the predominant orientation of winds (N-S) during the season of the year.

In Paraguay our research focused on the quantification of the effects and interactions between natural and anthropogenic factors, such as climate, land use and the conditions involved on fire management practices. Our main results indicate that agriculture reduces significantly the fire density over prairies and savannas. In contrast, when agriculture is present in tropical forests, fire density is incremented. These results suggest that the presence of agriculture in semi arid regions can prevent fire occurrence, while promoting it in humid environments, where biomass accumulation is possible.

We have been combining meteorological data, remote sensing, and a fire model to quantify the sensitivity of fire regimes to climate for in the Basin. We used the WMO meteorological database to calculate daily values of the McArthur Forest Fire Danger Index (FFDI) for 67 locations across Argentina for 2003-2006. Counts of active fires from MODIS were obtained for this same period and were related to the FFDI using negative binomial regression. Although there is a great deal of spatial variation in the absolute numbers of fires, this approach has proved to be a very robust method of quantifying the

sensitivity of fire regimes to climate. Forest ecosystems exhibited the greatest climate sensitivity, whereas agricultural landscapes exhibited the least. This activity yielded several publication in year 2: **(Dibella et al. 2008 Ciencia Hoy, Chuvieco et al. 2008 Ecol Appl, Dibella & Fischer, submitted to Journal of Wild Fire)**

Activity 8 – Water balance changes from stands to watersheds

Current work is focused on groundwater – land use interaction in the flattest areas of the basin (Chaco-Espinal & Pampas) and on stream/river dynamics in rolling or hilly landscapes (Cerrado, Mata Atlantica, hilly grasslands in Cordoba and Uruguay).

8.1. Afforestation of grasslands
One of the work lines has focused on grassland afforestation and its impacts on the water balance, particularly groundwater consumption and salinization, in flat landscapes (CoPI Jobbágy and student Nosetto). This line has yielded a general conceptual model that is able to predict the vulnerability to afforestation-induced salinization in plains (recently published in the journal GBC, Nosetto et al. 2008). In the same work line we have linked groundwater use to carbon uptake. This work has been complemented with watershed studies in rolling landscapes in Argentina and Uruguay in which stream flow and chemistry in paired small basins has been measured. Results of this line are in press **(Farley et al. 2008 Water Resources Research)**.

8.2. Agriculture expansion on dry forests
We explore the effect of dry forest replacement by annual croplands on water balance and groundwater recharge. In the flat territory of Chaco and Espinal groundwater recharge and salt migration is being documented though deep soil and vadose zone sampling (dryland salinity syndrome reported in Australia) (CoPI Jobbágy and student Santoni). In the same systems continuous monitoring of soil moisture down to three meters of depth is being implemented and complemented with satellite estimates of evapotranspiration. So far we have identified very subtle changes in annual ET that translate, nevertheless, into large shifts in deep recharge and salt migration. At same sites salt accumulation under natural forests is >1kg/m2. Less than 3 decades of agriculture are enough to leach this salt load to groundwater. In rolling landscape of the Cerrado (Formoso river basin), the effects of land use change on water quantity and quality will be monitored. This activity is in its planning stage through a participatory process that involves the local community (CoPI Coutinho and Meirelles). First results from this activity have been submitted **(Jobbágy et al. submitted to Ecología Austral)**

8.3
The larges effort in this activity is being focused in the Pampas of Argentina. Our team identified this region as a very valuable "laboratory" to explore the multiple connections between hydrology, climate, land use and human decision making. Activities here involve four lines of action:

A. Reciprocal connections between crops and groundwater. Based on our previous experience on afforested systems we established two networks of continuous yield and water table level and salinity monitoring. We developed accurate functions of yield response to water table depth and adapted them to estimate evapotranspiration

responses, this is a critical step in the formulation of feedbacks on further water table level responses. Impact of different rotations on groundwater level has been identified in the field. Some of the results are already being applied by farmers in the region.

B. Regional assessment of flooding cycles based on remote sensing observations of surface water coverage and on an extensive compilation of water table level records on multiple points in the western Pampas. These observations are being used to explore the ability of the GRACE satellite system to estimate water storage in the Pampas Plains. We are progressing in the understanding of flooding cycles and the relative causal effect of climate (as opposed to land use). A critical threshold of flooding beyond which water transfer at the regional scale takes place has been identified. This activity has been complemented with a vast survey of land use shifts and their relationship with flooding for the last 25 years (Viglizzo et al. in preparation)
C. Coupled modeling of water table level and ecosystem water balance has been performed based on a new code developed by the team named VEGNAP. Based on MATLAB and taking advantage of the existing UPFLOW routine for capillary transport and groundwater consumption simulation, this model is able to represent flooding/waterlogging intensity and frequency based on a one-dimensional bucket type model that is able to reproduce groundwater uptake and its manifestation through yield satisfactorily

Although results from this line are part of publications that are still in preparation, we decided to produce a couple of divulgation articles for farmers to facilitate their collaboration and interest **(Jobbágy et al. 2007 Agromercado, Jobbágy et al. 2008 Revista AACREA)**

Activity 9 – Land use changes and their impact on climate

This activity has been initiated in collaboration with other researchers. We started our collaboration with Hugo Berbery providing support on land cover assessment for the modeling task that he leads into another IAI grant. Complementing this work, CoPIs Jobbágy and Jackson, in collaboration with Duke Professor Roni Avissar and Bruce McCarl, initiated a modeling effort that seeks to connect expected land use changes based on an economic model (FASOM) to climate shifts based on the application of model B-RAMS.

GOAL C: Identify critical feedbacks and plausible future trends

Activity 10 – Interactive models:

Work is being conducted along two independent lines that are expected to converge in the following two years. We are progressing with A) a spatially explicit model aimed to describe and predict land use changes (CoPI Paruelo + student Vega) and B) with a physically based model that represents water dynamics and its reciprocal link with land use in flat landscapes (CoPIs Jobbágy+Viglizzo+Podesta, students Aragon, Nosetto, Contreras).

In the first work line, a spatially explicit simulation model of land use change (LUC) has been developed. The model includes spatially explicit environmental and socioeconomic variables and identifies which LUCs are more sensitive to fluctuations of the above mentioned variables. The model evaluates possible regional-scale consequences of changes in the main variables of LUC. At present there a definitive version of this model with the following capabilities/characteristics:

- Spatially explicit variation is simulated through a rectangular grid; temporal change from time (t) to (t+1) of cell cij depend on: i) its particular set of environmental conditions at time (t); ii) the conditions in its immediate neighborhood at time (t);
- Each cell cij has layers of environmental and socioeconomic variables and of response variables (land use covers);
- LUC in a cell cij is simulated through a markovian model, composed by a matrix A of transition probabilities between the land use covers, and a vector v with the proportions of each land use. Temporal change of these proportions from (t) to (t+1) are stated as $A \times v(t) = v(t+1)$;
- Transition probabilities of A can be modified by: i) the particular set of variables in cell cij ; ii) relatives abundances of each land cover in the neighborhood of the cell; iii) relatives abundances of each land cover in all the grid.

