NEWSLETTER OF THE GLOBAL LAND PROJECT

GLP NEWS

GLP - A JOINT RESEARCH AGENDA OF IGBP & IHDP ISSUE NO. 8 MARCH 2012

Global LAND Project

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Editorial

New faces

It is with pleasure that I am writing the editorial for this newsletter. This newsletter is the first one edited by the new International Project Office (IPO) of the Global Land Project (GLP) in Brazil. In the past months a smooth transition of the former IPO hosted by the University of Copenhagen to the new IPO hosted by INPE in Brazil has taken place. We are thankful for all the good work the IPO in Copenhagen has done for the GLP community over past 6 years. IPO staff Tobias Langanke, Lars Jorgensen and Rico Konsager and the Chair of GLP Scientific Steering Committee (SSC), Anette Reenberg, have organized many activities with the 2010 Open Science Meeting in Arizona as a major highlight. During this event it became clear the GLP science community has been matured and, although coming from different disciplinary backgrounds, has been able to successfully establish land change as an interdisciplinary science. On behalf of the GLP community I would like to express my gratitude to Anette and the IPO staff for their enormous commitment and achievements.

This issue of the GLP newsletter introduces the new IPO, the new executive officer Giovana Espindola and the project officer Camille Nolasco. Also, we have included some scientific contributions of the new members of the SSC. The diversity of contributions and the different world regions covered are a nice reflection of the scope of GLP research and its global representation. Reports of two exciting recent GLP activities are presented: a workshop organized by the new IPO on Land Use Transitions in South America and a workshop on 'Linking models of human behavior and decision making processes with land system models' which brought together representatives from both the GLP community as well as from other IHDP and IGBP core projects discussing the role of insights on land-use decision making in global scale assessments of climate and earth system dynamics.

For me it is an honor to chair the SSC of GLP for the coming years. Many have asked me: 'What are you going to do with GLP?' Often I have returned the questions asking for suggestions and indicating that GLP is open for all activities organized by the community that address the issues outlined in the GLP Science Plan. Together we are GLP and together we shape the agenda. As a network project with very limited resources GLP depends on the incentives and activities of the GLP community. Workshops that contribute to the GLP science plan may be endorsed by GLP and our IPO can provide support to bring such activities under the attention of the broader community. At the same time we provide support to projects that aim at synthesis of GLP science. Also, many have asked me: 'When is the next GLP Open Science meeting'. The success of the 2010 meeting and the importance of having a venue for exchanging ideas within the GLP community have made the organization of the next open science meeting a top priority for the IPO and myself. I am therefore happy to announce the next GLP open science meeting will take place in the fall of 2013 or early 2014. More detailed announcements will follow soon.

Another important objective of GLP in the coming years is to initiate and support activities that synthesize the state-of-art of land change research. A fine example of GLP involvement in such a synthesis activity is presented in this newsletter by new SSC member Erle Ellis who is leading a project aimed at providing an infrastructure to determine the representativeness of individual land change case studies for larger regions. Synthesis of knowledge across the GLP community is of large importance to broaden the empirical base of findings and indicate the global validity and relevance of such results.

Will the Global Land Project change? How will GLP respond to the transition of the Earth System Science Partnership (ESSP)? I believe the Global Land Project has only become more relevant as a key component of Global Environmental Change research and will certainly find a proper place in the new structure that will replace the current Earth System Science Partnership in the coming years. Land change is both a cause and effect of the interactions of humans with their environment. The way in which we modify and manage the land has major impacts on climate, water availability and quality, and biodiversity. At the same time, land change and the management of the land resources offer the opportunity to adapt to environmental changes. Land science, therefore, provides an important platform for integrating global change research and policy. This requires reconciling our understanding of the human dimensions of environmental change including governance, economy and behavior with the physical and ecological dimensions of global change. Linking human dimensions research to physical and ecological dimensions has always been one of the grand challenges of environmental research. It is especially land science that has the tradition of integrating the different disciplinary insights into a consistent analysis of the land system as a whole. Land systems are at the interface of human, ecologic and physical dimensions of global change and therefore of prime importance to many of the other core projects of IHDP and IGBP. A strong collaboration and the organization of joint activities with the other core projects will therefore be one of the priorities for the coming period.

I look very much forward to a very good collaboration with the SSC, the IPO and the GLP community as a whole. I hope you enjoy the contributions to this newsletter and look forward to your contribution to a next issue of this newsletter or to any of the GLP activities.

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Contents

The GLOBE Project: accelerating global synthesis of local studies in land change science

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Global understanding of land change processes requires synthesis of observations and models across local and regional scales. The GLOBE project, newly funded by a grant from the US National Science Foundation, is working closely with the GLP and others to build an online scientific collaboration environment designed to enhance and accelerate the process of cross-scale collaboration and global knowledge synthesis from local and regional studies of land change.

Global understanding of local and regional land change processes is essential to global change science and Earth stewardship. While remote sensing and global climate modeling have revolutionized our ability to observe and model the global patterns and dynamics of biophysical systems, the human systems that cause land change are not directly observable from space nor can they be modeled successfully at global scales without understanding how they function locally and regionally and are built from multidisciplinary case study observations and models made at local and regional scales (Turner II et al. 2007).

Land change scientists have made great progress in generating global knowledge from local and regional case studies by acquiring and combining sets of published studies using a variety of methods that have become increasingly quantitative and powerful (e.g. Rudel 2008, van Vliet et al. 2012). Yet these studies still suffer from serious not quantified geographical biases in the study site selection process ("interesting locales", logistical concerns) and in the availability of case study results (languages, publication access, social networks, etc.). Researchers conducting global and regional meta-studies must also overcome major logistical and technical challenges in collecting and integrating large sets of studies for meta-analysis and other methods to produce quantitative global estimates (Rudel 2008, Ellis et al. 2009, van Vliet et al. 2012). As a result, global collaborative studies of local and regional land change processes remain all too rare and offer much room for improvement.

To address this situation, the GLOBE project is now working together with the GLP and others in the land change science (LCS) community to develop and implement an online social-computational system designed to enhance and accelerate the processes of cross-scale collaboration, data sharing and global knowledge synthesis from local and regional case study observations, models and expertise.

The idea for GLOBE emerged at a GLP-endorsed global land use workshop in Vienna, Austria in May, 2008, from discussions on the need to better link the efforts of local, regional, and global land change researchers. The central idea was to create an online community for sharing and synthesizing case studies built around a "Global Comparison Engine" (GCE; See Figure 1) that would leverage existing global data, such as temperature, land cover, terrain and/or human population density, together with an advanced geocomputational system to rapidly identify similar study sites, biases, and observational needs in the selection of sets of case studies for global meta-analysis. Such a system would enable local case study researchers to work across spatial scales more easily by helping them to locate and communicate with researchers at other sites globally similar to their own. For those interested in conducting global meta-studies, the system would rapidly search for globally-representative sets of case studies and weight each study in relation to its global representativeness of a given global variable or set of variables (such as population and agricultural land), thereby speeding up the meta-study process while improving the strength of predictions by reducing geographic biases. The system would also rapidly determine where the greatest global knowledge gaps were located and help identify those best placed to fill them. A full suite of tools enabling rapid global mapping together with other global data visualizations and social networking would be made available online, together with a large searchable database of LCS case studies to which researchers could contribute by adding their own studies.

