1 *Bridging Ecosystem Services and Territorial Planning (BEST-P): A southern South American initiative*

Principal Investigator: *Dr. José M. Paruelo*. LART-IFEVA. Facultad de Agronomía and CONICET. Av. San Martín 4453. 1417 Buenos Aires – Argentina.
E.mail: paruelo@agro.uba.ar/www.agro.uba.ar/users/paruelo

2 Project Funding

During the reported period we have additional funds coming from several national agencies, governmental offices and ONG of Argentina, Chile and Uruguay. Additional and international agency (CYTED) supported networking activities of several of the coPIs and investigators of BEST-P. A total of 9 related projects have been linked to the activities of BEST-P. Table 1 Summarize the projects obtained during 2013 and 2014 by the coPIs of BEST-P. A project directly derived from BEST-P ("Tipos Funcionales de Socio-ecosistemas: una alternativa para la zonificación del territorio en procesos de planificación y ordenamiento") was presented at CONICET (Argentina).

TITLE	Source of Funding	Period	BEST-P participants
Caracterización de estados del campo natural en sistemas ganaderos de Uruguay.	INIA - FPTA (UY)	2014-2016	AIA
Situación Ambiental Argentina, estado actual y cambios ocurridos recientemente en los ecosistemas argentinos.	FVSA (AR)	2013-2014	JMP
Ordenamiento Territorial Rural: cuantificacion de Servicios Ecosistémicos clave para el diagnóstico, planificación y gestión de los bosques Chaqueños	FONCYT (AR)	2014-2016	JMP
Desarrollo de un sistema para el seguimiento y alerta de desmontes e incendios a nivel local y regional en la Región Chaqueña, mediante el estudio y análisis de imágenes satelitales	REDAF (AR)	2013-2014	JMP
Consecuencias de los cambios en el Uso del Suelo sobre procesos ecosistémicos	UBACYT (AR)	2014-2016	JMP
Complementariedad entre usos de la tierra y sinergismo entre servicios ecosistémicos en paisajes rurales multifuncionales.	FONCYT (AR)	2014-2016	PL
Red Temática “Vulnerabilidad, Servicios Ecosistémicos y Planeamiento del Territorio Rural".	CYTED	2013-2016	PL
Consequences of spatial heterogeneity on biodiversity and ecosystem services in changing forest landscapes.	FONDECYT-CONICYT Chile	2014-2016	LN
Landscape Sustainability Research, LandSUR Nucleus	Iniciativa Científica Milenio, Chile	2014-2016	LN

Table 1 Projects obtained during 2013 and 2014 by the coPIs of BEST-P

3 Research Activities and Findings

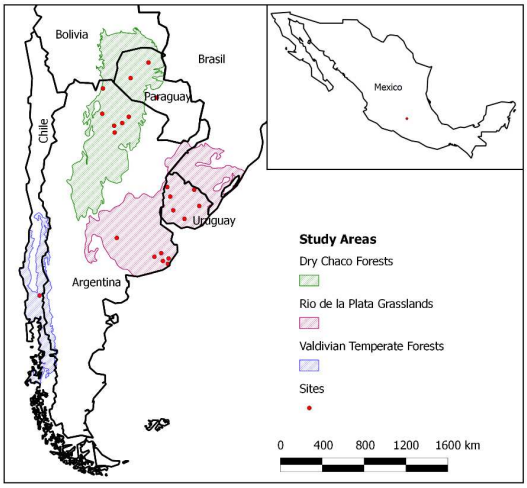

Figure 1. Regions and study sites of BEST-P

This report is organized around the original Specific objectives of BEST-P:

1. To characterize and map the supply of key Intermediate ES related to C, trace gases production, water and climate dynamics, specific final services for each region and the delivery of benefits (economical, cultural and social) to the main stakeholders on landscapes of the three study regions (Valdivian and Chaco forest, Rio de la Plata Grasslands) under different land use and land cover scenarios.
2. To evaluate the predictions of the five stated hypothesis (see the hypothesis at bestp.agro.uba.ar/proposal) in landscapes of the three study regions.
3. To develop toolboxes to incorporate ES flows and benefits, and stakeholders perception into the territorial planning processes
4. To develop alternatives to restore ES provision at the plot and the landscape/watershed level in the three study regions.
5. To implement training programs (courses, workshops, field courses) oriented to the use of the ES framework in the land planning processes at the landscape level. We are planning two types of programs, one oriented to the professional sector and one oriented to empower local stakeholders
6. Outreach activities throughout web pages of the Project, conferences, press releases and a strong interaction with ONGs, agencies, local and national governments.

These objectives are directly linked to a common conceptual framework, the "cascade model" (Haynes-Young & Ptschin 2010), that functionally connect structural attributes of ecosystems and landscapes, ecological processes (intermediate ecosystem services), final ecosystem services, and benefits to the society (see an scheme at http://bestp.agro.uba.ar/wp-content/uploads/2014/09/figures_conceptual_framework.pdf).
A complementary conceptual framework of our project put in the center of our project the definition of "impact functions" (functional relationships between human intervention degrees associated to stress factors or disturbances and environmental distance to reference values, usually linked to ES loss) and connect them to the decision making processes (see an scheme at http://bestp.agro.uba.ar/wp-content/uploads/2014/09/figures_conceptual_framework.pdf). The general factor of stress and disturbance that BESTP consider is land use/land cover change. Those changes may represent different types of socio-ecological transitions according to the region or site considered. We organized our work on the stated objectives around a number of activities. Each activity contributes to more than one specific objective.

Activity 4.1: Selection of specific landscapes (Obj. 1 to 3)

In the workshop held at Buenos Aires in December 2013 (see http://bestp.agro.uba.ar/meetings/) we defined a set of 29 sites (Figure 1, Table 2 (http://bestp.agro.uba.ar/study-areas/) where to focus the specific activities of BEST-P. . Sites corresponded to administrative units of different entity depending on the country, and included in general more than one landscape type. Sites are being characterized in terms of both land use/land cover and Ecosystem Functional Types (EFT) dynamics (Soriano and Paruelo, 1992; Paruelo et al. 2001).

Activity 4.2: Characterization of ES Supply:

a) *ECOSER:* *Improvement and application of ECOSER , a socio-ecological vulnerability mapping tool*

We launched the ECOSER website: www.eco-ser.com.ar. This site includes set of indices and models of ecosystem processes that were translated into a Toolbox format (ArcGis), and integration matrixes of ecosystem processes into ecosystems services (***Ecological Production Functions***), an introductory document, and a tutorial. Integration matrixes were obtained for four ecoregions (Valdivian Temperate Forests, Dry Argentinean Chaco, Argentinean Pampas, and Uruguayan Campos), by expert consultation, revealing different contributions of ecosystem processes to ecosystem services according to the ecoregion.

Current ECOSER version was extended for the assessment of socio-ecological vulnerability (SEV) due to ES loss under selected scenarios, as a more informed basis for the support of land use policies than the usual maps of current ES fluxes. High differences between ES and SEV maps were obtained by applying ECOSER to the analysis of two study cases, the Ancud district (Chiloé Island, Chile) and the Mar Chiquita Basin (Buenos Aires, Argentina), which is in the core of a paper close to be submitted for publication.

In order to improve the demand side of ECOSER, benefits from ecosystem services are being conceptually and methodologically disaggregated a) between direct benefits (those mostly depending on spatial patterns of propagation and capture of biophysical flows) vs. indirect benefits (those depending on money circuits), and b) among main social sectors (according to stakeholders and economical sectors). This improvement is being applied to a new case study, the Nahuel Huapi National Park of Argentina and its buffer areas.

	Impact Functions			
	ES			
Region	Intermediate	Final	Covariable	Reference
Chaco	SOC		Age of deforestion	*Ciufolli, 2014*
Chaco	Groundwater level		Age of deforestion, agricultural management	*Amdan, 2014, Gimenez, 2014*
Chaco	C gains dynamics		Original Cover	*Volante, 2014, Volante el al. 2012*
RPG	SOC		Agricultural management	*Caride 2014, Caride et al. 2012*
RPG		NO2 emissions	Agricultural management	*Caride 2014, Della Chiesa et al. 201*
RPG	Hydrological yields			*Gallego 2014*

Table 3. Summary of the impact functions generated under the BEST-P project.

b) ES Impact functions of ES.

The development of Impact function to evaluate the effect of stress factors or disturbances (i.e. land cover changes) requires a proper characterization of final and intermediate ES (sensu Fisher et al. 2009). Our efforts were concentrated on developing ES Impact functions related to C and water dynamics, climate regulation and trace gas production. Table 3 summarize the advances made so far. The following sections describe the process of generation of these functions:

b.1) Characterizing the effect of deforestation and agricultural practices on deep drainage in the Chaco region

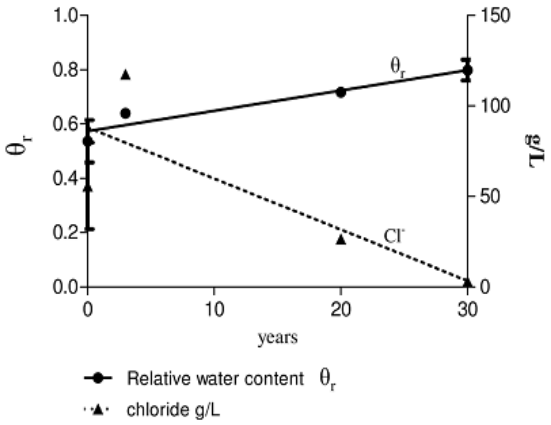

Figure 2. Relative water content (left Y axis) and chloride concentration in the soil solution (right Y axis) for different time since forest clearance. Standard deviation included in dry forest (time 0 years, no clearance; n=6) and 30 years agriculture (time 30 years;n=4). Amdan et al. (2014)

Previous work of the group identified the risk of increase of the water table level and salinization in xerophytic forests of South America from the case studies in San Luis (Santoni et al. 2010). As part of CRN-3095, Amdan et al. (2013) analyzed the processes of groundwater recharge and soil salinization in the semiarid plains of Chaco (central South America) where unprecedented deforestation rates are taken place. Based on deep soil sampling (0–6 m) in seven paired stands under natural dry forest, rain-fed agriculture and pasture, with different age of clearance (>30 years, 20 and 3years) in Salta, Argentina, this study provide evidence of groundwater recharge increase and onset of salt mobilization in areas where forests were replaced by annual croplands. Soils with higher water and lower chloride content are evidence of deep percolation and salt leaching. In Salta, stands subject to 30 years of rain-fed cultivation had profiles with 30–46% higher moisture content and 94% lower chloride stocks compared to dry forest (0.0560.04 kg/m^{2}versus 0.7760.4 kg/m^2) (Figure 2).

Estimates of groundwater recharge based on the displacement of chloride peaks suggested values of 27–87 mm yr^{-1} for agricultural soybean stands, and 10.4 mm yr^{-1} for pastures. While hydrological shifts in the regional groundwater system are poorly monitored and understood, these findings show that it is potentially sensitive to land use changes and to salinization processes. Following these observations water table under rain-fed agriculture may reach soil surface in a period that ranges from 30 to 120 years.

The assessment of the impacts of agriculture in the Gran Chaco should also have a landscape perspective, as the location, context, timing, extent, and type of land use replacement would have an effect on the groundwater recharge that cannot be estimated by plot scale analyses. The length of borders and the fragmentation level would play a critical role in defining the landscape water balance (Briant et al., 2010) and hence the magnitude of the recharge. To what extend forest patches can absorb the water drained from nearby

agricultural patches? Are there landscape configurations that, given a ratio of forests/croplands, minimize groundwater recharge? What land use alternatives could minimize or reverse the recharge process?