The second work line explores the multiple connections between climate, the hydrological system and land use in very flat and poorly drained plains (Pampa Interior). Ultimately, this approach attempts to represent the role of human decisions in land use/management as an agent that can potentially shape hydrology and perhaps climate. A simple coupled model that simulates ecosystem water balance and groundwater level allowed us to represent the reciprocal influences between crops or other vegetation types and shallow groundwater tables. The model, named VEGNAP, has its first fully operative version available running on MATLAB. In this first version the model represents a single cell and is able to show how waterlogging/flooding/drought respond to land use changes or to contrasting strategies of response to flooding (e.g. land abandonment vs. conversion of croplands to cultivated pastures). The model proved very effective to explore feedbacks and identify the magnitude of influence that management decisions can have on the hydrological regime of flat humid and subhumid sedimentary landscapes. This modeling activity is being now complemented by the use of more standard modeling packages like MODFLOW to explore landscape and regional responses to land use in terms of flooding.

Activity 11 – Plausible scenarios:

- This activity has not been initiated

GOAL D: Support regional planning through dissemination of knowledge and tools

Activity 12: Open scientific forum:

We have developed during this year the collaborative website LECHUSA (http://lechusa.unsl.edu.ar) and initiated an active interaction with more than 20 participants that approached the site voluntarily. Based on the detection of NDVI changes we identified several foci or “hotspots” of ecosystem functional changes. Local and global experts had

already provided their opinions on the type of changes and causal factors involved in hotspots on diverse systems such as the Patagonian Monte, the Inner Pampas, the Cerrado and the Parana Delta. This initiative is in its first trial stage and based on the feedback received so far we are planning to jump into a new step during year 3 that will involve marketing and multimedia knowledge to facilitate more engagement of colleagues around Latin America. From the weblog of visits to the page we are identifying interest on LECHUSA in many latinamerican countries. One of the main advantages that we see for this site is the possibility of showing to the general public that 1) where big functional ecosystem changes take place, 2) that causes and impacts are under progressing debate among scientists, 3) that those scientist can be contacted directly through the site which will serve as a directory of SA expertise. LechuSA database and website has been presented in a manuscript recently submitted **(Baldi et al, submitted to SENSORS)**

Activity 13: Land use planning to optimize ecosystem products & services

This activity has been initiated applying knowledge derived from activity 8. We are using a simple simulation tool to explore optimal strategies for groundwater management (waterlogging avoidance, supplementary water provision maximization) in the context of farming systems of the Pampas.

3.2. CRN 2031 Events during YEAR 2

During the reported periods we held four CoPI meetings/workshops (3.2.1) that helped us initiate work on CoPI clusters. At mid 2008 we plan a large plenary session. In addition many of our CoPIs participated in workshops organized or co-organized by IAI.

3.2.1. CoPI meetings

3.2.1.1. **Reciprocal interactions between climate, hydrology and land use in the Inner Pampas: Scientific and technological challenges**.
INTA La Pampa, Argentina - October 9-10, 2007
Goal: Research update on a) regional flooding dynamics, b) land use responses, c) vegetation influences on GW level. Presentation of dissertation research plans by grad students.
Participants: (INTA La Pampa, GEA, FAUBA) Aragón, Roxana - Carreño, Lorena - Contreras, Sergio - De Oro, Laura - Frank, Federico - Jobbágy, Esteban - Nosetto, Marcelo - Viglizzo, Ernesto

3.2.1.2. **Opportunities for new global insights on groundwater – ecosystem (or land use – hydrology) interactions**
San Luis – November 15-16, 2007
Goal: Achieve a common view of major challenges and opportunities on GW-ecosystem interactions
Specific tasks
a. Introduce people and their driving questions, study systems, and research tools
b. Identify major knowledge gaps and interesting opportunities for progress in our general (global) knowledge of GW-ecosystem interactions

c. Define possible lines of actions on a 2 year time frame
Participants: (GEA, FAUBA, Duke) Roxana Aragón, Gervasio Piñeiro, Sergio Contreras, Marcelo Nosetto, Carla Rueda, Germán Baldi, John Kim, Rob Jackson, Esteban Jobbágy

3.2.1.3. **Groundwater-fed woodlands in the deserts of Argentina: Understanding their vulnerability to agricultural development**
San Luis - November 20, 2007
Goal: Join efforts on research and capacity building with members of CRN 2047 from IANIGLA-Mendoza. Exchange ideas, protocols, data and initiate codirection of students
Participants: (GEA, IANIGLA, FAUBA, Duke) Aragón, Roxana - Aranibar, Julieta - Contreras, Sergio - Giantomassi, Alejandra - Giordano, Carla - Jobbágy, Esteban - Kim, John - Nosetto, Marcelo - Villagra, Pablo

3.2.1.4**. Evaluation of energy generation potencial of fire-prone ecosystems in the Plata Basin**
Iriarte-Santa Fe - March 4, 2008
Goal: Outline a new research line to be conducted by postdoc Santiago Verón
Participants: (GEA, INTA Clima y Agua, FAUBA) Santiago Verón, Esteban Jobbágy, Carlos Di Bella

3.2.1.5**. Soil carbon synthesis across major land use change trajectories in the Plata Basin**
Buenos Aires, FAUBA – March 17, 2008
Goal: Redefine soil carbon synthesis tasks. Discuss major guiding ideas and distribute tasks among team member groups. NOTE: This line was interrupted following the desease of Michele Oliveira Machado in the previous year. Dr. Fabiano Baliero, from Coutinho´s lab is the new person leading this task together with posdoc Marcela Aboim.
Participants: (EMBRAPA, FAUBA, GEA) Fabiano Baleiro, Gervasio Piñeiro, Esteban Jobbágy

3.2.1.6. **Remote sensing assessment of cerrado to sugar cane conversion: Guiding hypotheses and research strategies**
Buenos Aires, FAUBA – March 20, 2008
Goal: Outline a research plan for this important land use change to be conducted as part of the dissertation work by Rodrigo Ferraz from Meirelles lab
Participants: (EMBRAPA, GEA) Rodrigo Ferraz, Margareth Meirelles, Esteban Jobbágy

3.2.1.7. **Ecosystem service's valuation as tools for sustainable agriculture**
FAUBA, Buenos Aires - March 24-25, 2008
Goal: Discuss future work on ecosystem service's valuation and its use for evaluating the sustainability of croplands in the Pampas and Chaco-Espinal. Several research objectives and activities were identified. In this meeting we also evaluated a potential master student that did not meet the requirements necessary to successfully conduct the research planed. We further set the requirements for incorporating a new Master student to conduct part of the research. In the following dates a new student, Florencia Rositano, was selected and started working immediately. This meeting promoted the search for additional funding and a new project was submitted to CONICET by June 20 for evaluation

Participants (FAUBA, U of Miami): Guillermo Podesta, Diego Ferraro, Federico Bert and Gervasio Piñeiro

3.2.2. General IAI meetings and interaction with other IAI grantees

3.2.2.1. **Climate Change and Irrigated Agriculture**
Santiago de Chile - January 7-10, 2008.
Goal: Start-up event in the collaboration of CRNs 2031 (platabasin) and 2047 (climate change & hydrology in the Andes) and the recently awarded SGP-HD 003 project under the direction of Dr. Francisco Meza from Universidad Catolica de Chile. Complementary capacities and common interests and challenges were discussed in the meeting and agenda for collaboration and student exchange was set.
Participants (IANIGLA, GEA, INTA Clima y Agua, U of Miami, Pontificia Universidad Catolica de Chile) Boninsegna, José - Donoso, Guillermo - Gurovitch, Luis - Jobbagy, Esteban - Letson, David - Meza, Francisco - Travasso, María Isabel