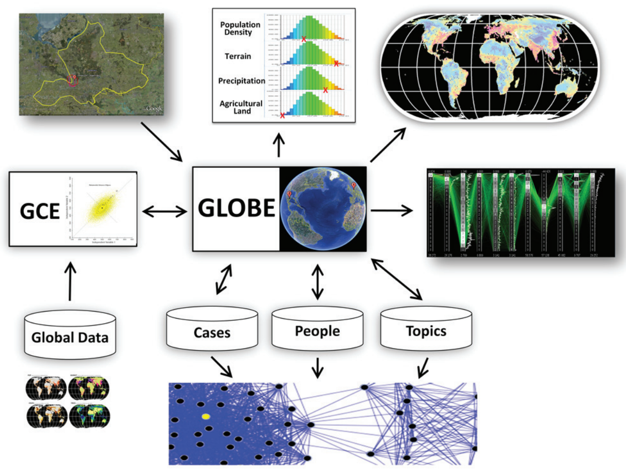

Figure 1. GLOBE model showing a full suite of tools enabling rapid global mapping together with other global data visualizations and social networking.

The GLOBE project is now progressing rapidly towards making these capabilities available online, thanks to a $1.8M grant from the US NSF's Cyber-enabled Discovery and Innovation (CDI) Program, which began on September 15, 2011. The project is led by the author and teams of faculty, postdoctoral researchers, graduate students and undergraduate students across the Departments of Geography & Environmental Systems, Computer Science & Electrical Engineering, and Information Systems at the University of Maryland, Baltimore County (UMBC). The project is being conducted in close collaboration with the GLP together with the Coupled Human and Natural Systems Research Collaboration Network (CHANS-Net), and a host of collaborators across the social, natural and computational sciences. Development of the online system is just the centre piece of a four year effort that also includes: an assessment of the "state of the art" of global meta-study methods in LCS; a study of the structure of the LCS community and its embrace of global synthesis and data sharing, and changes in this resulting from GLOBE implementation; an investigation of LCS site selection processes and their impacts on global knowledge generation in LCS; and the development of advanced computational systems to optimize the knowledge generation workflows of its users.

Currently, the GLOBE team is developing a survey of global synthesis and data sharing practices in LCS (expect to be contacted for this Spring!), building a database of georeferenced case studies, and developing the GLOBE online system, with the objective of putting the first version online for public beta testing in December of this year. Together with the GLP and your help, our goal is to make land change science more effective and globally relevant than ever.

Acknowledgements

Tobias Langanke's sustained encouragement was instrumental in developing GLOBE into a funded project. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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Analyzing land use transitions: how the HANPP framework can help to advance our understanding of changes in land use intensification

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The study of land-use intensification requires interdisciplinary approaches that guide data collection and analysis across scales. We here present an application of the indicator framework 'human appropriation of net primary production' (HANPP) for analyzing land-use transitions at the national level for six countries. Our analysis reveals a general pattern of HANPP trajectories across six countries, and argues for the (further) development and integration of integrated indicator frameworks such as HANPP in global Earth observation and monitoring systems, as they allow generating integrated, consistent accounts of coupled socio-ecological systems, and so provide the scientific basis for forging strategies of "sustainable intensification".

Changes in land-use intensity are essential aspects of land use change. Therefore it is surprising that, in general terms, changes in land use intensity appear to be much less in the focus of land-change science than the study of changes in land cover (the change from one land cover class to another) Changes in the land use intensity often are even more pronounced than changes in land cover; see Figure 1). For example, there exists no generally accepted, comprehensive and systematic definition of land-use intensity or land intensification (Shriar, 2000). In consequence, the causal understanding of the factors, mechanisms, determinants and constraints underlying land intensification remains largely unsatisfactory. Approaches that help in improving our understanding of land-use intensity, intensification and its interplay with socioeconomic land requirements and land cover are needed (Erb, 2012).

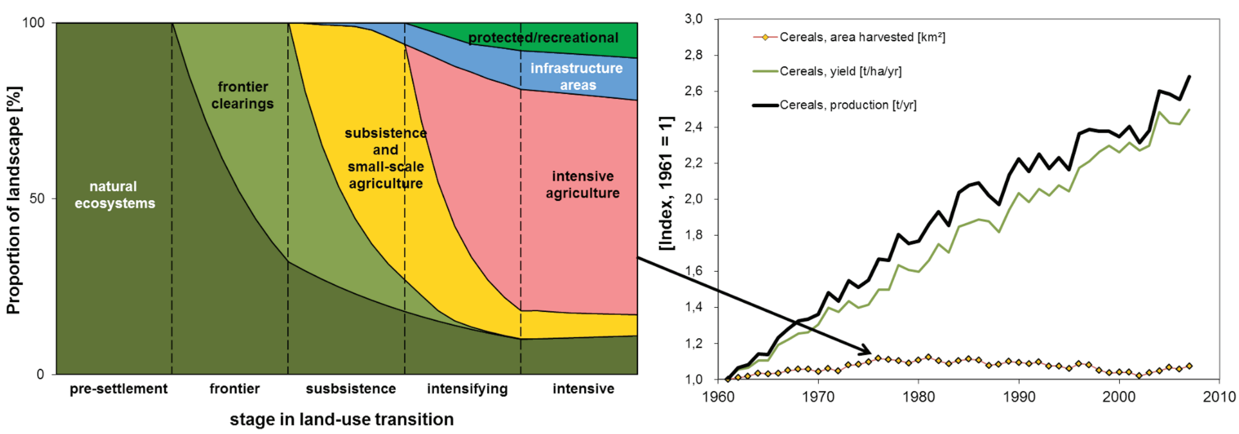

Figure 1. Changes in land use intensity play an essential role in land-use transitions. Left: land cover changes during land use transitions after Foley et al. (2005); right: growth in the global production of cereals since 1961 has depended almost exclusively on intensification (yield increases, due to the surges in inputs such as tractors, fertilizers and many more (not shown; data FAOSTAT, 2011). Redrawn after Erb (2012).

Such an integrated indicator framework is HANPP, the 'Human Appropriation of Net Primary Production'. HANPP integrates two distinct effects of land use on one of the most fundamental ecological process, i.e. the flow of carbon or energy, in one account: (a) human-induced changes in productivity due to land conversions (ΔNPP_{LC}) and (b) biomass harvest (NP_{Ph}). The latter is in itself a widely used surrogate indicator for output intensification in agriculture. The integration of this output intensification parameter with the associated land-use related alterations of ecological flows allows for two distinct perspectives at the same time: an ecological perspective that quantifies and monitors impacts on ecological flows on basis of a comparison of the hypothetical natural ('undisturbed') with the actually prevailing state. And a socioeconomic perspective that observes the amount of biomass gained from ecosystem, i.e. the provision of ecosystem services, as well as the associated collateral flow of energy, i.e. the unintended productivity losses due to land conversions.