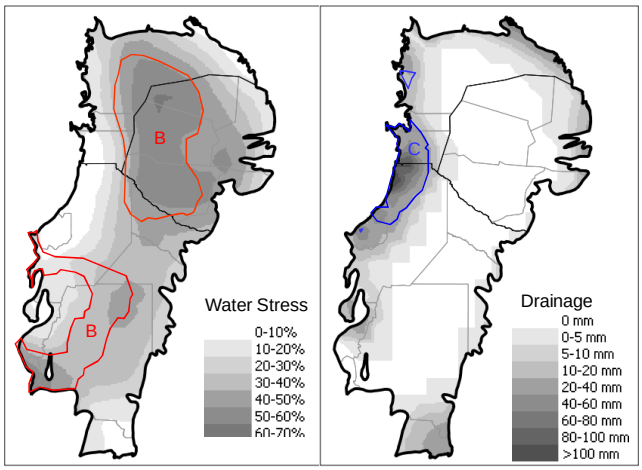

Figure 3. Mean water stress (left) and annual deep water drainage (right) in the Chaco plains.B and C are the areas with frequent high water stress and deep drainage respectively.

To address this issue, Gimenez et al. (in press) used monthly soil water balance approach to analyze both the productive and ecohydrologic effects of five different farming systems across the Chaco region (winter, spring, summer, late-summer and a winter-summer double crop system) and to assess the possibility of minimizing emerging trade-offs between them through flexible water-informed cropping sequences. The results indicate that water stress diminishes as crop systems are delayed towards the rainy season (winter > spring > summer > late-summer), but the productively safer late-summer strategy, is the one with highest drainage rates. In most of the region, the relatively high production risk and insignificant drainage probability (Figure 3) generally determine the convenience of conservative late-summer systems. However, in areas (or years) with higher amount and/or seasonality of rainfall, more intensive double-crop systems are necessary to minimize the likely high drainage fluxes. As rainfall is highly variable from one year to the other, the knowledge of soil water content at the onset of the season is useful to predict part of the available water offer and to asses expected production and ecohydrologic risks. In the most drainage-prone areas the implementation of flexible sequences that alternate conservative and intensive crop systems depending on soil water status, significantly reduced mean annual drainage with an acceptable increase in mean water stress index.

A spatial explicit quantification of evapotranspiration, using remote sensing tools (Nosetto et al., 2005), would allow us to relate water balance with landscape configuration including different land covers types and their consume of water. Ongoing projects that are part of the PhD dissertation of L. Amdan and R. Gimenez are dealing with these issues.

b.2) *Characterizing the impact on afforestation on hydrological yields in temperate grasslands of Uruguay.*

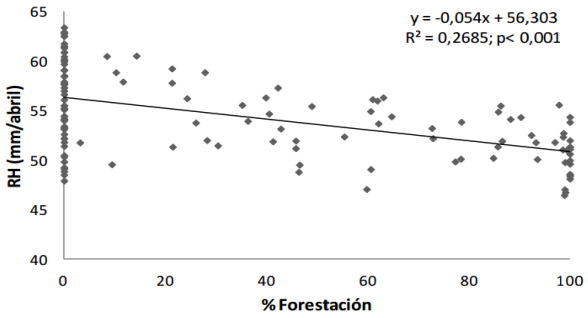

Figure 4. Regression Model between the % afforested an the hydrological yield of 133 watershed in Sierras del Este (Uruguay).

As part of a MSc thesis, Federico Gallego defined the impact function that describe the change in hydrological yields as a function of the change in the area afforested in small watershed of the Sierras del Este region in Uruguay. This study analyzed also the influence of the land cover structure of the watershed on the water dynamics of each cover type. Afforestations evapotranspirated a 21.5 % more than the original grasslands (2.99 vs. 2.45 mm.día-1). Afforestation reduced, in average, a 5.4 % the hydrological yield of the watershed analyzed and reduced the water consumed by the other land covers (Figure 4).

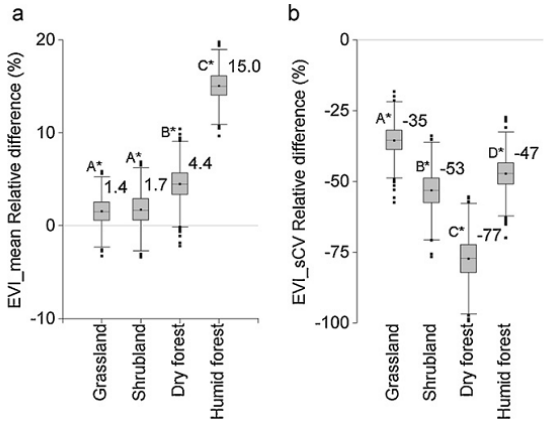

Figure 5. Relative change (%) of the Enhanced Vegetation Index annual mean (EVImean) (a) and seasonal coefficient of variation (EVIsCV) (b) due to land clearing of natural vegetation for agriculture and ranching across four differ-ent vegetation types in the Chaco and Yungas ecoregions. The Y axis represents the relative difference between natural vegetation and cleared plots ((Natu-ral − Cleared)/Natural × 100) in 1000 random subsets of 50 paired sites each (cleared plots versus natural vegetation within a 1500 m buffer around the cleared plots).

b.3) *Effect of deforestation and agricultural expansion / intensification on C dynamics.*

As part of his PhD dissertation José Volante (presented in 2014) analyzed the changes associated to the replacement of the original cover Chaco region on three aspects of the C gains dynamics: the total amount of C fixed (ANPP), the seasonal dynamics of C gains and its interannual variability. The seasonal dynamics of the MODIS satellite Enhanced Vegetation Index (EVI) was used to calculate the EVI annual mean as a surrogate of ANPP, and the EVI seasonal coefficient of variation as an indicator of seasonal variability of carbon gains. The 2000–2007 period showed a high rate of land clearing: 5.9% of NW Argentina (1,757,600 ha) was cleared for agriculture and ranching, corresponding to an annual rate of 1.15%. Dry forests experienced the highest rate and humid forests the lowest. Though land clearing for agriculture and ranching had

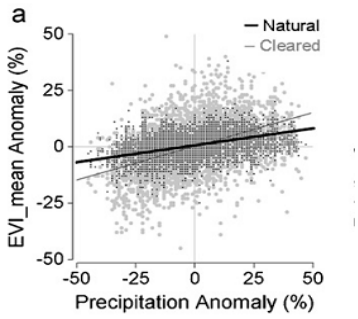

Figure 6. Relationship between the anomalies along the 2338 paired sites that have seven years of observations from 2001 to 2007.

relatively small impacts on total annual ANPP, once deforested, parcels significantly became more seasonal than the natural vegetation replaced (Figure 5). Such increase in seasonality is associated with a reduction of photosynthetic activity during a portion of the year (fallow). Direct consequences of this reduction can be expected on several ecosystem services such as erosion control and water regulation, due to greater exposure of bare soil, and biodiversity, due to the loss or decline in habitat quality and the decrease of green biomass availability for primary consumers during fallow. Land clearing also increased the magnitude of inter-annual differences in C gains, suggesting a greater buffer capacity against climate fluctuations of natural vegetation compared to croplands (Figure 6).

The effect of land cover changes on soil C and N contents within the Chaco area was analyzed in an undergraduate thesis (Ciufolli, 2014). We sampled soils in paired plots: native forests (grazed) and other uses, including croplands, pastures and forest without livestock grazing (exclosures). The years since clearing was recorded for the analysis as a covariable. The soil organic C and N (SOC and SON) of two organic matter fractions were analyzed (POM and MAOM). SOC and NOS in the first m of the soil profile was higher in the exclosures (82.4 and 10.3 Mg ha-1 of C and N, respectively) and in the grazed forests (69.2 and 8.6 Mg ha-1 of C y N, respectively) than in the croplands (54.1 y 7.9 Mg ha-1 of C and N, respectively) and pastures (52.4 and 6.7 Mg ha-1 of C and N respectively). Our result ssuggests that both grazing and cropping significantly altered the structure and content of the OM in the Chaco region.

As part of two graduate level thesis (P. Baldassini at UBA and S. Villarino at UNMdelP) we are expanding geographically the analysis to cover a a broad gradient of precipitation and land use history. New sampling to complement the existing databases on SOC and NOS are focusing on Salta and Santiago del Estero provinces. We will use part of the data to calibrate and evaluate the biogeochemical model CENTURY for the Chaco region. Model simulation will allow us to explore the consequences of different types of transformation on organic matter composition and dynamics.

A similar approach, based on CENTURY, was used by Caride as part of her PhD dissertation (to be defended in November 2014) to explore the effect of different crop-pasture rotations and management (crop sequence, tillage and fertilization change) on C dynamics in Arguiudolls of the Rio de la Plata grasslands. Based on CENTURY simulations the crop management which had a most negative SOC balance (SOC reference value (100%) = 79 t ha −1) was crop sequence “maize/soybean” under conventional tillage and with no fertilizer application (37% losses of SOC in 60years). The management that presented the most positive SOC balance was “soybean/wheat-soybean double crop (6 years) pasture (4 years)” under no till and with high fertilization (10% increase of SOC in 60 years). A positive and linear relationship was found between APAR estimates derived from satellite data and simulated SOC providing basis for a quantitative hypothesis on the importance of C inputs on SOC’s dynamics. At regional scale, if crop sequences proportions remain constant, the lost of SOC would average a 15% in 60 years.

b.4) *Effect of Agriculture on NO_2 emission*

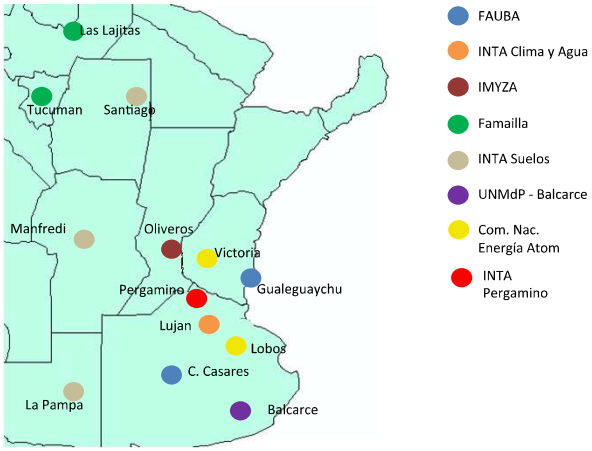

Figure 7. Distribution of the study sites of NO2 emissions.

We start to study the effect of land use change on NO_2 emissions over the plains of the Chaco and Rio de la Plata grasslands (Figure 7) building a network of sites (see **7 Regional Collaboration/Networking** for a description of the network**).** The network already defined a common protocol that will allow to define both impact functions and production functions for the regulation service for NO_2 for emissions. A critical point for that is always having a reference situation that correspond to less human-modified cover. Two PhD students linked to BEST-P (Costanza Caride and Tomas Della Chiesa) started to produce results from two of the sites (Carlos Casares and Gualeguaychú).

b.5. *Climate regulation Services*

Based on the work of Hugo Berbery and his PhD students we started to explore the use of the coupled models Weather Research and Forecasting Model–Noah land surface model (WRF–Noah), to evaluate changes in the provision of Final Ecosystem Services related to climate services for two of the regions to be analyzed by BEST-P: the Chaco dry forests and the Rio de la Plata Grasslands. Our approach involves a much more realistic definition of the biophysical properties of the surface model. The most used alternatives included the land cover descriptions provided by USGS and IGBP (Figure 8). The new approach that we are proposing is based on the idea of areas with a similar ecosystem functioning, called Ecosystem Functional Types (Soriano and Paruelo, 1992; Paruelo et al. 2001). EFT concept is defined on basis to ecosystem attributes that can be monitored using remotely sensed data. We are currently defining the best strategy to define impact function for climate regulation as a function of land transformation by following the procedures for EFT analysis that were recently outlined by Alcaraz-Segura et al. (2013).