3.2.2.2. **Annual IAI meeting for PIs**
Ciudad de Panamá, Panamá. February 21-23, 2008
Goal: Presentation of CRN and SGP-HD projects. Discussion of challenges and opportunitites for integration and relevance orientation.
Participant from CRN 2031: Esteban Jobbágy, PI

3.2.2.3. **Training Institute on Information Management: free and open access to, and use of data and information**
Ciudad de Panamá, Panamá. February 25-29, 2008
Goal: 1) to provide recommendations to help IAI develop its data and information policy; and 2) to encourage IAI projects (CRN II, SGP-HD) to make data available and expand international and interdisciplinary scientific interactions through improved information management.
Participant from CRN 2031: Germán Baldi (graduate student and data manager of the project)

3.2.2.4. **SCENARIOS PROJECT – IAI – Start up workshop for the Salto-Paysandu Cluster**
Salto-Paysandu, February 10-16, 2008
Goal: Presentation of project and discussion of Global Change issues in the area including Climate Change, Local Knowledge and Land Use Scenarios of producers
Participants: (many institutions) – From CRN 2031, Marcelo Nosetto (GEA and FAUBA) and Matías Carámbula (UDELAR Social Sciences)

3.2.2.5**. IAI-IDRC "Landuse change, biofuels and rural development in the La Plata Basin " Project start-up meeting**
Buenos Aires, 18-20 March 2008
Goal: Initial meeting of all CoPIs and associated IAI grantees. Discussion of project goals with stakeholders.
Participants from CRN 2031: Margareth Meirelles, Guillermo Podesta, Esteban Jobbágy

3.2.2.6. **Ecohydrological challenges at both sides of the Andes: Ongoing work in the Maipo, Mendoza and Quinto rivers**
San Luis – April 17-18, 2008
Goal: Presentation of SGP-HD 003 and its ongoing components. Presentation of GEA lab research lines on ecohydrology. Identification of common questions and complementary capacities. Update of LechuSA logs for Chile. NOTE: this activity preceded a training week for Chilean students Eduardo Bustos and Claudia Nuñez in the GEA lab learning remote sensing techniques.
Participants (Pontificia Universidad Catolica de Chile, GEA) Sergio Contreras, Marcelo Nosetto, Germán Baldi, Ana Acosta, Silvina Ballesteros, Celina Santoni, Carla Rueda, Eduardo Bustos, Claudia Nuñez, Paula León, Francisco Meza, Esteban Jobbágy.

3.2.2.7. **Characterization of land use changes for climate and hydrological modeling in the Plata Basin**
Univeristy of Maryland – April 28, 2008
Goal: Define collaborative steps for CRN 2031 and Berbery´s recent grant on Climate – Land Use interactions. Identify potential students and collaborators.
Participants (GEA, U of Maryland) Esteban Jobbágy, Hugo Berbery

4 Contributions of Co-PIs

In the second year our CRN team has continued work within "clusters" of CoPIs dealing with the most challenging and cross-cutting aspects of our project as follows:

Land use change description and monitoring at the whole basin level and spatially explicit modeling
Paruelo + Meirelles + Altesor + Epstein
Steering postdoc: Ernesto Vega (FAUBA)
Additional collaboration from: Domingo Alcaraz (U of Virginia)

Soil carbon across land use changes – Ecosystem carbon balance
Jobbágy + Jackson + Coutinho + Noellemeyer + Panario + Oesterheld
Steering postdoc: Gervasio Piñeiro

Climate-Hydrology-Land use interactions in plains
Jobbágy + Viglizzo + Podesta
Steering postdoc: Roxana Aragon (GEA and FAUBA)
New Steering postdoc: Sergio Contreras (GEA)

Human and natural controls on biomass burning and impacts on C-uptake
AND
Bioenergy generation potential in fire-prone ecosystems
Di Bella + Hoffmann + Coronel + Jobbágy + Paruelo
Steering postdoc: Santiago Verón (INTA)

Land use change and policy making in the Plata Basin
Paruelo + Jobbágy + Schlichter + Maceira + Piñeiro + Podesta

This cluster initiated meetings on afforestation policy with stakeholder in Uruguay and Argentina and plans to expand this work mode to the issue of agricultural expansion in year 3.
Steering team: Jobbágy (GEA-FAUBA) and Pedro Laterra (non-CRN collaborator from INTA-Balcarce)

From decision making by famers to land use patterns to ecosystem service
Podesta + Viglizzo + Jobbágy
Steering postdoc: Gervasio Piñeiro (FAUBA)ditional collaboration from: Federico Bert (FAUBA and U of Miami)

In addition, all CoPIs worked in more specific lines that are indicated in section (3.1)

5 Publications

During the reported period our team has published 10 papers in international and national peer-reviewed journals and submitted 8 more. Several manuscripts are currently in preparation. Two divulgation articles had been published. Presentation in meetings involved 20 posters or talks by CoPIs and their students. Some of the forums included "Congreso Argentino de la Ciencia del Suelo - 2008", "Reunión Binacional de Ecología Chile-Argentina, 2007", "American Geophysical Union, Fall Meeting, 2007", and "Reunión Española de Teledetección-2007" (first meeting of this European association held in Latin America).

5.1. Published

1. Paruelo JM, EG Jobbágy, M Oesterheld, RA Golluscio and MR Aguiar. 2007. The grasslands and steppes of Patagonia and the Rio de la Plata plains. In T Veblen, K Young and A Orme (eds.). Chapter 14. The Physical Geography of South America. The Oxford Regional Environments Series, Oxford University Press. Pp 232-248.
NOTE= book chapter did not accept acknowledgements to grants.

2. Di Bella CM, MA Fischer and NA Mari. 2008. Teledetección satelital y fuego en áreas naturales. Ciencia Hoy 18:7-13

3. Noellemeyer E, F Frank, C Alvarez, G Morazzo, A Quiroga. 2008. Carbon content and aggregation related to soil physical and biological properties under a land-use sequence in the semiarid region of Central Argentina. Soil and Tillage Research 99:179-190.

4. Aragón R, M Oesterheld. 2008. Linking vegetation heterogeneity and functional attributes of temperate grasslands through remote sensing. Applied Vegetation Science 11, 117-130.

5. Moraes M and D Piñeiro. 2008. Los cambios en la sociedad rural durante el siglo XX. Banda Oriental. Montevideo. **Book in press**

6. Chuvieco E, S Opazo, W Sione, H del Valle, J Anaya, C Di Bella, I Cruz, L Manzo, G López, N Mari, et al. 2008. Global Burned Land Estimation in Latin America using MODIS Composite Data. Ecological Applications, **in press**

7. Farley K, G Piñeiro, S Palmer, EG Jobbágy and R Jackson. 2008. Stream acidification and base cation losses with grassland afforestation. Water Resources Research, **in press**.