This integration of socioeconomic and biophysical perspectives renders HANPP a useful framework to analyse land-use intensification trajectories. In a comparative analysis of six national long term case studies (forthcoming in the journal of Ecological Economics ; Krausmann et al., 2012) we employed the HANPP framework in order to analyse differences and similarities in land use intensification trajectories and so contribute to an enhanced understanding of land use transitions (Krausmann, 2001; Kastner, 2009; Kohlheb and Krausmann, 2009; Musel, 2009; Schwarzlmuller, 2009; Niedertscheider et al., 2012)

Figure 2 shows the development of HANPP and key components of HANPP in the six countries. In the UK and the Philippines, HANPP increased considerably during the first half of the 20th century (Figure2a). It peaked

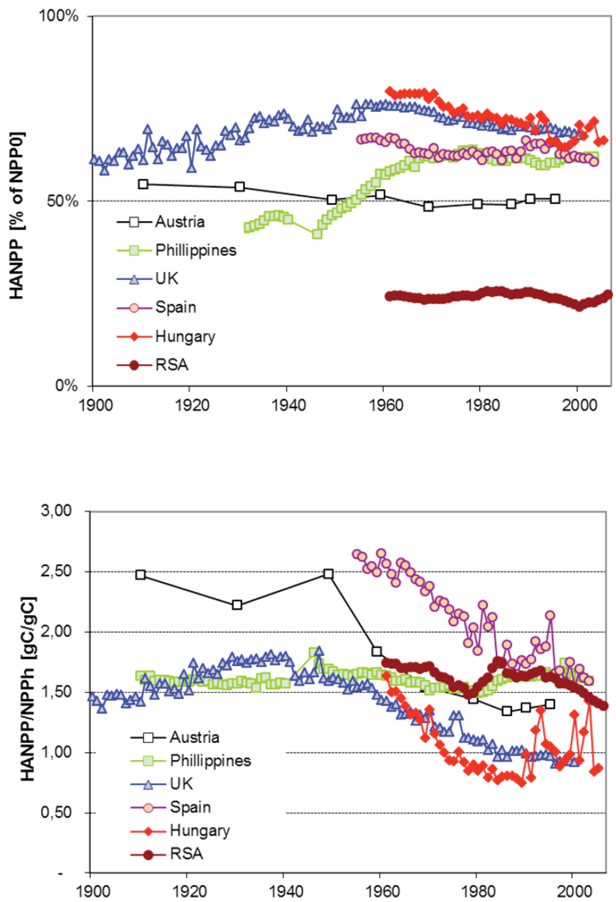

Figure 2. HANPP trajectories in Austria, Hungary, the Philippines, South Africa (RSA), Spain and the United Kingdom (UK). (a) HANPP in % of NPP0, (b) HANPP intensity (HANPP/NPPh). Redrawn from Krausmann et al., 2012).

in the 1960s and has since stabilized (Philippines) or even declined (UK). Also in Spain and Hungary HANPP declined after 1950, while it stagnated in Austria after some decreased in the first half of the 20th century. In these five countries, HANPP was high and amounted to 50-70% of NPP0in 2000. South Africa, in contrast, is characterized by a stable, low level of HANPP throughout the observed period.

In all cases, the amount of biomass harvested (NPPh) was increased drastically (not shown), resulting in a considerable decline in HANPP intensity (the ratio of HANPP over NPPh; Figure2c) for all countries except for the Philippines where HANPP intensity did not change significantly during the 20th century. The periods of drastic political and economic restructuring, the end of the Apartheid regime in South Africa, as well as the collapse of the planned economy in Hungary, are characterized by a decrease of this HANPP efficiency.

The analysis reveals general patterns of HANPP trajectories in the course of land use transitions. In early stages of industrialization, HANPP apparently increases parallel to population growth. In this stage growth in the demand for food and feed is met by the expansion of agricultural land, at the expense of forests. In this phase, population growth (or, in certain cases, export production) outgrow yield increases and result in HANPP increases. The industrialization of agriculture stops or even reverses this HANPP trend. In all case studies improvements in agricultural technology allowed for drastic yield increases. Growing harvests could be met without further increases in HANPP. Land of marginal productivity could increasingly be taken out of production and was reforested, which contributed to reductions of HANPP. As a consequence, HANPP intensity, that is the amount of HANPP associated with each ton of biomass extraction, declined.

This observed decoupling HANPP from biomass harvest illustrates vividly the extent to which – by means of technological change – human societies have been able to decouple human population and economic growth from HANPP. Up to today, however, these increases of the capacity of the ecosystems to provide biomass to human society came at considerable ecological and social costs: surges in nitrogen use and water, mechanization, commodification, and the like. In the future, novel ways of "sustainable land use intensification" that avoid these side-effects will have to be identified. This requires significant scientific progress in the basic understanding of land use intensification processes, as well as the establishment of integrated, comprehensive and sustained earth observing systems. Integrated indicator frameworks such as HANPP could be valuable complements to existing observing systems, such as the Global Earth Observing System of Systems (GEOSS), the Global Terrestrial Observing system (GTOS), or the Integrated Global Observing System (IGOS), as they allow generating integrated and consistent accounts of the coupled socio-ecological systems.

Acknowledgements
This research was funded by the ERC-Starting Grant 263522 LUISE, the Austrian Science Funds (projects P20812-G11 and P21012-G11) and the EU-FP7 project VOLANTE.

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Carbon hotspots in cities can ameliorate carbon loss due to urban sprawl

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In the semi-arid western United States, urbanization transforms landscapes from sparse grasslands with tree-lined riparian corridors to matrices of asphalt, concrete, grass, and wooded stands. Previous work in the Colorado Front Range showed carbon storages higher in urban green spaces than in agricultural or native grassland areas (Golubiewski, 2006). To understand the regional C shift, distribution of carbon across the landscape was investigated. Carbon hotspots exist in urbanized residential and green space areas and along riparian corridors. Extrapolation of field-measured C content to regional scales was accomplished using two approaches, bounding the 20th century carbon trajectory as -3% to+18%, when urbanization quintupled.

Worldwide, land-use change is considered a source of carbon (C) rather than a sink (Schimel,1995). U.S. non-urban land-use change released ~27 Pg C before 1945 and accumulated ~2.4 Pg C after 1945 due to fire suppression and forest regrowth (Houghton, Hackler & Lawrence, 1999).

Decreases and increases occur in urban areas depending on the natural ecosystem present prior to development (e.g. Imhoff et al, 2000). Overall, coarse approximations show that land transformation to urban uses results in a loss of net primary productivity (NPP), although in some resource-limited areas, production increases (Imhoff et al, 2000 ; Milesi et al, 2003). Urban trees planted alongside streets and in green spaces such as parks and residential yards sequester substantial amounts of C and ameliorate the effects of urban heat islands and air pollution (Nowak,1993; McPherson et al,1994).

This study undertook a regional application of previously-measured vegetative and edaphic carbon pools (Golubiewski, 2006) in order to understand the consequences of urbanization upon ecosystem functioning in Colorado's Front Range (USA). Regional C estimates derived from ground-cover constituents (Golubiewski & Wessman, 2010). were compared to categorical estimates of carbon storage using historical land-cover information.

Colorado's Front Range sits at the eastern edge of the southern Rocky Mountains, the cordillera's largest human settlement. Change was examined in the region's five main lowland cover types: grassland, riparian, agriculture, suburban, and urban. Boulder, a city in the central-western portion of this study area (40°0'54" N, 105°16'12" W), provided a focused site for relating areal proportion of ground-cover constituents to carbon.