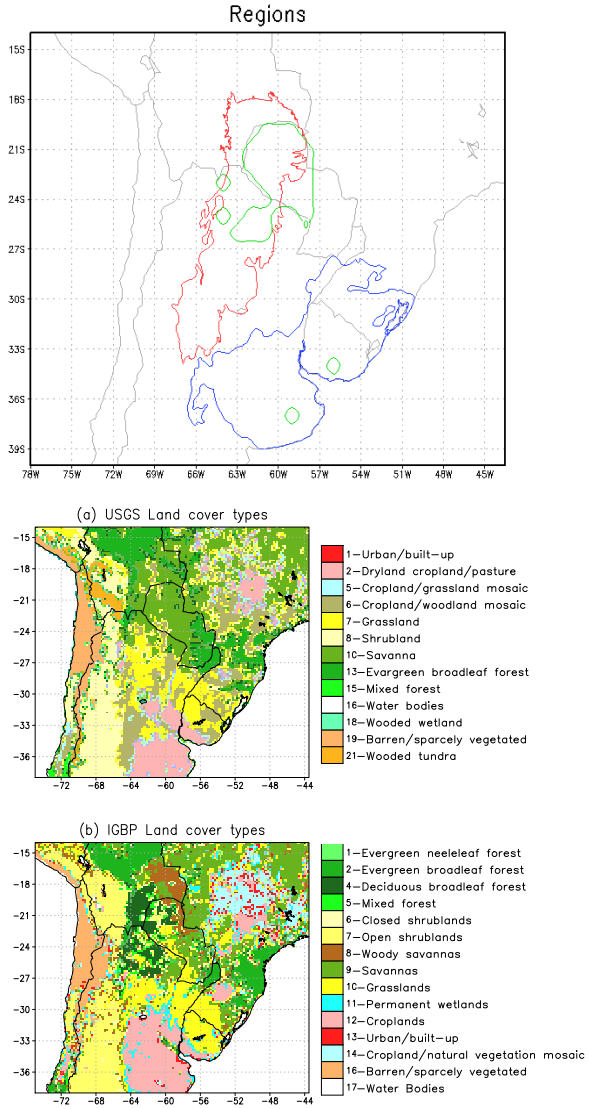

Figure 8. Regions to be studied using the WRF-Noah coupled model and land cover types defined by USGS and IGBP.

c) ES Production functions. As an effort to develop Production Functions we worked on characterizing the level of provision of critical Final Ecosystem Services and the processes that determine them. We were also focusing on mapping those FES over the BEST-P focus regions using generalized production functions.

c.1.Water supply

Harvesting rainwater has been essential for the development of human settlements, domestic herbivore grazing, and agricultural production in the Chaco. Harvesting rainwater is the production systems of a key final service: water supply. A part of his PhD dissertation P. Magliano studied the major types and geographical distribution of reservoirs; characterized different strategies of water capture, storage and use; and identified emerging challenges for water provision in the Chaco plains of Argentina and Paraguay. For these purposes he used satellite imagery, performed in-situ hydrological measurements, and conducted interviews with farmers and ranchers in charge of the design and management of these widespread structures. The study found a much higher density of water harvesting in Paraguay than in Argentina (1 vs. 0.1 per km2) with those in the first country being predominantly located in pasture areas (76%) while those in Argentina being dominant in the forest matrix (94%). More primitive water harvesting systems in Argentina are based on a horse shoe-shapped impoundment that collects run-off from non-dedicated areas with some aid from roads and cattle trails. In Paraguay more sophisticated tanks + impoundments often accompanied by dedicated harvesting areas in which vegetation is removed are the most frequent structures. As a result of density and design differences, Paraguay is harvesting approximately 5 mm/year of rainfall, whereas Argentina only less than 0.5 mm/year.

A simple monitoring scheme of the major (in)efficiencies of water harvesting systems based on continuous records of water depth in impoundments or storage structures has been evaluated in Argentina. Uprise measurements allowed to estimate water yields in response to rainfall magnitude and intensity for watersheds that are very difficult to describe given the very focalized nature of run-off generation and the ill-defined nature of

basin boundaries in the flat landscape of the Chaco plains. Level decline records allowed to describe losses through direct evaporation and infiltration, showing the surprising fact that the second are the most significant ones in the impoundments that we explored.

c.2. Forage production

As part of his PhD dissertation, Lisandro Blanco developed a model for the Chaco vegetation types in order discriminate the signal of woody and herbaceous vegetation on the NDVI, a widely used spectral index to estimate to estimate Net Primary Production (NPP) from the amount of photosynthetically active radiation absorbed (APAR), by following the model proposed by Monteith (1978). This represents an important achievement due to the difficulties from the presence of a woody layer. In the context of his Master thesis Pablo Baldassini is currently investigating the effect of a woody cover on the radiation use efficiency. This research lines are included within cooperation programs that the LART maintain with different public and private institutions (i.e. AACREA in Argentina and Instituto del Plan Agropecuario in Uruguay) to provide regularly forage production estimates to ranchers and decision makers

c.3. Regulation of NO_2 emissions

As we state above (se point b.4.) field experiments on the environmental and management controls of NO_2 emissions will allow to define production functions for this regulating services. The environmental factors to be considered include soil water content, soil NO3 and NH4, organic matter and temperature. Among the management factor to consider the most important include crop type, fertilization, tillage system, previous crop, sowing date and density. So far we have data for a whole growing season for just one site (Carlos Casares). We are calibrating and evaluating DAYCENT (CITA) to use it as complex ES production function.

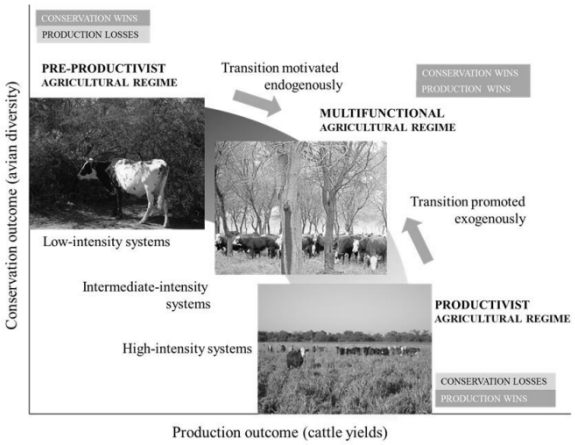

Figure 9. Socio-ecological trade-offs and desired transitions between agricultural regimes in Dry Chaco agricultural frontiers. Multifunctional agricultural regimes simultaneously provide high conservation and high production outcomes. A transition from pre-productivist to multifunctional regimes is motivated endogenously due to the willingness of pre-productivist landholders to intensify some portions of their landholdings. In contrast, a transition from productivist to multifunctional regimes should be promoted exogenously through incentives and regulations as productivist landholders are not willing to conserve forests

d) Tradeoffs among ES provision and stakeholder attitude toward conservation.

Agricultural intensification in rural areas of developing countries compromises the provision of ecosystem services. Social conflict arises among landholders with different preferences for ecosystem services and land-use practices in agricultural frontiers of the Argentine Dry Chaco. Mastrangelo et al. (in revison) explored policy and management options by assessing the actual and potential outcomes of alternative land-use systems and

scenarios. A efficiency frontier for avian habitat and agricultural productivity was constructed to analyze the combinations of ecosystem services that can be achieved under different land-use intensities (Figure 9). A non-linear, concave efficiency frontier indicated opportunities to achieve large gains for production with small losses for conservation, for instance, by transitioning from low- to intermediate-intensity systems. Second, the production and conservation outcomes that can be achieved through the implementation of five alternative policy options were projected. The land-sharing with conservation scenario (70% of the landscape covered by intermediate-intensity systems and 30% by undisturbed forests) yielded the higher combination of avian habitat and agricultural productivity. Third, indifference curves of three landholder groups (pre-productivist, multifunctional and productivist) were constructed by assessing their intentions (proxies for preferences) to conserve and convert remnant forests in their landholdings. Multifunctional landholders showed balanced preferences for conserving and converting forests in their landholdings, and maintaining intermediate-intensity systems. A general willingness to conserve forests co-existed in pre-productivist landholders with the intention to clear some portions of the landholding and intensify land-use, indicating the potential of an endogenously motivated transition towards a multifunctional regime. Such transition may increase their productivity by 35-65% without compromising avian habitat. Productivist landholders showed a strong inclination towards converting forests for pasture cultivation, despite the observation that they can increase their conservation outcomes by 30-50% without significantly reducing productivity by transitioning towards a multifunctional regime. Promoting this transition will require exogenous incentives and regulations tailored to the behaviour of this landholder group.

e) Human Appropiation of Net Primary Production

HANPP is an aggregated indicator that reflects both the amount of area used by humans and the intensity of land use (Haberl et al., 2007), HANPP analysis made a characterization of this attribute at regional level (see i.e. Rueda et al. 2011 as result of a previous CRN project). In this project we started the characterization at the farm/ranch level on different sites across the regions, by applying the same protocol on at least 10 of the selected sites. The process involve the description of land uses at the farm/ranch level, to define a reference land cover and to characterize, based on remotely sensed data the NPP of each individual paddock. The harvested PPN will be derived from records or estimates of crop yield, timber or charcoal production and stock densities. The analyses would be performed on at least two contrasting groups of stakeholders. So far we completed the data collection for two groups of ranchers in the Flooding Pampa in Argentina differing in technological resources and capital availability. We are staring the same process in an area of Sierras del Este, Treinta y Tres, Uruguay.

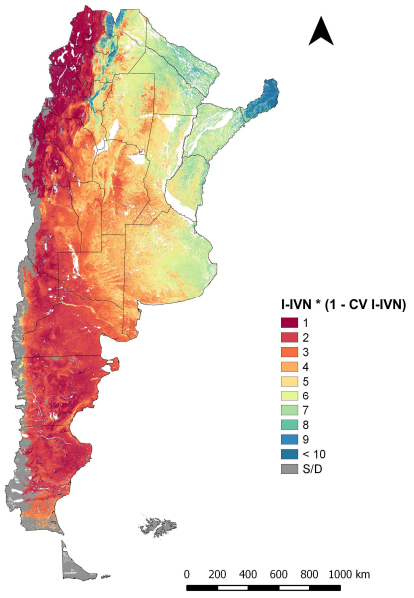

Figure 10. Average value for the period 2000-2013 of the producto of NDVI-I x (1-CVNDVI). Data were derived from the NDVI 1x1 km product of MODIS.

f) Integration

f.1. ***Mapping ES.***

During the first year aside from the analyses on each site we started to develop some synoptic view of the level of provision of ES using the general scheme of production functions proposed by Viglizzo et al. (2011). The basic idea proposed by Viglizzo et al. is that several provision and regulation services included as Intermediate Services depend on two key ecosystem functional variables: annual net primary production and the seasonality of C gains. In Paruelo and Vallejos and in Paruelo et al. (in press) we formalize the methodological approach to estimate several Final Ecosystem Services from data provided by the MODIS on board of the TERRA satellite. We are characterizing the changes in the two functional attributes for the last 14 years from the annual integral of the NDVI and the intra-annual CV of NDVI in a joint project with Fundación Vida Silvestre Argentina and INIA and the MGAP in Uruguay. Figure 10 present the average for the period 2000-2013 of the product of NDVI-I x (1-CVNDVI), our integrative estimator of Intermediate ES provision, for Argentina. Values need to be refered to either a temporal or spatial resolution. In such a way the evaluation of changes in the level of provision need to be based on temporal trends of this index or in the comparison with reference sites (the national network of protected areas, for example). We will extend the analysis to the sites in Chile, Paraguay and México.