8. Piñeiro, Gervasio, S Perelman, J.P. Guerschman y J.M. Paruelo. 2008. Evaluating models: observed vs. predicted or predicted vs. observed? Ecological Modelling, **in press**

9. Irisarri JGN, M Oesterheld, SR Verón and JM Paruelo. 2008. Grass species differentiation through canopy hyperspectral reflectance. International Journal of Remote Sensing, **in press**

10. Baldi G and JM Paruelo. 2008. Land use and land cover dynamics in South American temperate grasslands (1985/2005 period). Ecology and Society, **in press**

Divulagation

1. Jobbágy E, Nosetto MD. 2008. Como hacer de las napas un aliado. Pautas y criterios para el monitoreo de niveles freáticos en sistemas de producción agrícola en la región pampeana. **Revista CREA** 328:32-38

2. Jobbágy EG, Aragón R y MD Nosetto. Los cultivos y la napa freática en la llanura pampeana. **Agromercado**, Agosto 2007 N-268

5.2. Submitted

1. Jobbágy EG, MD Nosetto, CS Santoni, G Baldi. El desafío ecohidrológico de las transiciónes entre sistemas leñosos y herbáceos en la llanura Chaco-Pampeana. Ecología Austral (submitted 07/08)

2. Baldi G, MD Nosetto, R Aragón, F Aversa, JM Paruelo, EG Jobbágy. Long-term satellite ndvi data sets: Evaluating their ability to detect ecosystem functional changes in South America. Sensors (submitted 06/08)

3. Di Bella CM and MA Fischer. The effect of land cover and use on the temporal and spatial pattern of fire occurrence in northeastern Argentina. Journal of Wildland Fire (submitted 4/08)

4. Piñeiro G, JM Paruelo, EG Jobbágy, RB Jackson, M Oesterheld. Grazing effects on belowground C and N stocks along a gradient of cattle exclosures in temperate and subtropical grasslands of South America. Global Biogeochemical Cycles (submitted 12/07, revised version submitted 5/08)

5. Piñeiro G, EG Jobbágy, J Baker, BC Murray and RB Jackson. Conservation reserve stores more carbon for less money than corn-based ethanol. Ecological Applications (submitted 4/08)

6. Piñeiro G, JM Paruelo, M Oesterheld and EG Jobbágy. Conceptual models of grazing effects on carbon and nitrogen dynamics in rangelands. Rangeland Ecology and Management (submitted 06/08)

7. Paruelo JM, G Piñeiro, G Baldi, S Baeza, F Lezama, A Altesor and M Oesterheld. Carbon stocks and fluxes in rangelands of the Rio de la Plata Basin. Rangeland Ecology and Management (submitted 06/08

8. Baeza S, F Lezama, G Piñeiro, A Altesor and JM Paruelo. Spatial and Functional Heterogeneity of Uruguayan Grasslands. Journal of Applied Vegetation Science (submitted 03/08)

5.3. In preparation

Alcaraz D, H Epstein and JM Paruelo. Considering interannual variability and trends in the definition of Ecosystem Functional Types. To be submitted to Global Ecology and Biogeography.

Piñeiro G, EG Jobbágy, RB Jackson, CS Santoni, SI Portela, CM Di Bella. Atmospheric Depositions across The Rio de la Plata Basin. To be submitted to Global Biogeochemical Cycles.

Vega E, G Baldi and JM Paruelo. The spatial heterogenity of land cover transitions: the role of biogeographic and political factors. To be submitted to Global Change Biology

Nosetto MD, Jobbágy EG, Sznaider G. Reciprocal crop-groundwater effects in the Argentinean Pampas. To be submitted to Field Crop Research

Jobbágy EG, S Contreras, S Calderon, MD Nosetto. Vegetation controls on groundwater level in sedimentary plains. To be submitted to Water Resources Research

Aragon RM, Jobbágy EG, Nosetto MD, Viglizzo E. Regional flooding events in the Inner Pampas: Connecting surface and groundwater dynamics. To be submitted to Geophysical Research Letters.

5.4. Presentations in scientific meetings

D. Alcaraz, J. Chuvieco, H. Epstein. Temporal Trends in Post-fire Regeneration Patterns of Boreal Forests Using 1 km AVHRR NDVI. EOS Transactions of the American Geophysical Union 88/(52):B11D-0777
San Francisco - American Geophysical Union Fall Meeting 2007

Fischer, M.A., C.M. Di Bella y E.G. Jobbagy.. “Factores que controlan la distribución espacio-temporal de los incendios en la Región Semiárida Argentina”. XII Congreso de la Asociación Española de teledetección- Buenos Aires, Argentina- Septiembre 2007

Mari N; Di Bella C; Fischer María de los Ángeles; Ferrer Francisco; Kanpandegi Jon Ander. “Respuesta espectral de la vegetación quemada para distintos ecosistemas de la Argentina”. XII Congreso de la Asociación Española de teledetección, Septiembre 2007

Boca Teresa; Mari Nicolás; Di Bella Carlos, Kanpandegi Jon Ander, “Aplicación de modelos no lineales en el estudio de la tasa de recuperación de la vegetación post disturbios de fuego para distintos ecosistemas de la Argentina”. XII Congreso de la Asociación Española de teledetección, Septiembre 2007.

Piñeiro, G.; Jobbágy, E.G. ; Paruelo, J.M, Farley K.A. y Jackson R.B. Oportunidades y consecuencias de las forestaciones en Uruguay, bases para la planificación del uso del territorio. XII Jornadas de la Sociedad Uruguaya de Biociencias. Minas, Lavalleja, 28 al 20 de Septiembre de 2007.Uruguay.

Lezama, F. ; PIÑEIRO, G. ; Baeza, S. ; Chaneton, E.; Altesor, A. y Paruelo, J. M.. Los efectos del pastoreo sobre la composición florística de pastizales son mayores en los sitios más productivos. III Reunión Binacional de Ecología. La Serena, Chile. pp .30 septiembre - 4 octubre 2007.

Morazzo G.C., E.J. Noellemeyer, J.R. Saad y C. Ardanaz. Impacto de la forestación con diferentes especies vegetales sobre la cantidad y calidad de la materia orgánica del suelo. XXI Congreso Argentino de la Ciencia del Suelo. San Luis. Arg. Mayo 2008

Morazzo G.C., E.J. Noellemeyer, J.R. Saad y C. Ardanaz. 2008. Secuestro de carbono en suelos bajo diferentes especies forestales. XXI Congreso Argentino de la Ciencia del Suelo. San Luis. Arg. Mayo 2008

Riestra, D., Zalba P., Quiroga A., Noellemeyer E. Distribución del tamaño de agregados en sistemas forestales: efectos del sistema de muestreo. XXI Congreso Argentino de la Ciencia del Suelo. San Luis. Arg. Mayo 2008

Quiroga A., R. Fernández, E. Noellemeyer, N. Peinemann. 2008. Influencia del manejo sobre la distribución del tamaño y estabilidad de agregados en suelos influenciados por variaciones en la granulometría y contenidos de materia orgánica. XXI Congreso Argentino de la Ciencia del Suelo. San Luis. Arg. Mayo 2008.

Vega, E.; Baldi, G. y Paruelo, J. ¿Desaceleración del cambio de uso de suelo en los pastizales del Río de la Plata? III Reunión Binacional de Ecología, La Serena, Chile, octubre de 2007.

Vega, E.; Baldi, G., Paruelo, J.; Jobbagy, E; Altesor, A. Are rates in land use change in Río de la Plata grasslands slowing down? SENSOR meeting - Berlin

Baeza, S.; Paruelo, J. y Altesor, A. Dinámica de la intercepción de radiación y su relación con factores ambientales y usos del suelo en Uruguay III Reunión Binacional de Ecología, La Serena, Chile, octubre de 2007.