Two approaches were used to determine regional carbon densities (g C/m2). A categorical approach utilized maps from the USGS' FRIRP time series (1930s, 1950s, 1970s, 1990s) classified according to a modified Anderson land-use/land-cover (LULC) scheme (Anderson et al, 1976; U.S. Geological Survey, 2001). The second, abiophysical approach, utilized fractional cover of vegetation, soil, water, and impervious surfaces derived from partial spectral unmixing of an Airborne Visible/Infra Red Imaging Spectrometer (AVIRIS) image over Boulder (Golubiewski & Wessman, 2010). Carbon data of vegetation and soil organic carbon (SOC) pools were collated from field research and a literature survey (Golubiewski, 2006 ; Golubiewski, 2003). Carbon densities were then applied to the corresponding LULC categories in the FRIRP time series and land cover constituent areas derived in the unmixed AVIRIS image.

Regional structure

The carbon map shows distinct landscape patterns of both aboveground and total C (Figure 1). Both natural and anthropogenic hotspots dominate the carbon landscape. In natural areas, C is high where large trees dominate overstory canopies. High SOC also contributes to hotspots in riparian and wetland areas. The speckled appearance of Boulder's C signal indicates the interspersion of vegetation and soil with manmade structures throughout the built environment (Figure 1).

Land-use history and landscaping choices contribute to C hotspots in the city's western half. These anthropogenic hotspots reveal high C in older, well-established residential neighborhoods and the tree-lined commercial district of downtown. The mid-range C content of Boulder's southeastern quadrant reveals a development-age gradient, where neighborhoods ~50 years younger than the city's original neighborhoods in the west have smaller biomass pools with lower C content (Golubiewski, 2006). Carbon hotspots also expose intensive landscape management practices (e.g. soccer fields, golf courses).

Trajectories of landscape structure between the 1930s and 1990s show decreases in all vegetated categories. Corresponding increases occurred in all developed and bare categories. Cultivated herbaceous land use decreased the most in area (26%), followed by natural herbaceous/grassland area (21%). Developed and residential categories increased most, by 359% and 533%, respectively.

Carbon trajectories

The carbon content of this study area followed different trajectories, depending on the scaling approach (Figure 2). The total C content for the FRIRP study area increased 18% from 24 Tg in the 1930s to 28.4 Tg in the 1990s. The biophysical approach suggested a 3% decrease in regional C content, from8.5 Tg in the 1930s to 8.2 Tg in the 1990s. Thus, the carbon trajectory is bounded as -3% to +18%.

Despite 300-500% increases in area of developed land during the 20th century, carbon may have remained relatively neutral or increased moderately. Regardless, urbanization did not radically reduce C pools due to higher productivity in urban areas relative to the native system. Indeed, cities harbour "hotspots" of carbon.

The overall slight decrease in C stores in this region (the AVIRIS-C estimate) fulfills expectations that urbanization decreases productivity, but contradict another set of expectations that, given afforestation accompanying development (Golubiewski, 2006; Golubiewski & Wessman, 2010), C storage should increase in this semi-arid region: forests contain more carbon than grassland. This disconnect between land conversion and changes in C pools occurs through an ameliorative effect: Vegetated areas decreased by 22% and developed areas increased nearly 500%, yet carbon pools reduced only 3% due to high C density in green spaces.

At a continental scale, urbanization decreases productivity, but the impact of urbanization on NPP depends on development characteristics as well as the biogeophysical environment (Imhoff et al, 2000). The sprawling, low-density pattern of development allows for enhanced productivity due to its urban green spaces maintained with irrigation and fertilization.

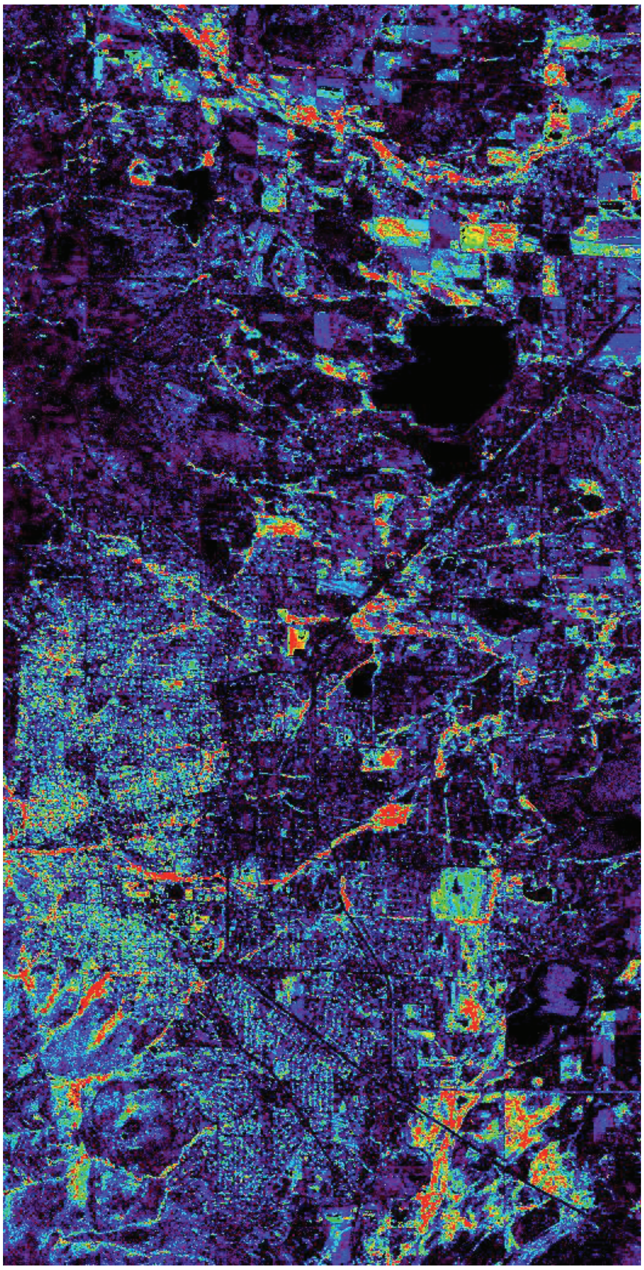

Figure 1. Carbon content (kg) of the city of Boulder and its surroundings based on fractional abundances of biophysical components detected in the AVIRIS image. Displayed as a color density slice (rainbow color scale: cool colors (purple/blue) denote low carbon content; hot colors (yellow/red) illustrate high C).

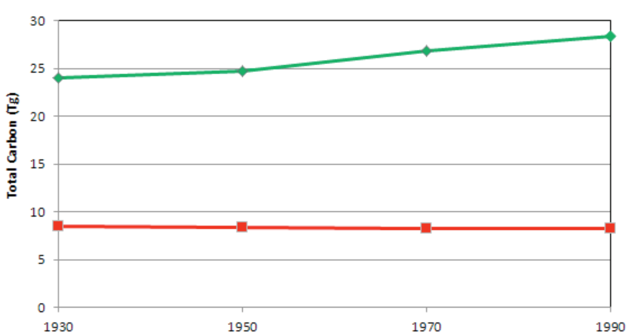

Figure 2. Trajectory of regional carbon content in Colorado's Front Range. Carbon trajectories for the based on both generalized carbon conversion numbers for Anderson land-use/land-cover classification categories (green line) and carbon densities of biophysical entities derived from AVIRIS imagery (red line).