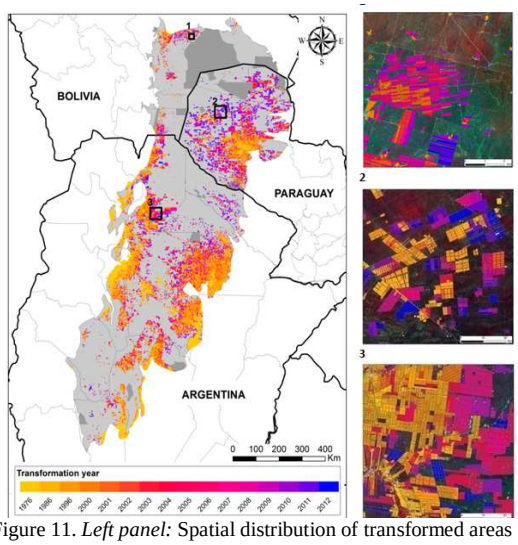

Figure 11. *Left panel:* Spatial distribution of transformed areas from 1976 to 2012 in the South American Dry Chaco ecoregion. Darker gray color corresponds to protected areas inside the region. *Right panel:* Detail of the transformed plots in three zones from Bolivia (1), Paraguay (2) and Argentina (3). From Vallejos (in press)

f.2. **A *review of different methodological approaches to map ES***.

ES mapping literature shows a diversity of methodological approaches which adequacy and consistence has been criticized. To evaluate such approaches is a critical point to asses the suitability of mapping options as tools for decision makers and land use planning. In a on going project lead by Laura Nahuelhual and Pedro Laterra, we analyzed published articles regarding: i) the correspondence between the goal of mapping ES and the procedures used and ii) the consistence of the methodological procedures (Nahuelhual et al. in revision.).

Activity4.3: Land use / land cover dynamics: Our goal is to characterize land cover land use dynamics over the different regions and sites. We made some important progress:

1) We just finish a database of the deforested areas of the whole South American Chaco (Vallejos et al. in press) in a collaboration with INTA and REDAF. The database cover an area of 787.000 km2 and span over almost 40 years (1976-2013) and it was generated by visual interpretation of individual LANDSAT images (Figure 11). This is a critical piece of information for further analyses and from BEST-P we are putting these data available for

the whole community. We already set a site to share the database (http://monitoreodesmonte.com.ar/).

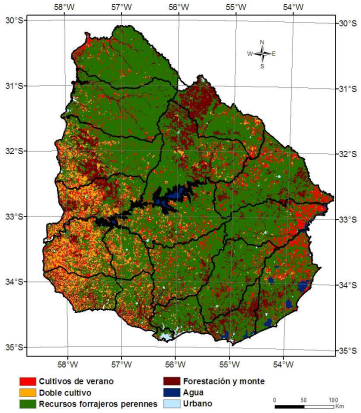

Figura 12: LULC map of Uruguay based on the classification of time series of MODIS-NDVI and regression trees

2) We made an exhaustive search and comparison of the available land cover maps for the area (see bestp.agro.uba.ar/sites)

3) Based on a protocol developed by the group we generated two land cover/land uses maps. The protocol is based on the identification of phenological signatures of the different land cover. Phenological signatures are based on the field identification of covers and the ananlysis of time series of either NDVI or EVI data provided by MODIS.

One of the maps was generated for Uruguay with a spatial resolution of 250x250 m (Baeza et al. in press) . In this case we performed decision tree classifications using phenological information derived of NDVI-MODIS time series (period: May 2011-March 2012), field data (more than 2400 plots), and high spatial resolution images (Landsat) to identify "pure" agricultural lots (belonging to a single land use /land cover class). 1.7x107 hectares were classified, discriminating 4 major categories: Perennial forage resources, Afforestation and forest, Summer crops and Winter-Summer crops; these occupied respectively 63.6, 13.1, 14.3 and 7.4% of mapped area (Figure 13).

The other maps were generated for the whole area with a resolution of 1x1 km. Such maps focused only on agricultural areas and the conceptual resolution include winter,

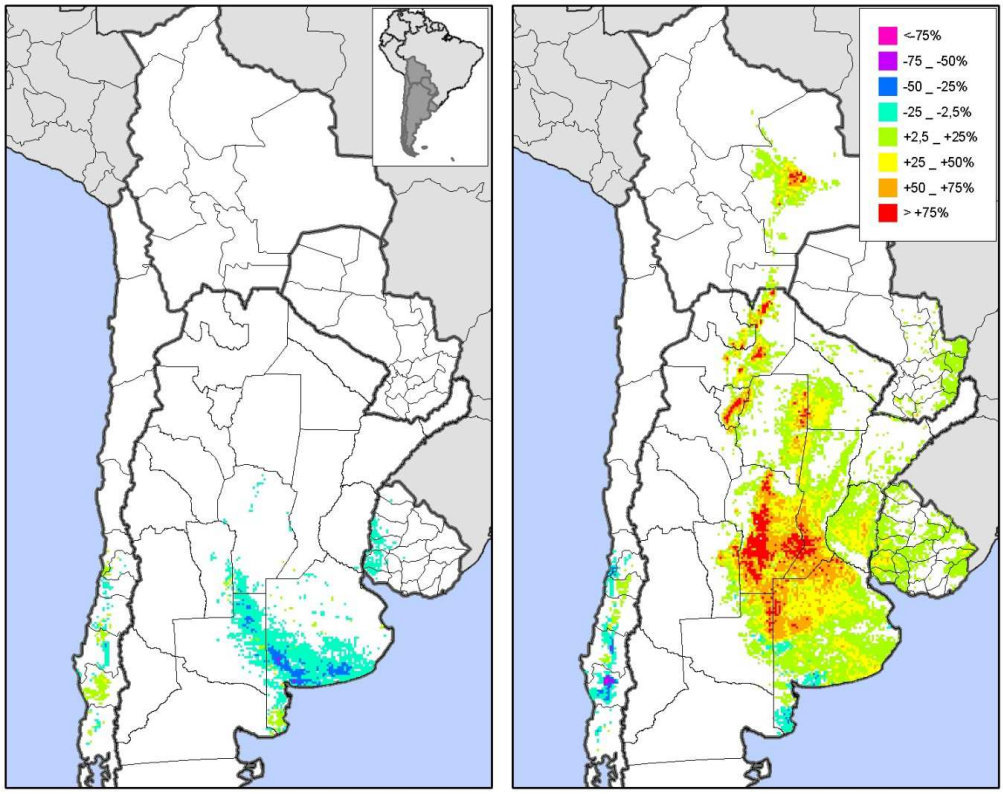

Figure 13. Maps of change in the % of the crop areas in cells of 10.000 ha betwwn 2000/01 and 2010/11 (cropped area in 2010/11 - cropped area in 2000/01) / 10.000 ha. Left: winter crops, Right summer crops.

summer and double crops (Volante et al. in press). In this case maps were produced for two periods (2000 and 2010) in other to track changes during a period of great agricultural expansion and intensification (Figure 13)

Activity 4.4: Stakeholders analyses and Governance systems (Obj. 1 to 3).

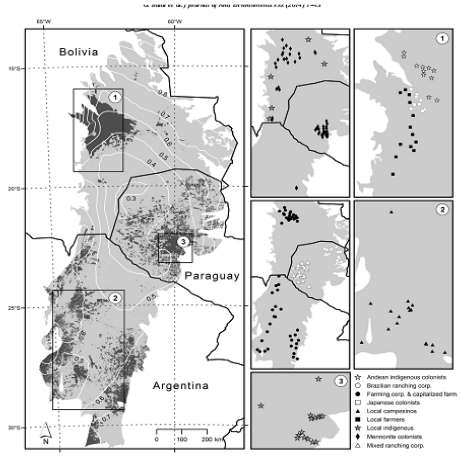

Figure 14. Left panel in light gray, Dry Chaco and in dark gray, agricultural areas (crops and pastures) in March 2013. In the detailed maps, different symbols indicate sample sites of agricultural land users. Due to their reduced size, local indigenous samples in Bolivia were characterized only for their landscape patterns. White lines represent constant values of water availability (PPT:PET).

a. ***Regional Analysis***. The analysis of the stakeholders in BESTP started from a regional study over the whole Chaco region (Baldi et al. in press) Although typically associated to a homogeneous agribusiness system, agriculture and its expansion in this territory involve a diverse array of land users. The study recognized 14 groups of land users of local or foreign origin, composed by individuals or corporative **organizations,**

and dedicated either to pasture or crop production, or its combination (Figure 14). These groups displayed a wide variation in the scale of their operations as suggested by a 60-fold difference in paddock sizes. Moreover, , in this study we connected the description of the social composition of the productive systems with the biophysical component. Twelve years of MODIS-NDVI data showed small and non-significant differences in the magnitude of primary productivity (1.2-fold difference) but strong contrasts in its seasonality and long-term variability, including shifts in the rates of vegetation greening and browning (up to 4-fold differences), growing period length (193 to 278 days y^{-1}), number of cultivation seasons per year (1-1.75), and inter-annual coefficient of variation (up to 0.13). The agricultural system of capitalized groups was characterized by very large paddocks, less stable productivity patterns, and more divergent seasonality. Instead, all smallholders showed more stable productivities both seasonally and inter-annually. Deforestation and cultivation in these dry regions do not have a single imprint on landscapes configuration and primary production dynamics, but one that shifts depending on the human and productive context under which they take place.

b. ***Local studies.*** At a different scale (local instead of regional) we performed an analysis of ES perception in sites of three regions under study. Those studies are conducted by investigators of the different groups with the advice of Dr. Filardo from the College of Social Sciences of UdelaR in Montevideo.

In order to assess the values of different ecosystem services from farmers of the Argentinean Chaco, a set of social research tools were developed and applied, through personal interviews to farms of Almirante Brown county (Chaco province), and Copo county (Santiago del Estero province). Mastrangelo et al. (in revision) classified landholders in the Bermejo-Pilcomayo Interfluve (i.e., an agricultural frontier landscape in the Argentine Dry Chaco) into one of three stakeholder groups characterized by an underlying agricultural regime. The first cluster was associated with a pre-productivist agricultural regime as landholders identified themselves as stewards of the land. This identity has been built up over a long time of residence in these landscapes and as a result of strong feedback interactions between the social and ecological local systems. Pre-productivist landholders of the Chaco developed a land-use system of low intensity and productivity known as “puesto”. Raising small livestock and cattle in puestos relied on the natural forage productivity of ecosystems and provided the subsistence base of households.

The second cluster was associated with a multifunctional agricultural regime because landholders showed a co-existence of production and conservation-oriented actions and thoughts. Multifunctional landholders were mostly from within the Chaco region, and developed land-use systems combining elements of the native ecosystem and advances in modern agricultural technologies, for instance, silvopastoral systems integrating shade and forage trees and high-yielding pastures. The third cluster was associated with a productivist agricultural regime as they showed a strong attitude towards the intensification and expansion of an industrial mode of agriculture, to maximize production and economic output. Most productivist landholders arrived to the Chaco in the last two decades from the Pampas region. They deployed land-use systems based on the total clearing of the native ecosystem for the cultivation of high-yielding pastures or crops on cleared areas. The strategy of productivist landholders was based on a tight connection with international markets of land and agricultural inputs and outputs. There was a close relationship between

the psycho-social characteristics of landholder types and the level of land-use intensity of their landholdings, as indicated by the short distance between landholdings of the same typology in the trade-off space (Figure 9).

To obtain information and to analyze the relationships among landscape dynamics, livelihoods, and perception of the importance of some cultural ecosystem services (cultural heritage and sense of place) along agriculturization processes, different methodological procedures were selected and adjusted. Personal interviews were conducted to different social actors in the Mar Chiquita (Buenos Aires province, Argentina) case study. Preliminarily, it is interesting to note that changes are differently valued by different actors, independently from their perception of these changes.