Lezama F., Piñeiro G., Baeza S., Chaneton E., Altesor A. & Paruelo JM Los efectos del pastoreo sobre la composición florística de pastizales son mayores en los sitios más productivos. III Reunión Binacional de Ecología, La Serena, Chile, octubre de 2007.

Pezzani, F., Altesor, A., López, Senmartin, Lezama, Baeza, Fernández & Paruelo, JM. Efecto de los arbustos sobre el estrato graminoso de pastizales del Río de la Plata. III Reunión Binacional de Ecología, La Serena, Chile, octubre de 2007.

Hidalgo, C., C. Natenzon, G. Podestá and K. Broad. Changing views of the success of interdisciplinary research. VII Jornadas Latinoamericanas de Estudios Sociales de la Ciencia y la Tecnología. Rio de Janeiro, Brazil, 28-30 May 2008.

Jobbágy EG, MD Nosetto, PE Villagra, RB Jackson. 2008. Isótopos estables como trazadores de las fuentes de agua de bosques de algarrobo en un desierto arenoso. Congreso Argentino de la Ciencia del Suelo. San Luis, Argentina. Invited conference

Santoni CS. EG Jobbágy, V Marchesini, S Contreras. 2008. Diferentes usos del suelo: consecuencias sobre balance hídrico y drenaje profundo en zonas semiáridas. Congreso Argentino de la Ciencia del Suelo. San Luis, Argentina.

Jobbágy EG, MD Nosetto, S de Forteza, GA Sznaider. 2008. Control de la recarga, descarga y salinidad de la napa freática por cultivos en el Sur de Córdoba. Congreso Argentino de la Ciencia del Suelo. San Luis, Argentina.

6 Data

Web sites: Project site: http://platabasin.unsl.edu.ar
Collaborative site: http://lechusa.unsl.edu.ar
Collaborative site: http://stipae.ebd.csic.es

Databases and data sharing
Our team has developed a web site in which all users can download long-term satellite NDVI series (lechuSA, see above). We are working on similar initiative for data access on phreatic groundwater levels in the Pampas in collaboration with a farmer association (AACREA).

7 Capacity Building

7.1. Students

During the second year our team had 6 postdoctoral students with 3 who have finished their IAI fellowships but maintain their participation on CRN activities and 3 who have entered the project this year (current staff = 3, see appendix A). We had 14 grad students with 3 finishing their fellowships and 5 being recruited this year (crurrent staff = 11). A total of 4 undergrad students had fellowships in the project. In addition we have 36 students who were supported by other financial sources such as CONICET, INTA, EMBRAPA, and local Universitities. See Appendix A at the end of this document for details.

A specific goal of our project was to develop scientific capacities in Uruguay and Paraguay. In the case of Uruguay we have two PhD students (Baeza & Lezama, directed by Altesor and Paruelo) working on their dissertation in UBA, and a PhD student doing his degree in Universidad de Cordoba (Carambula, codirected by Piñeiro). A posdoc from Uruguay, Gervasio Piñeiro, linked groups in UDELAR, Duke and UBA and achieved the status of independent researcher during year 2 of the project. Dr. Nosetto from GEA is working as an active link with the Jackson lab at Duke. Regarding Paraguay the PhD candidate Andres Wehrle started his IAI fellowship in July 2007 to perform doctoral studies in Hydrology in Universidad del Litoral – Argentina, under the codirection of Jobbagy.

CoPIs in the CRN work as directors or codirectors of many students working in institutions with strong local influence such as INTA and EMBRAPA. These students participate in CRN-related activities and transmit goals, ideas, and capacities to their home institutions.

7.2. Training activities

Besides the courses and practices associated with the formal programs in which students are enrolled, in the current year CRN 2031 students visited the labs of different CoPIs for discussion of projects and training, acting as a very effective link across groups:

Gervasio Piñeiro (with Jobbágy) visited Jackson and Panario (**)
John Kim (with Jackson) visited Jobbágy and Paruelo (**)
Domingo Alcaraz (with Epstein) visited Paruelo, Jobbágy, Di Bella (**)
Andres Wehrle (with Coronel) visited Jobbágy (**)
Eduardo Bustos and Claudia Nuñez (with Meza SGPHD-003) visited Jobbágy (*)
Cristian Campos (from INTA Salta, new collaboration) visited Jobbágy (*)
Juan Pablo Martini (with Noellemeyer) visited Jobbágy (*)
Santiago Baeza and Felipe Lezama (with Altesor) visited Paruelo and Oesterheld
Dario Ceballos (with Schlichter) visited Jobbágy
Ernesto Vega (with Paruelo) visited Jobbágy

(*) - one week to one month
(**) – more than one month

7.3. Outreach

<u>7.3.1. Afforestation and its impacts</u>

Our team is involved in a series of debates with stakeholders regarding afforestation expansion.

We participated in follow-up events of the first science-production encounter organized jointly by CRN 2031 and INTA in 2006 by Jobbágy & Schlichte. A second encounter was held in Buenos Aires in July 2007. In this workshop the roles were reverted and major forestry companies presented their goals and actions with regard to the environmental and local societies. These presentations were discussed in an audience composed by policy makers, researchers, and NGOs representatives. The number of institutions enrolled in this continuous forum has increased including now AFoA (largest forestry association in Argentina). Currently two CRN members participate in a "responsible forestry" forum as consultants. This forum includes the most important companies and AFoA. CoPI Piñeiro has been engaged in discussions on afforestation issues with policy makers of Uruguay.
It´s important to highlight that the scientific production our team (papers reported here and in year 1 report) have been playing a central role on the regional debate on forestry impacts and benefits and ways for sustainable forestry development.

7.3.2. Climate, Hydrology and Agriculture

During Year 2 our team has developed strong links and initiated a participative research plan with farmers in two locations in the Pampas: Western Pampas in Cordoba, Inner Pampas in Buenos Aires. These programs involve collaborative work with two large farming companies and a famer consortium (AACREA) and the service company "GeoAgris" (http://www.geagris.com.ar)

We developed to large networks of continuous groundwater monitoring – CRN researchers are in charge of the hydrological monitoring design and farmers take the periodic measurements. In addition, farmers and GeoAgris collect yield maps from the studied plots. In this way we have been able to relate yields to water table depth in a very large number of plot and borad range of environmental situations. We discuss with farmers the mechanisms of yield-groudnwater links and outline a decision support scheme to take maximum advantage of groundwater contribution to crops and minimize waterlogging and flooding risks.

We adopted the strategy of publishing encouraging early results in farmers magazines (see articles below) to attract other farmers to start a groundwater level and yield measurement plan. So far we have connected four large farming companies and had three workshops done (July 2007 in Pehuajo with AACREA, late and early August 2007 in Villegas with INTA and the private group "Labrador") and two more planned in different location in the Pampas (July 2008 in Villa Mercedes with AAPRESID, August 2008 in Trenque Lauquen with AACREA).