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Carbon markets as a driver for multiple ecosystem service and economic benefits

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The evolving carbon market in Australia holds substantial prospects for restoring degraded agricultural landscapes and enhancing the supply of ecosystem services by providing financial incentives to plant tree and shrub species that sequester carbon. Our work integrates high resolution spatially-explicit biophysical and economic analysis to estimate the potential uptake of tree-based carbon sequestration and quantify the multiple benefits provided by those trees. We demonstrate that a market for carbon sequestration could drive substantial land use change that has multiple benefits, but there are risks to food production and the supply of water that need to be considered.

Consequences of the development of agricultural landscapes typically include the depletion of natural capital stocks of species and ecosystems, soil and water resources and the atmosphere (Robertson et al. 2000, Tilman et al. 2001, Scanlon et al. 2007). Changing land use from annual crops and pasture to ecological restoration, i.e. the permanent planting of a mix of indigenous tree and shrub species, is an increasingly popular ameliorative action to address widespread degradation and restore stocks of natural capital. Ecological restoration sequesters carbon dioxide and provides habitat for native species, but it also restores soil and water resources through preventing soil wind erosion and rising groundwater tables, respectively. However, ecological restoration can reduce surface water yields and compete with food production.

The Australian Government's Carbon Farming Initiative provides economic incentives for landowners to undertake ecological restoration that sequesters carbon (Australian Government, 2012). Our work aims to understand how much carbon could be sequestered by tree planting assuming income could be earned. We also explore the benefits and trade-offs potentially arising from the change in land use from its existing annual crop and pasture activities to permanent trees for carbon.

We use various models to quantify: i) food production; ii) carbon sequestration under ecological restoration and tree monocultures; iii) changes in water yield moving from grass to tree cover; iv) spatial priorities for ecological restoration, and; v) spatial priorities for reducing soil degradation. Outputs of our models are high resolution (1 hectare) spatially explicit layers that can assist in the design of carbon sequestration economic instruments. The scale of our analysis extends from the catchment to State and focuses on agricultural landscapes in south-eastern Australia dominated by annual cropping and grazing.

Our recent work has focussed on three specific lines of enquiry:

1) Will spatial targeting of tree-based carbon sequestration in hotspots provide greater environmental and economic benefits than a non-targeted random approach that could be expected under a completely free market?
2) What incentive is required to encourage landowners to plant ecological restoration that yields less carbon over tree monocultures that sequester more but provide minimal biodiversity benefit?
3) What are the potential trade-offs in the supply of ecosystem services from wide-spread uptake of tree-based carbon sequestration?

Our analysis concludes that there are many potential ecosystem service and economic benefits and trade-offs from the uptake of tree-based carbon sequestration. We demonstrate that smart spatial planning could be used to underpin the payment of economic incentives for carbon sequestration that would increase potential benefits and minimise trade-offs. For example, a policy that targets payments to the most cost effective locations for ecological restoration, that is, where the cost:benefit ratio is maximised, could result in 25% improvement to biodiversity, 100% improvement in water quality, 30% more carbon sequestered and cost 66% less than if ecological restoration was randomly located throughout the landscape (Crossman and Bryan, 2009).

There is a risk that incentives to plant trees for carbon sequestration will encourage plantings of fast-growing non-indigenous monoculture trees that sequester more carbon. Provided they are located strategically, these plantings would still provide the water quality and carbon benefits for less cost, but little if any gains in biodiversity. An incentive on top of carbon payments is required to encourage landowners to switch to ecological restoration that is less profitable but more beneficial to biodiversity. We demonstrate that, depending on the price of carbon, direct annual payments to landowners of AU$7/ha/year to $125/ha/year may be sufficient to augment economic returns from a carbon market and encourage plantings that contribute more to ecological restoration than monocultures (Fig. 1; Crossman and Bryan, 2011). However there is a trade-off because less carbon is sequestered by mixed native tree and shrub plantings.

There is the potential for unintended consequences if widespread uptake of tree-based carbon sequestration does occur, whether it is ecological restoration or monocultures. It is important to understand what the potential trade-offs may be so that mitigation measures can be incorporated into economic instruments that encourage carbon sequestration. Our most recent work has shown that considerable ecosystem services trade-offs may exist following the uptake of carbon plantings in South Australia's agricultural landscapes (Bryan and Crossman in review). For example, given increasing carbon price, an increasing amount of carbon could be sequestered, but there would be impacts on food production and the supply of water for human consumption (Fig. 2). Requiring landowners to pay for the water they use, particularly in water supply catchments, could mitigate this trade-off.

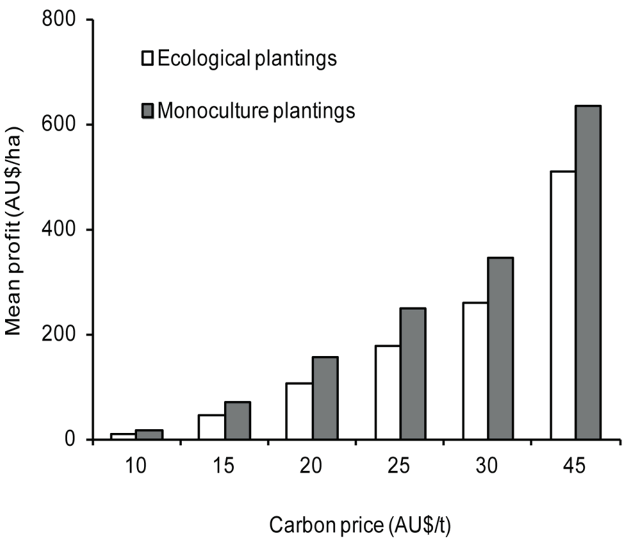

Figure 1. Mean profit from ecological and monoculture carbon plantings within priority locations for ecological restoration. The gap in mean profit between the two types of carbon plantings is the value of the payment. Source: Crossman and Bryan (2011).

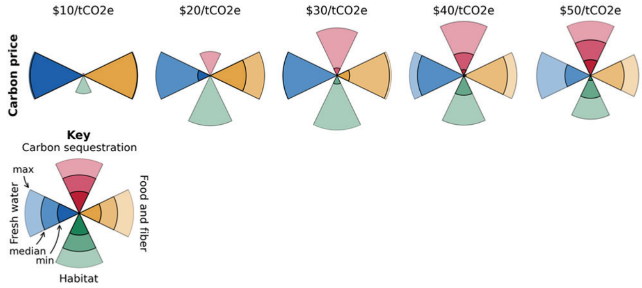

Figure 2. Relative impact of a carbon payment on multiple ecosystem services. Minimum, median, and maximum values were calculated across the scenario space for each market price. Source: Bryan and Crossman (in review).

We recommend that incentives designed to encourage the planting of trees to carbon sequestration in degraded agricultural landscapes should be supported with extensive modelling to identify locations where benefits are potentially greatest. We also recommend that complementary incentives be carefully designed to motivate land owners to plant trees that provide benefits beyond carbon, whilst minimising potentially perverse outcomes.

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Land systems after socio-economic disturbances: the collapse of the Soviet Union versus Chernobyl

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We explored to which extent socio-economic disturbances can shift land-use systems on a different trajectory. Our analyses show that the collapse of the Soviet Union in 1991 caused a major reorganization in land-use systems, which was similar to that following the nuclear disaster in the Chernobyl region. National policies and institutions played an important role in mediating land use change. Our results illustrate the potential of socio-economic disturbances to revert land-use intensification and the important role institutions and policies play in determining land-use systems' resilience against such socio-economic disturbances.