Figure 14. Interviews on ES peception at the Quebrada de los Cuervos

In Sierras del Este (Treinta y Tres, Uruguay) and as part of an undergraduate thesis partially supported by BEST-P (Bindritsch 2014) we conducted a survey based on interviews to populations with a different bond with nature (ranchers and rural workers, people living in rural towns (Isla Patrulla), a small city (Treinta y Tres) and Montevideo). This study had the support and collaboration of two key stakeholders: the Sistema Nacional de Areas Protegidas (SNAP) and a local ranchers association, the Cooperativa de Productores de Quebrada de los Cuervos.

As part of his PhD dissertation Maria Fernanda de Torres (a BEST-P fellowship carried on an etnographic study of ranching in Northern Uruguay. The study try to understand the relationship between the different social components of the socio-ecological systems that have as core activity livestock production as well as the direct and indirect benefits provided by native grasslands. The first analysis focused on the area around Rivera.

Figure 15. Participatory mapping with CEAM and Bosque Modelo Panguipulli

In the study area of Panguipulli, Los Ríos Region, Chile, BEST-P a significant group of stakeholders (10 institutions and community organizations) represented under Bosque Modelo Panguipulli (BMP) supported the implementation of the project in this study area (Figure 15). The research activities began in January 2014 with an study (graduate thesis supported by BESP-P) aimed at the participatory identification and assessment of ES. Stakeholders identified food provision, water provision, provision of fibers, pollination, pest control, cultural identity and sense of place, and recreation opportunities as the most relevant ES .With these ES identified, three other students supported by BESTP started to analyze the perceptions of stakeholders regarding water provision using the socioecological system's framework (Master of Rural Development; Carol Perugache), the governance of water provision as an ES (Master of Ecological Economics and Human Scale Development; Felipe Hasen), and the spatial assessment (mapping) of recreation opportunities values using participatory techniques (Undergraduate, Natural Resources Conservation Engineering; Felipe Benra). A doctoral thesis is also ongoing (Forest Sciences Program; G. Ignacio Díaz), aimed at the identification of the social value of cultural ES in Panguipulli.

c. ***A common framework to map stakeholders and to characterize social capital***

We held two internal workshops aimed at defining a protocol to characterize social capital at the different sites of BEST-P. Workshops were led by Verónica Filardo and Virginia Rossi of UdelaR and included the participation of investigators and graduate students linked to the South American sites. Based on the protocols developed we are engaged in building stakeholders maps in 10 of the BEST-P sites. From these maps we will measure the social capital of those groups identified as the most vulnerable with regard to LULC changes.

Activity 4.5: Professional training program (Obj. 5).

As part of the development of a training program for professionals, we completed a book on Rural Land Use Planning. The final draft of the book (edited by three of the coPIs of BEST-P and with the participation of several investigators and graduate students as authors of different chapters) is being currently editing by the regional office of FAO. BEST-P, contributed with funding to hold a workshop where we discussed the structure of the book. Likewise, the conceptual frameworks and the preliminary results from BEST-P made a substantial contribution to the book. The final draft of the book is available at the page of BEST-P (http://bestp.agro.uba.ar/publications-from-bestp/; http://bestp.agro.uba.ar/wp-content/uploads/2014/09/OTR_completo_0906.pdf)

Activity 4.6: Restoration of ES

We plan to conduct research on restoration of ES in the three regions of BEST-P. The synthesis of the restoration experiences in the Valdivian Forests will start in the second year. During the first year we started two ambitious projects in both the Chaco region and the Rio de la Plata grasslands.

In the Chaco region and as part of a PhD thesis (María Basualdo) we have identified (using the deforestation database built, see above) 45 plots that were cleared, cropped for a given period and abandoned. The plots selected were located by a patch of forest non - cleared (since 1976) and a patch cropped. We defined then "triplets" of non-cleared forest-succesional forests and crops. All the selected triplets are being characterized using remotely sensed data in terms of their C gains dynamics. A subset of the plots (half in Salta and half in Santiago del Estero) are being sampled to record floristic composition, forest structure and soil characteristics (bulk density, SOC and SON). So far, the results showed that its is possible to substantially restore the structure and functioning of the forests in a decade.

In the Uruguayan part of the Rio de Plata grasslands the processes of restoration of ES is embedded in a program led by Alice Altesor with the partnership of MGAP, IPA and ranchers associations. The program, that just started, will defined State and Transitions for the main grassland communities of Uruguay from an exhaustive field sampling. The state of grasslands will be defined inductively from the field *releves* randomly located in each of grassland communities in areas that match MODIS pixels. Each state will be characterize in terms of intermediate services related to C and water dynamics from spectral data. The hypothesis on the transitions among states will be derived from a patch dynamics model of the grasslands that is under development. Based on the agreement with MGAP and rancher

association 10 adaptive management units will be set in commercial ranches to evaluate management alternatives to restore Final ES.

Activity 4.7 (Stakeholders training program) and Activity 4.8 (Outreach activities, Networks, Meetings and workshops).

a) Advances in natural grasslands management - Mesa de Campo Natural/MGAP (Uruguay). Seminars by Alice Altesor and José Paruelo for technicians and ranchers, Tacuarembó (28/10/2013), Treinta y Tres (25/11/2013).
Available at:
https://www.youtube.com/watch?v=J7Zl6Jh0aq8, https://www.youtube.com/watch?v=PSSiYR17sdw

b) Whiteboards on grasslands ES: M.Fernanda de Torres is leading the development of a series of short videos (aprox. 5-10 min) where the investigators of BEST-P will present different aspects related to the importance of grasslands as ES provider.

c) Participation in the Program "Ambiente y Memoria Social" of the Facultad de Agronomía UBA (http://ced.agro.uba.ar/gran-chaco/)

d) Seminar
Course “Sustainable cattle raising and management tools to value production and conservation of pampean grasslands”.
Title: “Ecosystem services: general framework and case studies in pampean grasslands”.
Speaker: Federico Weyland, Place and date: General Belgrano, 27th May 2014.
Course organized by INTA and FVSA for cattle rangers in natural grasslands. Attendance: aprox. 30.

Seminar for farmers of the cooperative association “Agricultores Federados Argentinos”.
Title: “Biodiversity refugres in pampean agroecosytems: concepts and ideas for their conservation”.
Speaker: Federico Weyland, Place and date: Rosario 23th September 2014.
Attendance: aprox. 50.

e) Contribution of several investigators of BEST-P (S. Baeza, F. Gallego, J. Paruelo, M. Oyarzabal) to the "Índice de Contribución a la Conservación de Pastizales Naturales del Cono Sur. Una herramienta al servicio de incentivos para productores rurales". This is an initiative of Alianza del Pastizal, a ONG working in Paraguay, Brazil, Uruguay and Argentina on integrating production and conservation in the Rio de la Plata Grasslands.

f) Daily weather forecast from the WRF-Noah model: www.atmos.umd.edu/~berbery/research/forecasts

4 Publications

Trabajos publicados y en prensa

- Magliano PN, Fernández, RF, Mercau, JL, Jobbágy, EG. Precipitation event distribution in central Argentina: spatial and temporal patterns. **Ecohydrology** (in press)

- Baldi G., Houspanossian J., Murray F., Rosales A. A., Rueda C.V. y E.G. Jobbágy. Cultivating the dry forests of South America: Diversity of land users and imprints on ecosystem functioning. **Journal of Arid Environments** (in press)

- Guido, A., R.D Varela, P. Baldassini & J.M. Paruelo. 2014. Spatial and Temporal Variability in Aboveground Net Primary Production of Uruguayan Grasslands. **Rangeland Ecology & Managment** 67:30–38

- Müller O., E. Berbery, D. Alcaraz-Segura, and M. Ek. 2014. Regional Model Simulations of the 2008 Drought in Southern South America Using a Consistent Set of Land Surface Properties. **Journal of Climate** 27: 6754–6778.

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- Gimenez R, Mercau JL, Houspanossian J, Jobbágy EG. Balancing agricultural and hydrological risk in farming systems of the Chaco plains. **Journal of Arid Environments**.

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- Nahuelhual, L., P. Laterra, A. Carmona, N. Burgos, A. Jaramillo, P. Barral, M. Mastrángelo, S. Villarino. Mapping of ecosystem services: missing links among what, how and what for. **Ecosystem Services journal** .*Under review - Submitted April 2014.*

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- Della Chiesa, T.; Yahdjian, L. Y Piñeiro, G. Emisiones de óxido nitroso de ecosistemas agrícolas y naturales de la región pampeana. Reunión Binacional Uruguay-Argentina de Agrometeorología y XV Reunión Argentina de Agrometeorología. Piriápolis, Uruguay. 01-03 de octubre de 2014.

- Berbery, E. H., K. Mo, O. Müller, and L. Sgroi, 2014: Large-Scale Dynamics and Regional Processes Affecting Droughts in Central Argentina. Second Int'l Congress of Hydrology of Plains, Santa Fe, Argentina, 23-26 September 2014.

- Müller O., E. Berbery, 2014. Routine Forecasting and Monitoring System for Agricultural and Hydrological Applications on La Plata Basin, 2° Congreso Internacional de Hidrología de Llanuras, Santa Fe, Argentina. 23 al 26 de Septiembre 2014.

- Sgroi, L. C., E. H. Berbery, 2014. Caracterización regional de sequías en la zona núcleo de cultivos de la República Argentina, 8 pp. 2° Congreso Internacional de Hidrología de Llanuras, Santa Fe, Argentina. 23 al 26 de Septiembre 2014.

- Nahuelhual, L., P. Barral, A. Carmona, P. Laterra. ECOSER mapping tool: from ecosystem functions to socio-ecological vulnerability. 7th Ecosystem Services Partnership (ESP) Conference, San José, Costa Rica. September 8 to 12, 2014.

- Nahuelhual L., P. Barral, A. Carmona, P. Laterra. ECOSER mapping tool: From ecosystem functions to socio-ecological vulnerability. Ecosystem Services Partnership (ESP) Conference, San José, Costa Rica. September 8 -12, 2014.

- Nahuelhual, L., P. Barral, A. Carmona, P. Laterra. Spatial uncoupling between ecosystem services and socio-ecological vulnerability. Ecosystem Services Partnership (ESP) Conference, San José, Costa Rica. September 8-12, 2014.

-Paez Bistrain, R., A. Flores Díaz, M. I. Ramírez y M. Ramos Escobedo. Water quality assessment in the Monarch Butterfly Biosphere Reserve, México: community-based monitoring and laboratory techniques. CARTEL. Ecosystem Services Partnership (ESP) Conference, San José, Costa Rica. September 8-12, 2014.

- Filardo, V.; Rossi, V. Desafíos metodológicos para el estudio de servicios ecosistemicos en América Latina. Ponencia. Presentada en IV Encuentro Latinoamericano de Metodología de las Ciencias Sociales (elmecs) Heredia, Costa Rica, 27-29 de agosto de 2014.
- Barrena J., L. Nahuelhual. Rethinking economic resilience to climate change: A proposed framework based on ecosystem services. ISEE 2014 Conference: Wellbeing and equity within planetary boundaries Reykjavik, Iceland. August 13-15, 2014

- Barral, M.P., Rey Benayas, J.M. y Maceira, N.O. Meta-análisis global del impacto de la restauración ecológica sobre la biodiversidad y los servicios ecosistémicos en agroecosistemas. III Congreso Internacional de los Servicios Ecosistémicos en los Neotrópicos. Medellín, Colombia, 6 - 9 October 2013.

- Barrena, J., Nahuelhual, L. Marco conceptual para el análisis de la resiliencia económica frente al cambio climático desde la perspectiva de los servicios ecosistémicos. 3er Congreso Internacional de Servicios Ecosistémicos en los Neotrópicos.October 7-11, 2013. Medellín, Colombia.