Divulgation articles associated with this topic:

Jobbágy E, Nosetto MD. 2008. Como hacer de las napas un aliado. Pautas y criterios para el monitoreo de niveles freáticos en sistemas de producción agrícola en la región pampeana. **Revista CREA** 328:32-38

Jobbágy EG, Aragón R y MD Nosetto. Los cultivos y la napa freática en la llanura pampeana. **Agromercado**, Agosto 2007 N-268

7.3.3. Participation in AACREA national congress

The most important farmer´s association of Argentina, AACREA, invited Drs. Oesterheld and Viglizzo as keynote speakers for its national congress in 2007 http://www.aacrea.org.ar/genericos/XVIII_Congreso_CREA/

Their presentations dealed with the application of ecological knowledge in agriculture (Oesterheld) and future scenarios for agriculture in Argentina (Viglizzo)

8 Regional Collaboration/Networking

In the current year our team continues its involvement in the following networks/teams

SENSOR: This European Commision funded project, carried out by 33 Institutions from 15 European countries, aims at developing a Sustainability Impact Assessment Tool for policies related to land use changes. It relates to the IAI CRN project since it has components for the identification of land use change drivers, the elaboration of a spatial reference database, integrating thematic data from the La Plata basin, modeling future land use changes considering different scenarios for the state of the drivers, and the involvement of stakeholders, from land owners to policy makers to validate the system that will be developed, specially the impact indicators and their thresholds. The knowledge acquired in the Sensor project, involving UBA, UDELAR, and Embrapa, will be greatly useful for the development of the IAI CRN project. CoPIs Coutinho, Meirelles, Jobbagy, Altesor. (see www.sensor-ip.org).

ENVIAR: Ongoing effort bringing together researchers at Embrapa, UFRJ (Federal University of Rio de Janeiro), UERJ (State University of Rio de Janeiro) and INRIA (Institut National de Recherche en Informatique et en Automatique, France). It is focused on the development of advanced digital image processing technologies for the automatic monitoring of deforestation, land degradation and expansion of no-tillage agriculture through systematic classification of land use and land cover. CoPIs Meirelles & Coutinho

Redlatif (Red Latinoamericana de Incendios Forestales): The principal goals is to compile a list of Latin-American experts working on remote sensing and forest fires, to foster the participation of Latin-American scientist in global networks related to the fire programs, and to generate thematic networks for participation in fire-related projects within the Latin-American region. CoPI Di Bella coordinates this initiative.

ADMIT-Consortium: Consortium for "Climate change ADaptation and MITigation strategies and policies for land use activities in the Parana-Plata basin" (ADMIT), coordinated by Alterra – Green Research Centre (Wageningen UR, Netherlands) as an

effort to produce a research proposal submitted to Europe's Seventh Research Framework Programme (FP7). This network involves researchers from several countries in Europe and South America, thus providing an interesting opportunity to foster valuable partnerships for our CRN project, particularly in the field of land use change modeling. Approval of this proposal may also contribute with significant financial support for data assemblage necessary to our CRN project, as well as for important pilot area field works and research activities. CoPIs Meirelles and Coutinho

Involvement in other IAI projects:

During this year we have established a direct and active collaboration with Dr. Meza and the SGP-HD 003 project. We had a meeting in Santiago and a second meeting in San Luis that was followed by a 10 day training period of students from Meza´s lab in Jobbagy´s lab.

We have an ongoing collaboration with members of Luckman´s CRN in IANIGLA-Mendoza, regarding land use effects and their interaction with climate change regulating the hydrology of Andes water in the desert. With this team we obtained matching funds from National Geographic Society. Antonio Lara, from the same CRN project has contacted Jobbagy for a brief course in Universidad Austral in Valdivia, Chile.

Steps for climate-vegetation coupled simulations had been initiated with Dr. Hugo Berbery after a meeting with Jobbagy in Maryland.

Posdoc Nosetto and student Carambula collaborated in a workshop organized by Tourrand´s SGP-HD project in an area of intense research by our CRN group: Salto-Paysandu afforestation zone.

Our LECHUSA initiative has captured the attention and provided long term remote sensing information to CoPIs from Sarmiento and Luckman CRN´s

Finally, several CRN 2031 members (Podesta, Meirelles, Jobbagy) are involved in the IDRC project together with participants of different CRN and SGPs

9 Media Coverage and Prizes

Diego Piñeiro – Changes in rural society of Uruguay – Suplemento agropecuario diario "El País"- Uruguay

Several TV channels, Newspapers and Radios covered Drs. Oesterheld and Viglizzo at the national AACREA congress, Argentina

Esteban Jobbagy – Two articles in the newspaper of San Luis "Diario de la Republica" on recent floodings in the semiarid Pampas and the possible impacts of land use change, Argentina.

Jobbágy & Viglizzo where part of IPCC AR4 team of authors. The Nobel Prize for IPCC was covered in local media and both contributors were acknowledged

José Paruelo was distinguished by Elsevier with the Scopus award 2007 for highest citation impact among Argentine scientists.

10 Policy Relevance

At this stage the project has generated its major impact on policy through the involvment of CoPIs in the discussion of afforestation laws and their implementation. CoPIs Jobbágy, Altesor, Panario, Paruelo and Piñeiro had participated in several discussions, workshops, and published articles for the general public. Many of these participations had a strong impact on the current debate on afforestation among policy makers of Argentina and Uruguay, with some international influence through articles in Le Monde (France) and the participation of the PI Jobbágy as a contributing author in the last IPCC report (2007) from Work Group III (Mitigation) in Chapter 9: Forestry.
http://www.mnp.nl/ipcc/pages_media/FAR4docs/chapters/CH9_Forestry.pdf

CoPIs Jobbágy, Paruelo, Viglizzo, Noellemeyer, Coutinho are now engaged in the important debate on agricultural expansion. A workshop which will be joinly organized with INTA will discuss ecosystem services outputs in the light of ag expansion. The team has introduced key information on water services (hydro regulation and fresh water provision) in the debate.

CoPIs Jackson and Jobbagy together with posdoc Piñeiro had submitted a paper in which the carbon benefits of corn for ethanol policies in the US are estimated and discussed. Due to the high market effects of this US policy, Plata Basin systems are highly sensitive to their influence. Our contribution will be of value for both US policy makers as well as Latin American policy and lobby agents negotiating agricultural regulations in the region.

11 Main Conclusions

In the second year of the project our team has progressed on five clusters a) description, monitoring and spatial modeling, b) carbon cycling shifts, c) interaction with hydrology and climate, d) interaction with fire dynamics, e) connection with policy and production through debates and tool development for the general public. While in year 1 afforestation in grasslands was the land use trajectory with fastest progress, in year 2 we consolidated work on the more widespread issue of agricultural expansion. We are now covering crop expansion issues in the Cerrado, Chaco, Espinal (all dry forests) and de Pampas. In this case connection with stakeholders has been established from the beginning of our activities.

The project maintains a staff of 3 posdocs and 11 graduate students with IAI funds and involved 36 additional students more financed by other sources. These students continue to bridge the labs of different CoPIs. We have published and submitted 18 publication and made 20 presentation in scientific meetings. Members of the team had been actively involved in workshops and debates with stakeholders such as ag-policy officials, farmer

associations and environmental NGOs. Two active web sites maintain their growth and are regulare updated by the team

12 Work Plan for Next Year with Associated Costs

We will continue our work in the clusters mentioned above, focused on the following aspects of land use change in the Plata Basin: a) description, monitoring and spatial modeling, b) carbon cycling shifts, c) interaction with hydrology and climate, d) interaction with fires, e) increased connection with policy makers (debates and tool development) and farmers (collaborative research on land use –hydrology links).