Coupled human-natural systems are often characterized by nonlinearity and tipping points in their responses to stressors (Scheffer, 2010). Land system dynamics may thus be described as a sequence of stable periods followed by rapid changes with potentially long-lasting effects (Dearing et al., 2010; Lambin and Meyfroidt, 2010), and the challenge is to better understand the triggers that can shift land systems onto new land-use trajectories. Specifically, effects of fast drivers, such as economic shocks, rapid institutional transformations, or revolutions, on land-use transitions are not well understood.

We assessed to which extent a major socio-economic disturbance can cause a fundamental reorganization in land-use systems. We focused on the border region of Ukraine and Belarus and studied the effects of the collapse of the Soviet Union in 1991, which triggered the abandonment of millions of hectares of farmland (Ioffe et al., 2004; Kuemmerle et al., 2008; Baumann et al., 2011). To provide a reference against which to evaluate land-use impacts of that socio-economic disturbance, we also studied a major technological disturbance that affected the same region a few years earlier, i.e., the nuclear disaster in Chernobyl on 26 April 1986. The Soviet administration evacuated the local population within a 30-km exclusion zone around the reactor, and implemented additional large-scale re-settlement schemes.

Our study region (Fig. 1) covered an 80-km radius around the reactor within the limits of one Landsat footprint. We conducted a multi-temporal classification of Landsat TM/ETM+ images to map farmland change from 1986 to 1992 (post-meltdown period) and from 1992 to 1999 (post-Soviet period). Farmland was defined to include both, arable land and managed grasslands. We considered an area abandoned if it was only farmed in the earlier satellite image of the respective time period. See Hostert et al.(2011) for details on the methodology.

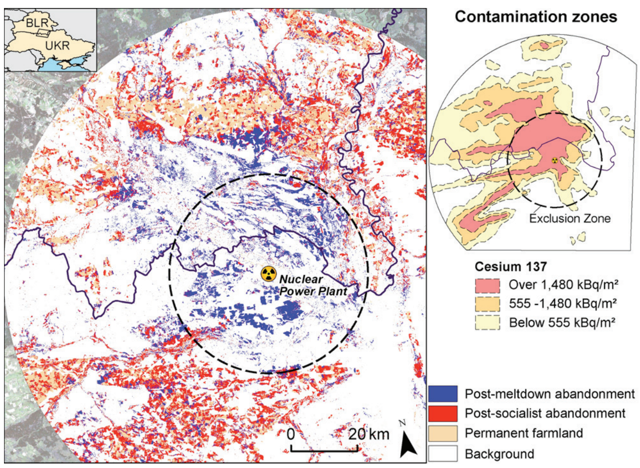

Figure 1. Farmland abandonment in the Ukrainian-Belarus border region after the Chernobyl nuclear meltdown in 1986 and the collapse of the Soviet Union in 1991.

The Chernobyl meltdown and associated re-settlements resulted in high farmland abandonment rates across the study region. Before the 1986 meltdown, farming patterns were similar in Belarus and Ukraine with

Figure 2. Vast areas of farmland were abandoned after the collapse of the Soviet Union (Photo credits: A. Prishchepov).

222,000 and 207,000 ha of farmland in the study region, respectively. In total, cultivation of 32.5% of all farmland ceased after the nuclear disaster, but land use outside heavily contaminated areas did not change substantially (Fig. 1). Given the severity of the nuclear disaster, high rates of farmland abandonment were not surprising. What was surprising, however, was that the collapse of the Soviet Union resulted in abandonment rates even higher (36% of all farmland in the study region). In Ukraine, abandonment rates reached 55.4% in uncontaminated regions in the post-socialist periods, compared to only 14.8% in the post-Chernobyl period. In Belarus, abandonment rates in uncontaminated areas were considerably lower in the post-socialist periods (32.8%).

Our study showed that the effect of the socio-economic disturbance, the collapse of the Soviet Union, on land use systems was at least as drastic as that of the technological disturbance of the Chernobyl nuclear disaster. Both disturbances resulted in less intensive land use, but the major difference between them was that the Chernobyl disaster were fairly local, whereas the collapse of the Soviet Union affected land-use systems across one sixth of the planet's land surface (Ioffe et al., 2004; Henebry, 2009; Kuemmerle et al., 2011). Brief events, such as the Chernobyl meltdown and the collapse of the Soviet Union affected land-use patterns for at least two decades thereafter, suggesting that the land-use systems in Central and Eastern Europe may have indeed shifted onto new trajectories.

Another major result from our study was that national policies and institutions play important roles in mitigating the effects of socio-economic disturbances and can therefore increase the resilience of land-use systems. Ukraine and Belarus, the two countries followed very different strategies to deal with the collapse of the Soviet Union (Lerman et al. 2004). Ukraine, on the one hand, allowed privatization of all farmland, but implemented land reforms slowly, resulting in tenure insecurity and dysfunctional land markets, and price liberalization limited the economic viability of farms. Farmland in Belarus, on the other hand, was not privatized and government support for agriculture continued. As a result, land systems in Belarus were more resilient against the effects of the collapse of the Soviet Union, resulting in substantially lower abandonment rates in Belarus compared to Ukraine.

Whether or not socio-economic disturbances result in permanent reorganization of land-use systems will ultimately depend upon the resilience of land-use systems and whether or not a fundamental shift is irreversible. Our work clearly shows though that land-use theory needs to account for the effects of socio-economic disturbances to better understand land-use trajectories, and thus to identify pathways towards sustainable land use systems. The interactions of socio-economic disturbances and the accelerating and powerful forces, such as climate change and globalization, that increasingly drive land-systems dynamics, will likely bring about surprises.

Figure 3. View of the abandoned city of Pripjat, close to the Chernobyl nuclear power plant (Photo credits: C. Montgomery via Wikimedia Commons).

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How collaborative research programmes will support policies in a better way

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Land management, the organisation of the use and development of land, is an important approach for addressing problems of rising greenhouse gas emissions and loss of natural resources. Yet natural-societal systems in which land management policies are realised are poorly understood, which decreases the effectiveness and efficiency of policies. Local studies can provide valuable insights, but only for the local conditions prevalent during the study period. Generalising results through synthesis of local studies is confounded by the variety of local conditions. Collaborative research programmes may prevent some of these problems and support sharing of insights across temporal, ecological and spatial-economic contexts. From existing literature we identify the challenges facing synthesis and show how a German research programme attempts to address a number of them.

Improving conditions for synthesis

Collaborative research programmes can be used to reduce the differences between individual studies and promote conditions for successful synthesis, which is a key for the dissemination, adoption and implementation of results. Large research programmes usually have a special group to take care of cooperation and synthesis of knowledge flows as well as administrative tasks. Such a group is well placed to attempt scientific overspill of the individual studies.

For ecosystem service studies for example, understanding the local ecology will be an important goal, with all the diversity in data collection, indicators and modelling approaches this entails. Specific detailed projects will achieve this including the prescription of research methods in detail. In contrary, collaborative research activities in programmes will facilitate discussion about methods and indicators by providing the infrastructure necessary for information and knowledge exchange. For individual studies, it will be easier to compare results and test each other's methods. If significant differences appear, the infrastructure facilitates exploration of their causes.