- Burgos, N., Nahuelhual, L., Laterra, P., Aguayo, M., Carmona, A. Aproximación Metodológica para la Evaluación y Mapeo de la Vulnerabilidad Socioecológica de servicios ecosistémicos. El caso de los Bosques Nativos en Chiloé, sur de Chile. III Congreso

Internacional de Servicios Ecosistémicos en los Neotrópicos. 7-11 October 2013. Medellín, Colombia.

- Carmona, A., L. Nahuelhual, P. Laterra. Protocolo de mapeo de vulnerabilidad al cambio climático. Un enfoque desde los servicios ecosistémicos. III Congreso Internacional de Servicios Ecosistémicos en los Neotrópicos. 7-11 de October 2013. Medellín, Colombia.

- Díaz, I., Nahuelhual, L. Dinámicas de cambio espacio temporales sobre el paisaje y sus implicancias para la provisión de servicios ecosistémicos. 3er Congreso Internacional de Servicios Ecosistémicos en los Neotrópicos. October 7-11, 2013. Medellín, Colombia.

- Jaramillo A., Nahuelhual L., Oyarzún C., Aguayo M. Cuantificación y modelación del servicio ecosistémico de provisión y regulación hídrica bajo diferentes escenarios de uso de suelo: caso de estudio en el sur de Chile. 3er Congreso Internacional de Servicios Ecosistémicos en los Neotrópicos. October 7-11, 2013. Medellín, Colombia.

- Mastrangelo, M. E., Weyland, F., Villarino, S. H., Barral, M. P., Laterra, P., Nahuelhual, L. (2013) Divergencia conceptual y metodológica en torno a la multifuncionalidad del paisaje: Propuesta de un marco unificador basado en los servicios ecosistémicos. Tercer Congreso Internacional de Servicios Ecosistémicos en el Neotrópico, Medellín, Colombia, 6 al 9 de octubre de 2013.

- Nahuelhual, L., Carmona, A., Laterra, P., Barrena, J., Aguayo, M. Mapping flows and benefits derived from cultural ecosystem services: agricultural heritage in Chiloé Island, Southern Chile. 3er Congreso Internacional de Servicios Ecosistémicos en los Neotrópicos. October7-11, 2013. Medellín, Colombia.

- Vallejos, M. y J.M. Paruelo. Servicios ecosistémicos relacionados a la dinámica de carbono: evaluación mediante el uso de sensores remotos. 3er Congreso Nacional de los Servicios Ecosistémicos en los Neotrópicos. 7 al 11 de octubre de 2013. Medellín, Colombia.

- Weyland, F., S.H. Villarino, P. Laterra. Zonas de conflicto potencial entre servicios ecosistémicos de provisión de alimentos y potencial recreativo en Argentina. III Congreso Internacional de los Servicios Ecosistémicos en los Neotrópicos. Medellín, Colombia, 6 - 9 October 2013.

- Berbery, E. H., K. Mo and O. V. Müller, 2013. Droughts in Southern South America: Large-Scale Dynamics and Regional Processes. Joint Conference of the 11th AsiaFlux Int'l Workshop, the 3rd HESSS, and 14th Annual Meeting of KSAFM "Communicating Science to Society: Coping with Climate Extremes for Resilient Ecological-Societal Systems", Seoul, Korea, 21-24 August 2013

- Mastrangelo, M. E., Gavin, M. C., Laterra, P., Linklater, W. L., Milfont, T. L. (2013) Understanding and influencing landholders´ options for conserving dry Chaco forests at the agricultural frontier. International Congress for Conservation Biology, Baltimore (USA), 21 y el 25 de Julio de 2013.

Invited conferences

- Jobbágy EG. 2014. ¿Hay lugar para las Salicáceas en la Pampa? Revision de los incentivos ecológicos. Jornada de Salicaceas, 19 al 21 de marzo, La Plata, Buenos Aires, Argentina.

- Jobbágy EG. 2014. Sales en la llanura: Su control por el clima, la topografía, la vegetación y el manejo. Congreso de la Red Argentina de Salinidad. Argentina.

- Laterra, P. ECOSER y VESPLAN: Dos iniciativas para mejorar la incidencia del enfoque de servicios ecosistémicos en la región. LAC Regional Consultation Meeting del IPBS (Intergovernamental Platform on Biodiversity and Ecosystem Services). 11 - 13 July, 2013, Sao Paulo, Brazil, Organizado por la Sao Paulo Research Foundation (FAPESP) y el UNEP**.**

- Laterra, P. Evaluación y mapeo de servicios ecosistémicos: Retos para la gestión territorial en América Latina. Simposio Internacional Valoración Integral de la Biodiversidad y los servicios ecosistémicos. Instituto de Investigación en Recursos Biológicos Alexander von Humboldt. Bogotá, Colombia, 22-23 de mayo de 2013.

- Paruelo J.M. New agricultural models, some old problems. Agriculture and the integrity of Socio-Ecological Systems. WCRP Conference for Latin America and the Caribbean: Developing, linking and applying climate knowledge. Montevideo, Uruguay. March 17-21, 2014.

Berbery, E. H., K. Mo and O. V. Müller, 2013:Droughts in Southern South America: Large-Scale Dynamics and Regional Processes.**Joint Conference of the 11th AsiaFlux Int'l Workshop, the 3rd HESSS, and 14th Annual Meeting of KSAFM "Communicating Science to Society: Coping with Climate Extremes for Resilient Ecological-Societal Systems"**, Seoul, Korea, 21-24 August 2013

Berbery, E. H., K. Mo, O. Müller, and L. Sgroi, 2014: Large-Scale Dynamics and Regional Processes Affecting Droughts in Central Argentina. **Second Int'l Congress of Hydrology of Plains**, Santa Fe, Argentina, 23-26 September 2014.

Berbery, E. H., 2014: Land cover change effects on South American regional climate. **Ninth International Congress of the Spanish Association of Climatology**, Almeria, Spain, 28-30 October 2014.

5. Data

a) A database on deforestation for the whole Semi-arid Chaco of South America is available at http://monitoreodesmonte.com.ar/

b) Data base of 139 experts in ecosystem functions and ecosystem services for the four studied ecoregions.

c) Data base of values assigned to 12 ecosystem services by farmers of 89 Dry Chaco farms.

d) Database on published papers on ecosystem services assessment and mapping from 1997 to 2013. List and classification according to different criteria, with focus on mapping procedures.

e) Outputs of the WRF-Noah climatic forecast model since July 2012. The variable included are temperature, atmospheric pressure, soil water content, runoff and precipitation and heat fluxes.

6 Capacity Building

a. Workshop with a key presence of BEST-P members

- Mainstreaming ES assessment and application in Latin America. A session with 20 presentations organized by Pedro Laterra and Antonio Lara at the 7th Conference of the Ecosystem Services Partnership. September 9, 2014.

- Servicios ecosistémicos: un marco conceptual para la valoración y el manejo de los ecosistemas para asegurar el bienestar humano. Round table coordinated by Federico Weyland with four presentations held at the XXVI Reunión Argentina de Ecología, Comodoro Rivadavia, Argentina, 2-5 november 2014.

- "Seminario sobre indicadores de sustentabilidad de la bioenergía en Argentina". Participación en la mesa de evaluación de la presentación de resultados preliminares. Buenos Aires 4 y 5 de septiembre de 2014, Hotel Aspen. Ministerio de Agricultura Ganadería y Pesca, GBEP, BID, UCAR. Santiago R. Verón

- Foro sobre Servicios Ecosistémicos en Uruguay. Agosto-Octubre 2014. Montevideo. IICA-Proyecto EUROCLIMA y Ministerios de Ganadería, Agricultura y Pesca (MGAP) y de Vivienda, Ordenamiento Territorial y Medio Ambiente (MVOTMA). Funcionarios de organismos gubernamentales de Uruguay con competencia en los Recursos Naturales participaron activamente del Foro. Conocer el estado del arte respecto a los servicios ecosistémicos y marcos conceptuales utilizados para su caracterización e investigación en Uruguay, así como identificar las acciones y los desafíos para la incorporación del enfoque de servicios ecosistémicos en la gestión y la toma de decisiones, eran los objetivos perseguidos por el evento. BEST-P tuvo un papel destacado a partir de dos conferencias invitadas:
  - Ecosistemas de pastizales y sus servicios ecosistémicos asociados. Dra. Alice Altesor. Grupo Ecología de Pastizales. Facultad de Ciencias. Universidad de la República (UdelaR).
  - Valoración de SE. Es necesario hablar de dinero?. Dr. José Paruelo. LART/IFEVA. FAUBA.

b. Partnership with public and private organizations

<u>Bosque ModeloPanguipulli (BMP)</u>

Our work in Panguipulli has been supported by a working alliance with BMP, which is a public-private organization that includes among others, the Municipality of Panguipulli, the National Forestry Corporation of Chile (CONAF), the Forest Institute (INFOR), and the indigenous (Mapuche) organization Parlamento de Coz-Coz. Through the development of undergraduate and graduate thesis, we are applying the ES approach in Panguipulli with the purpose of orienting territorial planning and conservation, by both public institutions and local actors. The alliance with BMP has been crucial for the validation of our work in Panguipulli and our research is responding fully to their territorial demands.

Red Agroforestal Argentina. We had an agreement with REDAF to built a deforestation database that will be use (among other thinks) on supporting the demand of peasants and aboriginal communities in the Chaco. The database is also a key product of BEST-P (see monitoredesmonte.com.ar). The partnership with REDAF substantially expand the impact of BEST-P activities in the Chaco region due to the strong bonds of this network of ONGs and loval Universities with local stakeholders.

Fundación Vida Silvestre Argentina. As part of an effort to evaluate the environmental situation of Argentina FVSA is contributing to the activity f.1. Mapping ES (see above). FVSA will be in charge of the distribution of the information both to the general public and policy makers.

c. Advice to policy makers

Ministry of Environment Chile (MMA for its initials in Spanish)
We have a working agenda with the department of Environmental Economics of MMA based on the following themes: 1. Ecosystem services indicators 2. Ecosystem services for ecosystem accounts and 3. Mapping and valuation of ecosystem services in Chile. We have had meetings with professionals of the MMA to agree a working agenda which aims at main streaming ES in public policy. One of the main targets of the MMA policy is to assess the gap between the information required to construct ES indicators and the available information in Chile.

Board of Livestock on Natural Grasslands
The Board of Livestock on Natural Grasslands, is an institution created by the Ministry of Livestock, Agriculture and Fisheries (MGAP) of Uruguay in 2012, and it is comprised by delegates of: Plan Agropecuario (National Agriculture Extension Service), Directorate of Natural Resources (RENARE-MGAP) and Directorate or Rural Development (DGDR-MGAP), National Agriculture Research Institute (INIA), Uruguayan Secretariat for Wool (SUL), College of Agriculture and College of Sciences of the University of the Republic (UDELAR). It is an inter-institutional body which aims to facilitate coordination and discussion of public policy on livestock on natural grasslands. One of the goals of the Board is to "analyze different strategies for conservation of natural grasslands, including regulatory aspects under the framework of ecosystem services". Alice Altesor is an active member of the board and who is leading the processes of incorporating the ES framework into policies for the sector.

c. ***Internal BEST-P Meetings***

- Taller sobre aspectos metodológicos de la caracterización de actores en el marco del proyecto BEST-P. 12 de Abril de 2013 – Facultad de Agronomía UBA, Buenos Aires.

- Reunión coPIs – 22 de Octubre de 2013

- Taller para la definición de Sitios de estudio de BEST-P, elaboración de proyectos transversales y definición de aproximaciones metodológicas para la cuantificación de SE y caracterización del capital social. 11 y 12 de Diciembre de 2013 – Facultad de Agornomía UBA, Buenos Aires.