The work initiated within these clusters will be continued along the same lines described in the results section (3.1.). However, the following four aims will guide some improvements and challenges in the activities of next years:

1. **"Humanize" clusters "a-c-d"**
   The team is interested in capturing the strong connection between societies and ecosystems in its research, yet, disciplinary and cultural barriers often favor a separation of biophysical and human aspects of the work in each cluster. We will include behavioral issues as well as policy and economy rules in the evaluation of land use change patterns (cluster a). Decision rules by farmers in relation to groundwater elevation will be included in the modeling of climate-hydrology-land use, this assessment will include an explicit analysis of the economic outcome of different groundwater scenarios in terms of gross margin, a variable that will likely have more direct effect on farmers decisions (cluster c). In the case of fire dynamics, human behaviour a more explicit representation will be seeked. The project counts now with the support from three teams dedicated to human dimension aspects funded by SGP-HD grants. We will initiate collaboration with them

2. **"Climatize" cluster "c"**
   Initially considered in our project, but eliminated after revisions with IAI before funding, the feedbacks of land cover on climate were an issue of great interest. We will include this issue in the exploration of groundwater-land use dynamics in the humid and semiarid plains of Plata Basin. We already established a collaboration with Hugo Berbery and will evaluate the potential impacts of agriculture in dry forests and flooding in the herbaceous pampas on climate through regional climate models and empirical observations based on the TRMM precipitation database developed by Goddard-NASA

3. **Take cluster "e" a step beyond in terms of the involvement of policy makers and regional visibility**
   We had very positive results from our participation in the afforestation debate in the Uruguayan and Argentine forestry community. Our team had been responsible of putting water and soil conservation issues in the agenda of this debate. In years 2-3 of CRN 2031 we want to achieve a similar impact on the debate of agricultural

expansion over native vegetation in the semiarid/subhumid belt of the basin. Negotiations with Secretaría de Agricultura de la Nación in Argentina are already in their way for a possible workshop. On a different avenue, our team wants to create a very visible forum of scientific discussion on land use changes, their causes and impacts that meets two complementary goals: brings the dispersed community of land use change researchers of South America together into the scientific discussion and makes this discussion visible to the general public with an explicit map-type representation of land use changes. This work is currently in its experimental face with the LECHUSA (http://lechusa.unsl.edu.ar) site and our aim for year 2 is to achieve the fully functional stage of the web-site (domain could be transferred to IAI if that can make it more successful) publicizing it to the broadest possible audience (policy makers, farmers, companies, NGOs, general public)

4. **Create stronger links across clusters**

As defined in the project formulation stage, our team identifies grad and postdoc students as the key agents capable of connecting groups, and more important, able to integrate disciplines more effectively than their advisors. The long term goal of CRN 2031 is to incubate a group of well connected young students that will become independent researchers at the end of the project. In year three we will conduct a Training Institute (initially planned for year 2) to connect clusters and integrate students and CoPIs from other IAI teams. The event will take a week in a retired location in San Luis and will respond to the following lines:

Title: Coupling climate, society, and land use change: Scientific tools to manage risk and opportunity

Goals

a) Advance land use change science through the explicit representation of coupled systems

b) Facilitate networking of land use change research teams through their g raduate and postdoctoral students

c) Promote the exchange and development of scientific tools

e) Identify outreach challenges and opportunities and shape strategies to cope with them

Target audience:

CRN2031 students and postdocs (20 students)

SGP Human dimension proposals (Meza, Tourrand) (4 students)

Other CRN´s students (Luckman, Diaz) (4 students)

Other groups (Grau, LIEY-CONICET) (2 students)

Forecasted budget for year 3 is the following

	UBA-CONICET	INTA cautelar	EMBRAPA SOLOS	UDELAR Ciencias	UDELAR Sociales	SAGPyA & UB	UNIV MIAMI	INTA La Pampa	UNIV N. Asuncion	INTA Bariloche	NCSU	Duke	UVA	Univ La Pampa	capacity building in PY	TOTAL
Salaries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fellowships	20160	10080	19352	7320	7320	0	7320	7320	0	0	0	0	0	16200	7320	102392
Travel	29510	6265	5854	2688	1937	1481	4109	569	569	569	1039	1039	1039	2761	0	59430
Equipment	1310	655	741	2810	584	584	0	0	655	0	0	0	0	563	0	7900
Expenses	9272	3414	5639	5421	587	587	0	587	1227	2027	0	0	0	2639	0	31400
Communication	2250	250	500	500	250	250	0	250	250	0	0	0	0	0	0	4500
Publication	2500	833	833	833	833	0	0	1667	0	0	0	0	0	400	0	7900
Administration	6740	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6740
Overhead	12935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12935
TOTAL	84676	21497	32919	19572	11511	2902	11429	10392	2701	2596	1039	1039	1039	22563	7320	**233197**

A few modifications from the budget presented in the original project were introduced:

1: Salaries adjusted for inflation in Argentina/Uruguay
Raises were financed by removing one posdoc position originally budgeted for UBA and requesting additional USD 1200 to IAI from funds not used in years 1 and 2 for this budget line

2: Based on UDELAR-Ciencias needs we added USD 1500 to this budget line and we request the amount from funds not used in years 1 and 2. We added USD 6400 in equipment by removing this funds from research expenses.

3: We included additional USD 4500 for journal costs that we are requesting from funds not used in years 1 and 2

Total budget additions requested from funds not used during years 1 and 2

USD 1.200,00
USD 1.500,00
USD 4.500,00

TOTAL USD 7.200,00

Details on each budget category can be seen in the original project

Appendix A – List of students enrolled in IAI fellowships in year 1 of CRN 2031 (PD=postdoc, G= grad student, UG=undergrad)

	Name	Affiliation	Nationality	Grade	Area of expertise	Training activity	Student involvement in project	Scholarship duration & amount	Exchange programs	Note
PD	Aboim, Marcela	EMBRAPA Solos	Brazilian	Postdoctoral student	Soil chemical and physical characterization	flexible training	Soil carbon stocks, organic matter fractionation gas emissions under contrasting land uses	1 year, 1600 USD/month		RECRUITED IN YEAR 2
PD	Aragón, Roxana	GEA-FAUBA	Argentine	Postdoctoral student	Pattern analysis, hydrological time series	flexible training	The inter-connection of land use change and the underground hydrology system in plain grassland ecosystems	2 years, 700 USD/month	INTA	FINISHED, now funded by SECyT-Ar
PD	Contreras, Sergio	GEA-FAUBA	Spanish	Postdoctoral student	Hydrology, Remote Sensing, Modeling	flexible training	The inter-connection of land use change and the underground hydrology system in plain grassland ecosystems	2 years, 840 USD/month	FAUBA, Almeria	RECRUITED IN YEAR 2
PD	Piñeiro, Gervasio	GEA-FAUBA	Uruguaian	Postdoctoral student	Soil carbon, grazing, grassland ecology	flexible training	Coordinates Soil C activities	2 years, 350 USD/month	Duke-UDELAR	now independent scientist
PD	Vega, Ernesto	FAUBA	Mexican	Postdoctoral student	Land use change and modeling	flexible training	Model patterns and drivers of land use change. Develop a spatially explicit simulation model of Land Use Change	2 years, 730 USD/month	GEA	now funded by SENSOR
PD	Veron, Santiago	INTA-Instituto de Clima y Agua	Argentine	Postdoctoral student	Primary productivity, Biomass burning, Remote Sensing	flexible training	Evaluation of the potential of fire-prone ecosystems to become a bioenergy source	1 year, 400 USD/month	Duke - FAUBA - GEA	RECRUITED IN YEAR 2