Similarly, a collaborative research programme can support some commensurability of data on socio-economic context and valuation. It could encourage the use of a method that is identical across all studies. In this way, a more useable source of valuation data will be generated. A collaborative research programme can also assist and realise the identification and selection of important stakeholders, the process of their involvement. This will enforce the efficiency of multi-level communication and governance. Single studies are furthermore likely to develop specific story lines for scenarios or employ different models to quantify them. Within a collaborative research programme, it is possible to develop consistent discussions about possible futures. If each study has a set of boundary conditions consistent with the other studies, then all studies are more comparable. Considering that ecological processes can be modelled at the overarching spatial scale as well, each study can perform a nested assessment and analyse differences between scales. Exchanging ideas and results allows studies to consider and compare results from other studies, improving the understanding of value transfer and up- and downscaling techniques.

Regional studies about local and regional problems of governance will allow detailed analysis of actor interrelations and interactions, understanding ways of persistence and change of land use in a better way. Comparison and meta-analysis will offer which solutions and governance options exist in general. Furthermore, the validation of effectiveness and efficiency of governance modes is possible.

Looking to ecosystem services and modelling of future land use options, two important recommendations have so far remained unaddressed. One, the use of a common framework for ecosystem service studies, which is arguably an ideal situation. Current knowledge on ecosystem service studies, however, is too limited for a collaborative research programme to prescribe a more detailed framework, e.g., Cowling et al. (2008), Fisher et al. (2008) and Carpenter et al. (2009). Second, yet collaborative research programmes can help assess uncertainty. The ability to set up an infrastructure for data exchange supports comparative analyses into data and methods that would be difficult to do without such an infrastructure. To make the most of it, a collaborative research programme should continuously look for and promote opportunities for cooperation.

Looking to land use change, more comprehensive models of cause-effect relations on the regional level are missing up to now. A high variety of land use drivers influence place and intensity of land cover and land use. In consequence, activities towards sustainable land use and management remain without high efficiency. Similarly, a high variety of modes for governing land exist. Activities towards a better solution of land use conflicts, creation of synergies and the development of strategies and instruments gaining sustainability need further elaboration and implementation.

Illustrating ways of improvement: Germany's Sustainable Land Management Programme

In November 2010, the German Federal Ministry for Research and Education (BMBF) launched the collaborative research programme 'Sustainable Land Management'. It aims to improve understanding of interacting ecological and socio-economic systems and to help design better land management policies.

Global change poses an enormous challenge for policy, economy and society. Innovative approaches for our use of natural resources and land are needed to cope simultaneously with adaptation and mitigation of climate change, changing demographic structures, and conflicts between nourishment, energy supply and other economic activities. Using various examples, the research projects in this programme will develop new models, technologies, system solutions and policy strategies for sustainable land management. The projects take into account integrative, interdisciplinary and regional perspectives, which enables them to address the variety and complexity of the demands placed on land and natural resources. Research is oriented towards policy development and the project scientists will work in close cooperation with regional and international stakeholders. The research programme is divided into two parts. The projects in module A address interactions between land management, climate change and ecosystem services. The main purpose is to identify key functions provided by natural resources that are indispensable to sustainable and climate-optimised land management. The projects in module B will look for ways to pursue an integrative development of urban, suburban and rural areas. The challenge here is to identify development policies that can take into account the complexities of regional socio-economic, ecological and social conditions. Two scientific coordination projects support the network and exchange between the different research projects and focuses on the synthesis and meta-analysis of project-based results.

Coordination project GLUES

Global Assessment of Land Use Dynamics, Greenhouse Gas Emissions and Ecosystem Services – Scientific Coordination and Synthesis of the Research Programme on Sustainable Land Management, Module A

GLUES supports the projects within module A of the research programme 'Sustainable Land Management', and aims to synthesise their results. In order to be able to identify transferable patterns from regional projects, the number of differing regional conditions needs to be reduced and this is something that GLUES aims to achieve by creating global scenarios and a common data pool via a geodata infrastructure (GDI). These global scenarios provide a context for all the regional scenarios that remains consistent across all projects. Scenarios are being developed for the medium (2030) and long-term (2100), which will enable the study of outcomes of immediate policy actions and how they correspond to long-term goals. The common data pool allows the exchange of well-described data between the different regional collaborative projects in the research programme and beyond. For instance, the GLP community can access this data base to eventually use appropriate data. To satisfy the demand for efficient communication infrastructures, networking, outreach (public relations and science policy interface) and the involvement of stakeholders and to assist in the effective implementation of results, GLUES also supports the regional projects within the research programme by managing the programme's major communication needs.

http://modul-a.nachhaltiges-landmanagement.de/en/scientific-coordination-glues

Support and coordination project, Module B

The support and coordination project in module B creates an organisational framework for generating synthesis and meta-analysis to analyse human-environment land systems, understand different types of conflicts and synergies in land use and develop conceptual models of problem solving for interaction in land use and changes of land use. Projects in module B, cover a wide range of different areas of research as well as diverse types of land use, landscapes, actor networks and institutional settings.

In conclusion, the scientific coordination project focuses on the development of successful governance modes and transdisciplinary transfer tools for sustainable land management in Germany and Europe.

Specific measures are integrative workshops about indicators, models and analytical concepts as well as working groups about governance modes.

With its integrated approach, the new funding measure "Sustainable Land Management" will allow initiating and supporting discussions about future forms and functions of governance in land use. Particularly all scientific and political debates, initiated by articles, workshops and network activities driven by various actors of the funding programme will benefit from the development of new strategic and instrumental options. Especially the transdisciplinary approaches will guarantee the possibility of applicable results.

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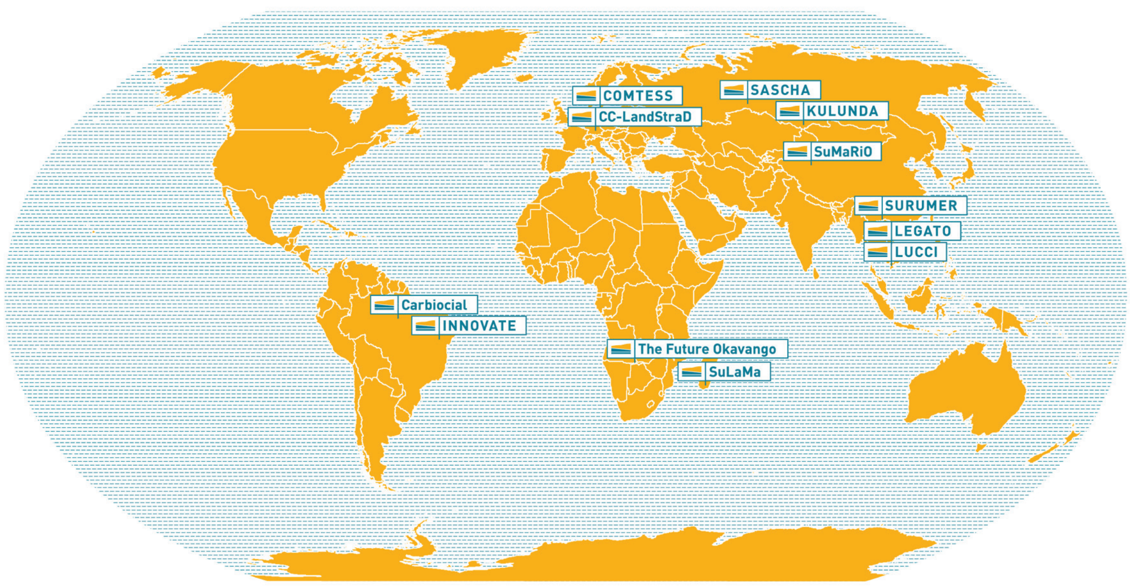

Figure1. Regional collaborative projects of the research programme "Sustainable Land Management" work on different topics and questions on sustainable land management in international regions. Note: this map only shows the regional projects in Module A of the funding measure.