- Taller BEST-P sobre Capital Social. 29 de Mayo de 2014 – Facultad de Ciencias Sociales UDELAR, Montevideo. FILARDO, Verónica, ROSSI, Virginia. Documento de trabajo: "Notas sobre el Capital Social". http://bestp.agro.uba.ar/wp-content/uploads/2014/09/Seminario_CAPITAL_SOCIAL_def_29de_mayo_sin_Q.pdf

- Taller BEST-P sobre Mapas de actores. 26 de julio de 2014- Facultad de Ciencias Sociales- UDELAR Montevideo. AUER, Alejandra, FILARDO, Verónica, ROSSI, Virginia. Documento de trabajo "Notas sobre Mapeo de Actores". http://bestp.agro.uba.ar/wp-content/uploads/2014/09/Seminario_Mapa_de_actores_16-7-2014.pdf

d. Academic training

Students working on the project

Name of Student	***Institution***	***Degree***	***Supervisor***	***Theme/ Project title***
María Vallejos	LART/IFEVA - CONICET/FAUBA	PhD	J.M. Paruelo	Cuantificación de Servicios Ecosistémicos en los Bosques Xerofíticos Chaqueños y su aplicación en procesos de Ordenamiento Territorial Rural.
Laura Amdan	LART/IFEVA - CONICET/FAUBA	PhD	J.M. Paruelo	Procesos de recarga y salinización como consecuencia del desmonte en planicies del Chaco Semiárido.
Pablo Baldassini	LART/IFEVA - CONICET/FAUBA	MSc	J.M. Paruelo	Impacto de los cambios en el uso del suelo sobre la dinámica del carbono en la región chaqueña semiárida
María Basualdo	LART/IFEVA - CONICET/FAUBA	PhD	G. Piñeiro	Recuperación estructural y funcional durante la sucesión secundaria postagrícola en bosques del chaco semiárido
Hernán Dieguez	LART/IFEVA - CONICET/FAUBA	PhD	J.M. Paruelo	Efectos de los cambios globales sobre el funcionamiento de los ecosistemas de Sudamérica: Un análisis basado en técnicas dendroecológicas y de teledetección
Camilo Bagnato	LART/IFEVA - CONICET/FAUBA	PhD	J.M. Paruelo, E. Jobbágy	Cambios en el uso del suelo y su efecto sobre la estructura, funcionamiento y provisión de serviciose cosistémicos en el Chaco Semiáridos y los Pastizales del Río de la Plata.
Sebastian Aguiar	LART/IFEVA - CONICET/FAUBA	PhD	J.M. Paruelo, E. Jobbágy	Cambios globales en la producción y consumo de alimentos y su efecto sobre el uso de la tierra en el sur de Sudamérica-
Jose Volante	INTA Salta	PhD	J.M. Paruelo	Dinámica y consecuencias del cambio en la cobertura y el uso del suelo en el Chaco Semi-Árido
Lisandro Blanco	INTA Chamical	PhD	J.M. Paruelo	Estimation of herbaceous forage based NDVI MODIS data in an Argentinean woody dominated ecosystem
Costanza Caride	LART/IFEVA - CONICET/FAUBA		J.M. Paruelo	

Raul Gimenez	GEA- IMASL	PhD	E. Jobbágy	Agricultura en el gran Chaco: Evaluacion conjunta de riesgo hidrologico y productivo bajo distintos sistemas de cultivo
Eva Florio	GEA- IMASL	PhD	E. Jobbágy	Respuesta del cultivo de maiz a la influencia freatica en el Oeste de la region pampeana
Francisco Murray	GEA- IMASL	PhD	E. Jobbágy	Comparacion de usos extensivos, pasturiles y agricolas del territorio a lo largo de gradientes de precipitacion
Carla Rueda	GEA- IMASL	PhD	E. Jobbágy	Apropiacion humana de la produccion primaria en el Chaco Seco
Patricio Magliano	GEA- IMASL	PhD	E. Jobbágy	Vias superficiales de perdidas superficiales de agua en bosques y pasturas semiaridas
Santiago Baeza	Fac. Agronomía - UDELAR	PhD	A. Altesor, J.M Paruelo	Caracterización del uso/cobertura del suelo en Uruguay y la Cuenca del Río de la Plata y análisis de los sistemas arbustivos
Federico Gallego	Facultad de Ciencias-UDELAR	PhD	A. Altesor	Servicios ecosistémicos del pastizal: el seguimiento de un área protegida como sistemas de referencia
Paula Barral	UNdeMdelP	PhD	Nestor Maceira/ Pedro Laterra	Desarrollo y perfeccionamiento del protocolo de evaluacion y mapeo de SE ECOSER
Sebastian Villarino	UNdeMdelP	PhD	Guillermo Studdert /Pedro Laterra	Funciones de producción ecológica del contenido de MO del suelo
Alejandra Auer	UNdeMdelP y Universidad Austral	PhD	Néstor Maceira/L. Nahuelhual	Influencia del tipo de actores sobre la percepción de la pérdida de SE culturales por agriculturización
Omar Müller	University of Maryland	PhD	H. Berbery	Sistema de pronosticos hidrometeorologicos y su sensibilidad a los cambios de uso de suelo
Leandro Sgroi	University of Maryland	PhD	H. Berbery	Modelación de variables hidroclimáticas de superfice y evolución de su comportamiento en eventos extremos
Claudia Tapia Friz	Universidad Austral	MSc	L. Nahuelhual, G. Blanco V. Filardo	Scoping ecosystem services with local stakeholders: a participatory approach in panguipulli
Carol Perugache Rodríguez	Universidad Austral	MSc	L. Nahuelhual, J. Barrena, V. Filardo, G. Saavedra	Applying the socioecological system approach to the assessment of ecosystem services: A case study in Panguipulli
Felipe Hasen	Universidad Austral	MSc	L. Nahuelhual, J. Barrena, V. Filardo	Local governance of ecosystem services: a case study for water provision in Panguipulli, Chile
Felipe Benra	Universidad Austral	Ing.	L. Nahuelhual, A. Carmona, I. Díaz	Mapping the value of natural capital in the provision of recreation opportunities: a participatory approach with local stakeholder and planners
G. Ignacio Díaz	Universidad Austral	PhD	L. Nahuelhual, P. Laterra, A. Lara	Linking natural capital, cultural services and social values: a case study in Panguipulli, Chile
José Barrena	Universidad Austral	PhD	L. Hein, L. Nahuelhual	To be defined
Andrea geymonat	Facultad de Ciencias - UDELAR	MSc	A.Altesor	To be defined
Claudia Martínez	Facultad de Ciencias – UDELAR	Undegrad thesis	A.Altesor	Apropiación humana de la PPN
Daniel Villarroel	FAUBA	Undergrad	S. Verón, D. Abelleyra	Cuantificación de la energía liberada por fuegos de vegetación en el Gran Chaco: Análisis del patrón espacial de la energía disipada por fuegos

Torrez		thesis		agrícolas, de desmonte y naturales
Gonzalo Camba Sans	FAUBA	Undergrad thesis	J.M. Paruelo	Avance de la frontera agropecuaria y su relación con la ley de bosques en Santiago del Estero
Fabio Trinco	FAUBA	Undergrad thesis	M. Román, J. Paruelo	Apropiación humana de la PPN en pastizales pampeanos
Luciana Bindritsch	UDELAR	Lic.Cs. Biológicas	A. Altesor	Estudio sobre la percepción de la población de Isla Patrulla, Treinta y Tres, acerca de los servicios ecosistémicos del pastizal y efectos de distintos usos del suelo

7 Regional Collaboration/Networking

a) Red Temática "Vulnerabilidad, Servicios Ecosistémicos y Planeamiento del Territorio Rural" (VESPLAN, Red 413RT0472). 2013-2016
PI: Pedro Laterra
Funding source: Iberoamericano de Ciencia y Tecnología para el Desarrollo, CYTED

b) Red para la medición de emisiones de oxido nitroso en cultivos agrícolas de Argentina. 2013-2014. ($1.300.000). PI: Gervasio Piñeiro. Convenio de Asistencia Técnica FAUBA-el Ministerio de agricultura, ganadería y pesca, Argentina.
Participantes.1) Grupo del IFEVA/FAUBA. Gervasio Piñeiro, Tomas Della Chiesa, Laura Yadhjian, Constanza Caride, JoseParuelo
2) Grupo FAUBA-INTA Castelar. Alejandro Costantini, Miguel Taboada, Carina Alvarez, Carolina Alvarez, EEA INTA- Manfredi, Edgar Lovera (EEA INTA - Manfredi), VaninaCosentino, Cristian Alvarez, de la Agencia de Ext. de Gral Pico
3) INTA Castelar-Instituto de Clima y Agua: Gabriela Posse, Nuria Lewczuk
4) IMYZA - INTA Castelar, Carlos F. Piccinetti.
5) Unidad Integrada FCA, UNMdP-INTA Balcarce: Laura Echarte, Liliana Picone, Cecilia Videla
6) INTA Famaillá: Martín Acreche
7) Grupo Agronómico de la Comisión Nacional de Energía Atómica: Mariana Malter Terrada, Silvia C. López
8) INTA *Pergamino*: Patricia Araujo, Silvina Portela

c) Center of Environmental Studies of Austral University of Chile (CEAM for its initials in Spanish). The Center of Environmental Studies (CEAM) develops an action-research approach fostering a strong link with local actors and stakeholders. We established a working alliance with CEAM since they currently work in two projects in Panguipulli Municipality. Among other activities, CEAM contributes to support some master thesis developed by BEST-P, with local information, logistic help for field work and analysis. This year, together with CEAM we organized graduate open seminars that included different presentations about socio-ecological system, ecosystem services approach, governance and territorial planning. Also, CEAM is a member of BMP directory, and for this reason they are a counterpart of our work in the territory.

8 Media Coverage and Prizes

Awards:

KONEX Awards to Esteban Jobbágy and José Paruelo

Documentary

Andando por esos montes (http://bestp.agro.uba.ar/outreach/)
Detection, monitoring and evaluation of the impact of deforestation and fires in communities of native peoples and criollos in the province of Salta

Media coverage:

Newspapers and magazines:

- Página 12. “Avanza el desmonte por los agronegocios”, por Darío Aranda. 23 de enero de 2014.
- Página 12. “Las imágenes del desmonte”, por Federico Funes. 20 de agosto de 2013.
- Revista Veintitrés. “Hacha y Sierra. Avanza la Deforestación en la Región del Chaco Salteño”, por Tomás Eliaschev. 23 de enero 2013.
- Revista Exacta-Mente, Nº52, Año 20. Revista de divulgación científica. “Bosques, a 5 años de la ley”, por Susana Gallardo. Junio 2013.
- Revista Tecnología Sur-Sur. Universidad Nacional de San Martín. “Satellite Pachamama”, Por Nadia Luna. 7 de octubre de 2013. http://www.unsam.edu.ar/tss/resiste-la-pacha/

Internet:

- El verdadero impacto de la agricultura argentina en el calentamiento global. Por Juan Manuel Repetto. http://www.agro.uba.ar/noticias/print/1151. Marzo de 2014.
- Entrevista en AGROTEMARIO. Pensando en el mañana: Plan de Uso y Manejo de Suelos. AÑO 13 - Abril - Junio 2013 Edición 54º - www.agrotemario.com
- Agronomía Informa: “Advierten por disparidades en la aplicación de la Ley de Ordenamiento Territorial”. 8 de noviembre de 2013.

Radio and TV

- Radio UBA 87.9. Programa Nº 142 “Sobre la Tierra”. Entrevista a María Vallejos y Sebastián Aguiar. Periodista: Matías Juan Manuel Repetto. 6 de febrero de 2014.
- Canal Rural- Entrevista televisiva sobre Gases de efecto invernadero. Marzo 2014.