	Name	Affiliation	Nationality	Grade	Area of expertise	Training activity	Student involvement in project	Scholarship duration & amount	Exchange programs	Note
G	Carambula, Matías	Fac. Cs Sociales UDELAR	Uruguaian	PhD student	Rural sociology	PhD Program U of Cordoba	Social impacts of afforestation	3 years, 510 USD/month	FAUBA	CONT FROM YEAR 1
G	Carreño, Lorena	INTA La Pampa	Argentine	PhD student	Ecological diversity	Program U of Mar del Plata	Ecosystem services assessment	3 years, 510 USD/month	GEA	FINISHED, now funded by INTA
G	Hernán Pereira	INTA La Pampa	Argentine	PhD student		Program U of Mar del Plata	Ecosystem services assessment	3 years, 510 USD/month	GEA	RECRUITED IN YEAR 2
G	Lezama, Felipe	Fac. Cs. UDELAR	Uruguaian	PhD student	Grassland Ecology	Program EPG FAUBA	Description of the structural and functional heterogeneity of the Rio de la Plata grasslands	3 years, 300 USD/month	FAUBA	CONT FROM YEAR 1
G	Morazzo, Germán	FAUNLPAM	Argentine	PhD student	Soil chemistry	Program EPG FAUBA	Characterization of humic substances under forest species	4 years, 600 USD/month		CONT FROM YEAR 1
G	Wehrle	UNA Asuncion and GEA-FAUBA	Paraguaian	PhD student	Hydraulic Engeneering	Program U del Litoral	Land use impacts on surface hydrology in Paraguay	530 USD/month	FAUBA - PhD in Universidad del Litoral	RECRUITED IN YEAR 2
G	Baeza, Santiago	Fac. Cs. UDELAR	Uruguaian	MSc student	Grassland Ecology	Program EPG FAUBA	analyzing the environmental and land use controls over ecosystem functioning over Uruguay	3 years, 300 USD/month	FAUBA	CONT FROM YEAR 1

	Name	Affiliation	Nationality	Grade	Area of expertise	Training activity	Student involvement in project	Scholarship duration & amount	Exchange programs	Note
G	Ballesteros, Sivina	GEA-FAUBA	Argentine	MSc student	Soil chemical and physical characterization	Program EPG FAUBA	Análisis regional de flujos de carbono en la cuenca del Plata y su vinculación con el uso de la tierra	3 years, 610 USD/month	INTA Clima y Agua	CONT FROM YEAR 1
G	Florencia Rositano	FAUBA	Argentine	MSc student	Agronomy	Program EPG FAUBA	farmer decision making and its influence on soil quality	1 year mo., 400 USD/month	FAUBA - U of Miami	RECRUITED IN YEAR 2
G	Mariano Bustos	FAUBA	Argentine	MSc student	Agronomy	Program EPG FAUBA	farmer decision making and its influence on soil quality	4 mo., 400 USD/month	FAUBA - U of Miami	RECRUITED IN YEAR 2, resigned
G	Martini, Juan Pablo	FAUNLPAM	Argentine	MSc student	Remote sensing and GIS	Program EPG FAUBA	Development of a land capability map	4 years, 600 USD/month	GEA - INTA San Luis	CONT FROM YEAR 1
G	Melchiori, Arturo	INTA-Instituto de Clima y Agua	Argentine	MSc student	Ecosystem modeling, data base analysis	Program EPG FAUBA	study of lightning as a factor controlling fire occurrence at the national level.	2 years, 400 USD/month		FINISHED, now funded by INTA
G	Perino, Ivan	GEA-FAUBA		MSc student	Electronic Engeneering, Instrument networks	Program U de San Luis	Involvment of farmers on Groundwater monitoring networks	2 years, 610 USD/months	FAUBA-Quantitative Methods Group	RECRUITED IN YEAR 2
G	Román Trucco	FAUNLPAM	Argentine	MSc student	Agronomy	Program U of La Pampa	Water table depth effects on crop productivity	4 years, 600 USD/month		RECRUITED IN YEAR 2

	Name	Affiliation	Nationality	Grade	Area of expertise	Training activity	Student involvement in project	Scholarship duration & amount	Exchange programs	Note
UG	Barraza, Matías	FAUNLPAM	Argentine	Undergraduate student	Agronomy	Program U of La Pampa	Carbon dynamics under different land use	2 year 100 USD/month		CONT FROM YEAR 1
UG	Cavigliaso, Marcelo	FAUNLPAM	Argentine	Undergraduate student	Agronomy	Program U of La Pampa	Evolution and impact of biofuel crops on land use and socioeconomic conditions in central Argentina	2 years, 110 USD/month		CONT FROM YEAR 1
UG	Cetolini, Karina	FAUNLPAM	Argentine	Undergraduate student	Agronomy	Program U of La Pampa	Evolution of different stubble mixtures during fallow and subsequent crops	2 years, 100 USD/month		CONT FROM YEAR 1
UG	Diaz, Guillermo	FAUNLPAM	Argentine	Undergraduate student	Agronomy	Program U of La Pampa	Carbon dynamics under different land use	2 years, 100 USD/month		CONT FROM YEAR 1

Other students funded by non-IAI fellowships

GEA-Jobbagy
Roxana Aragon - FONCyT
Marcelo Nosetto - CONICET
Germán Baldi - FONCyT
Carla Rueda - CONICET
Celina Santoni – CONICET
Victoria Marchesini – CONICET (with Fernandez from FAUBA)
EMBRAPA-Solos
Rodrigo Ferraz – EMBRAPA staff
FAUBA-Piñeiro
Paola Eclesia – INTA Misiones
Sebastián Massilli – INIA Uruguay
FAUBA-Paruelo
Costanza Caride - CONICET
Mayra Milcovic - FONCYT
Marcos Texeira – CONICET
Ernesto Vega - SENSOR
FAUBA-Oesterheld
Irisarri, Gonzalo - Fundación Estenssoro Doctoral Fellow
Durante, Martín - CONICET Doctoral Fellow
INTA Inst Clima y Agua - Dibella
Fischer, María de los Ángeles - INTA Inst Clima y Agua
Straschnoy, Julieta Verónica - INTA Inst Clima y Agua
INTA La Pampa
Lorena Carreño - INTA
Univ. Asuncion - Genaro Coronel
Fernando Pio Barrios – UNA Paraguay
Maria Elena Hume (LIAPA-Inst Clima y Agua INTA, Dibella)

Udelar -Piñeiro
Antonio Graciano - UDELAR.
Emilio Fernández - UDELAR
Natalia Vibel - UDELAR
Jimena Vázquez - UDELAR
Ivana Cúrbelo – UDELAR
Eduardo Méndez - UDELAR
Udelar – Altesor
Luis López - UDELAR-FPTA 175 INIA
Elsa Leoni - UDELAR-FPTA 175 INIA
Gastón Fernández - UDELAR-FPTA 175 INIA
Univ. Virginia - Epstein
Domingo Alcaraz – CSIC- Spain
INTA-Schlichter
Darío Ceballos – INTA Delta
Duke - Jackson
Berthrong, Sean - NSF
Kim, John – NSF/DOE
Univ. of Miami-FAUBA - Podesta
Federico Bert – NSF
FA UN La Pampa - Elke Noellemeyer
Riestra, Diego - CONICET
Perez, Mauricio – ANPCYT
Bazan, Juan Cruz - FAUNLPAM