9 Policy Relevance

BEST-P built a strong and solid relationship with governmental agencies in Argentina, Chile and Uruguay. We have formal on-going projects aimed to incorporate the ES conceptual framework into the definition of "best practices" and land use planning. Members of BEST-P (PL, JMP, EGJ) working with the Ministerio of Agricultura of

Argentina just finished a book on Land Use Planning specifically crafted to contribute to building capacity in local and provincial agencies. The objective is to provide conceptual frameworks and tools for land planning to a broad range of professionals. In the processes of making the book we strength the relationships with a key partner: INTA.

In Chile a current collaboration with the Ministry of Environment is having a high relevance in terms of positioning the ES concept and "best practices" regarding ES conceptualization, classification, modelling and mapping. The proposition and validation of indicators is a concrete collaboration to the Ministry working agenda. In the case of Chile, an un-precedent event was the invitation by the Ministry of Environment to Laura Nahuelhual and Antonio Lara to discuss the strategic action planning of the Ministry regarding ecosystem services policy actions.

In Uruguay the best evidence of the impact of BEST-P activities is the speach of the Minister in the main Rural Fair of the country (http://www.elpais.com.uy/economia/rurales/buscan-crear-coneat-medir-campo.html). The quote in Spanish of Min. Aguerre speach was explicit on recognizing the contribution of the institutions that are part of BEST-P:

"*La iniciativa está focalizada en la Mesa de Ganadería del Campo Natural, donde participan varias instituciones que abarcan desde la investigación a la transferencia tecnológica.*

"En esa usina de ideas comienza a surgir la necesidad de monitorear el crecimiento de las pasturas, proyecto que estaba haciendo el Instituto Plan Agropecuario con la Universidad de Buenos Aires, trabajos con la Facultad de Ciencias, aportes con la Alianza del Pastizal, hasta que en determinado momento vimos la necesidad de generar una herramienta para la mejora de la gestión y la mejora de la decisión técnica".

A key step to incorporate the idea of ES in the design of policy for native grasslands in Uruguay was the participation of one coPI of BEST-P (Alice Altesor) in the "Mesa de Ganadería del Campo Natural". The Board of Livestock on Natural Grasslands, is an institution created by the Ministry of Livestock, Agriculture and Fisheries (MGAP) of Uruguay in 2012, and it is comprised by delegates of: Plan Agropecuario (National Agriculture Extension Service), Directorate of Natural Resources (RENARE-MGAP) and Directorate or Rural Development (DGDR-MGAP), National Agriculture Research Institute (INIA), Uruguayan Secretariat for Wool (SUL), College of Agriculture and College of Sciences of the University of the Republic (UDELAR). It is an inter-institutional body which aims to facilitate coordination and discussion of public policy on livestock on natural grasslands. One of the goals of the Board is to "analyze different strategies for conservation of natural grasslands, including regulatory aspects under the framework of ecosystem services".

At more local level BEST-P is also making important contributions. In our site in Chile , we have had a high success in engaging relevant actors, particularly Bosque Modelo, and rural communities representatives. We have set a working agenda that covers scientific and outreach activities within the territory. A relevant starting point was the participatory identification of ES which established the basis for our work during 2014 and the coming years. We have had a permanent presence and communication of our results and products. In the Quebrada de los Cuervos , one of the sites in Uruguay, we have a critical role in incorporating the idea of ES and some monitoring tools into the management plans in the protected landscape.

In Argentina one specific product of BEST-P (the deforestation database, Vallejos et al. (in press), monitoreodesmonte.com.ar) contributed, on one side, to analyze the way the "Native Forests" law has been implemented in Salta, and, on the other side, to identify ilegal deforestation (in areas where the law explicitly prohibited deforestation). Almost 90.000 ha has been illegally deforested in Salta since the Native Forest Law was passed in 2008. This represent a 28% of the total area deforested in the province. This effort was made throughout a partnership with REDAF (www.redaf.org.ar, the Red Agroforestal Argentina), an institution that include ONGs, Universities and research centers involved with the native forests problematic. The main result is the report referred above (http://redaf.org.ar/wp-content/uploads/2012/12/REDAF_informedeforestacion_n1_casoSALTA.dic2012.pdf).

The release of this report generated a request of the Nation Ombudsman (Defensor del Pueblo de la Nación) (see bestp.agro.uba.ar). Products and knowledge generated by BEST-P were used as evidences to start trials and to make recommendations to the courts.

10 Main Conclusions

Following a socio-ecological perspective, our main achievements are pointed from highest to lowest integration of the social and biophysical dimensions, as follows:

By pursuing the general objective of this project, that is making operational the concept of ecosystem services for land use planning in southern South America, during the first year of activities the BEST-P team faced different challenges along all the steps of the ecosystem services approach. Some of them were made explicit in the original project and others, have emerged on the way. One of the main challenges we faced, the construction and sharing of socio-ecological insights, concepts and methods, belong to those that we did not completely acknowledged within the original project, but that revealed itself as fundamental for our general objective. Different activities gave us the opportunity for the necessary strengthen of our conceptual and methodological tools for bridging the two main dimensions of our general objective (ES and territorial planning), from the internal meetings and workshops with emphasis on social capital and social actors, to the effective collaboration between social and natural scientists in different research lines. Therefore, a significant improvement of our capacity to analyze socio-ecological systems can be concluded.

Instrumentation of the socio-ecological point of view was improved through two main activities. First, a common framework to map stakeholders and to characterize social capital was achieved through two internal workshops aimed at defining a protocol to characterize social capital at the different sites of BEST-P and testing hypothesis on SE flows vs. social capital relationships. Second, we improved our mapping tool, ECOSER, by including a module to map socio-ecological vulnerability (SEV) under land-use change scenarios. We have made it freely available on the web, and evidences of large differences observed between maps based on SE flows vs. scenario-specific SEV for two case studies have profound consequences for land use planning.

Different socio-ecological analyses are beginning to reveal new knowledge on the complex way that societies organize around tangible and intangible ecosystem services. Descriptive studies at regional scale show that deforestation and cultivation in the Argentinean Chaco have not a single imprint on landscapes configuration and primary production dynamics, but one that shifts depending on the human and productive context

under which they take place. A zoom at the agricultural frontier landscape in the Argentine Dry Chaco, show the coexistence of three main landholders clusters, which vary according to their residence in these landscapes, their feedback interactions between social and ecological systems, the intensity of the agricultural practices, the relative surface of remaining native forest within the farm, the balance between avian biodiversity and animal production from cow-calf operations, and the psycho-social characteristics of farmers in relation to their valuation of forest ecosystem services and deforestation intentions. Also with this perspective, ongoing research lines in Chile (Panguipulli community, mostly integrated by Mapuche people), Uruguay (Treinta y Tres, and northern region) and Argentina (Mar Chiquita) are next to offer results to be reported.

Down stepping the ES cascade, different biophysical studies started or deepened during this period provide new knowledge both on the provision of ES (production functions) and landscapes and their impaired provision under land-use intensification (impact functions).

Principal results obtained about impact functions studies can be pointed as follows: a) deforestation and agricultural practices have profound influences on deep drainage in the Chaco region and according projections from actual trends water table under rain-fed agriculture may reach soil surface in a period that ranges from 30 to 120 years; b) from ecohydrological analysis of farming systems across the Chaco region it can be stated that water stress diminishes as crop systems are delayed towards the rainy season (winter > spring > summer > late-summer), but the productively safer late-summer strategy, is the one with highest drainage rates, c) therefore, the last study suggest that in the most drainage-prone areas the implementation of flexible sequences that alternate conservative and intensive crop systems depending on soil water status, can significantly reduce mean annual drainage with an acceptable increase in mean water stress, d) afforestations on formerly Uruguayan grasslands increase the evapotranspiration rates by more than 20% and reduce the hydrological yield by more than 5%, reducing the water consumed by the other land covers, e) deforestation and agricultural expansion/intensification of dry Chaco during de 2000/2007 period profoundly affected the mean C dynamics at regional scale, which can be translated to direct to C emissions, erosion control and water regulation, due to greater exposure of bare soil, and biodiversity; e) land clearing also increased the magnitude of inter-annual differences in C gains, suggesting a greater buffer capacity against climate fluctuations of natural vegetation compared to croplands; f) by extensive soil sampling within the Chaco, it is concluded that both grazing and cropping significantly altered the structure and content of the OM in the region; g) on basis to CENTURY simulations of crop management within the Río de la Plata region (Argentina and Uruguay) high differences up to 37% losses of soil organic content were suggested between the worst ("maize/soybean" crop sequence under conventional tillage and with no fertilizer application) which had a most negative SOC balance (SOC reference value (100%) = 79 t ha −1) and the reference condition along 6 simulated years, so at regional scale, if crop sequences proportions remain constant, the lost of SOC would average a 15% in 60 years.

Up to now, main advances on the analysis and characterization of production functions have shown a) marked differences of harvesting water at both sides of national boundaries (Argentina-Paraguay) within a same ecoregion (Chaco), b) despite of acknowledged technical difficulties, forage production under Chaco woody vegetation was

successfully modeled using satellite imagery and processing techniques. Ongoing field experiments for the analysis of regulation of NO_2 emissions, and model calibrations for the analysis of regulation of CO_2 emissions will hopefully provide new insights about this intermediate ES to be reported.

11 Work Plan for Next Year with Associated Costs (cash-flow projection).

As the report clearly stated we have a number of on-going project. Our plan is to keep working on them. We will start with the development of a training program on land us planning for ONGs and governmental officers during 2015.

Año 2

Name of institution →	UBA (Paruelo)	UNMdelP (Laterra)	Univ Austral (Lara)	Univ Austral (Nahuelhual)	UDELAR (Altesor)	UDELAR (Filardo)	UnivMaryland (Berbery)	UNAM (Bocco)	TOTAL
Budget category ↓									
Salaries for Investigators	0	0	0	0	0	0	0	0	**0**
Salaries for Students / Scholarships	9600	9600	4800	9600	10271	9600	4800	0	**58271**
Travel / Workshops	8853	8125	3058	8125	5062	2541	2541	5041	**43347**
Equipment	0	0	0	0	0	0	0	0	**0**
Research Expenses / Materials and Supplies	14356	5780	5780	3786	0	0	0	1706	**31409**
Communications	400	400	400	400	400	400	0	0	**2400**
Publication / Documentation	0	0	0	0	0	0	0	0	**0**
Dissemination Costs	0	0	0	0	0	0	0	0	**0**
Administrative Support / Office Supplies	13350	0	0	0	0	0	0	0	**13350**
Total in US dollars of institution	**46560**	**23905**	**14038**	**21911**	**15733**	**12541**	**7341**	**6748**	**148777**

12 Summary for Non-Scientific Audiences

BEST-P is a project aimed to support processes of land use planning across Latin America countries. Our initial focus is on the Chaco and Valdivian forests and the Rio de la Plata grasslands. More than 30 scientists from 5 countries are working together, with local communities, organizations and governmental agencies to develop methodologies able to contribute to better organize productive and conservation activities in the territory. Our work is, one side, trying to better understand how land use changes modify water availability, soil properties and climate. On the other side is trying to empowered the more vulnerable stakeholders of the socio-ecological systems to face negotiation on land planning with better elements.

13 Remaining Funds

During the first year we spent 107.000 U$S out of the 196.000 U$S received. Additionally 54.000 U$S are already compromised. Part of the non spent funds corresponded to those assigned to Dr. Lara that could not start his activities during the first year. We are proposing to redistribute these funds among UBA, UNdeMdelP and Univ. Austral (Dra. Nahuelhual) for the second year.

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