Land use transitions in South America: framing the present, preparing for a sustainable future

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South America has experienced significant land use transitions in the past, especially due to the expansion of large-scale agriculture in countries such as Brazil and Argentina. This expansion has supported economic growth, but has caused serious environmental consequences. Therefore, countries in South America will continue to face major public policy decisions if they are to combine economic growth, income distribution, and environmental sustainability. Against this background, scientists came together in November 2011 in Ilhabela, Brazil for a GLP sponsored workshop to discuss four main topics linked to the sustainable future of the region: governance and institutions, vulnerability, environmental services and modeling and data provision & analysis. This article provides a general overview of the workshop outcomes.

Workshop outcomes

The workshop was planned to address four challenging topics linked to the sustainable future of the South America region: governance and institutions, vulnerability, environmental services and modeling and data provision & analysis, and was target to an audience with interests in improving the understanding of land use transitions across the entire region.

The first topic explored by a small expert group was the recent institutional evolution in Brazil and in other South American countries such as Peru and Bolivia over the last two decades, by recognizing the importance of environmental issues in matters of territorial planning and public policy. Despite the specificities of each country's history and the role played by social actors at different institutional levels and scales (including global), this evolution has to deal with current national land tenure and land use regimes. Examples are the restricted land use laws in agrarian reform policies – with the goal of avoiding deforestation (Brazil), and the denial of claims to exploit oil deposits inside indigenous territories (Ecuador), for example. However, the broad acceptance of a new framework of environmental laws and policies is far from being achieved, and the range and limitations of their enforcement, in opposition to ancient political and economic structures, demands more inquiry. In this sense, this group discussed key challenges in order to better understand global processes (social, economic and political) affecting land use transitions across the region, and the types of land use outcomes resulted from multilevel institutional arrangements. Moreover, given uneven knowledge of governance processes across

Figure 1. Session overview moderated by Dr. Gilberto Câmara (Photo: Giovana Espindola, GLP IPO).

eco-regions, this group discussed which are the scientific approaches and networking actions needed to fill the institutional gaps.

A second expert group discussed that although terrestrial ecosystems provide a number of vital services for people and society such as biodiversity, food, water resources, carbon sequestration, and recreation, the future capability of ecosystems to provide these services is determined by changes in socioeconomic characteristics, land use, biodiversity, atmospheric composition and climate. In this sense, vulnerability can be defined as the degree to which a system is susceptible to, or unable to cope with, considering adverse effects of climate change and including climate variability and extremes. Assessments regarding the vulnerability of the human-environment system under such environmental change are needed to answer important multidisciplinary relevant questions across the region. Some of the questions raised during this section's discussion were: can we agree on common properties of vulnerability in different systems? How can technology advances reduce land systems vulnerability under global change? How can such technologies be shared in a just way? How do we identify coupled social-environmental trajectories under global change as a resource to assess vulnerability? Moreover, this topic addressed how such concepts and issues are approached conceptually and methodologically in South America.

Still talking about ecosystem services (ES), a third expert group discussed that humankind benefits from a multitude of resources and processes supplied by natural ecosystems. Collectively, these benefits are known as environmental services and include products like clean drinking water and processes such as the decomposition of waste. In South America, four main types of environmental services currently stand out: carbon sequestration and storage, biodiversity protection, watershed protection and landscape beauty. The main questions raised in this topic included: what is the connection between human outcomes for ES? How are the drivers of shape the future of the landscape and what does this means for ES and people? How do land scientists speak and cooperate with stakeholders and decision makers to define research questions based on policy demand?

Finally, the last expert group discussed and addressed land change modeling and data provision for studies in South America. Land use change models are tools used to support the analysis of the causes and consequences of land use trajectories in order to better understand the functioning of the earth system and support land use planning and policy. Models are useful for disentangling the complex suite of socioeconomic and biophysical forces that influence the rate and spatial pattern of land use change and for estimating the impacts of changes in land use. Scenario analysis with land use models can support land use planning and policy, and numerous land use models developed from different disciplinary backgrounds are available. We can learn more about land use transitions in South America by looking both into modelling and provision of observations and derived data. This topic focused on approaches and methods for integrated earth system modelling, including issues of temporal and spatial scale for land dynamics studies, on recent advances in the availability of earth observation data and monitoring, as well as derived datasets on land-use and land-cover; and also on methodological progress in land change science.

The outputs of the workshop will include a GLP report, journal articles, research proposals and follow-up events. The workshop was also served as a kick off of the GLP IPO transition from Copenhagen to Brazil, which is now hosted in São José dos Campos.

Acknowledgements

GLP IPO Brazil would like to thanks Dr. Billie Turner II for chairing this event together with Dr. Gilberto Câmara. Also thanks the support from the former GLP IPO in Copenhagen, Denmark, during the preparation of the workshop, through all the advices given by Tobias Langanke and Lars Jorgensen and incentives by Anette Reemberg. We also have to thank the support of IGBP, IHDP, and IGBP Regional Office, INPE and all its staff involved, and the sponsors FAPESP, FUNCATE, Natura, and Tetrapack, for all the involvement on making this event happens in a successful way.

Figure 2. Discussion session on modeling and data provision & analysis (Photo: Giovana Espindola, GLP IPO).

LuccME-TerraME: an open-source framework for spatially explicit land use change modelling

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LuccME is an open-source framework for the development of spatially explicit land use and cover change models, built as an extension of the TerraME programming environment. LuccME simplifies the creation of deforestation, agricultural expansion, urban sprawl and other land change processes at different scales by combining basic components or developing new ones. The goals are to provide a collaborative platform for scientific advances in field, and to disseminate the use of dynamic models beyond the academic world. The framework was released last November during the GLP Workshop on Land Use Transitions in South America, and can be freely downloaded from http://www.terrame.org/luccme.

The field of land use and cover change modelling (LUCC) achieved considerable advances in the last decades, largely boosted by efforts of the IGBP/IHDP LUCC Project (Lambin et al., 2006), which preceded GLP. A wide variety of approaches and concepts underlie existing LUCC models (Briassoulis et al, 2000; Koomen et al., 2007). In spite of this diversity of modelling approaches, a common structure can be identified in several spatially explicit models (Verburg et al., 2006), as Figure 1 illustrates. Such models address the following two questions separately (Veldkamp and Lambin, 2001): where land-use changes are likely to take place (location of change) and at what rates changes are likely to progress (quantity of change). Land change decisions are controlled by an allocation mechanism which uses the suitability of each cell for a given land change transition. This suitability is computed according driving factors of location of change, using empirical evidence and/or expert knowledge. In general, three components are organized in top-down manner, in which a demand for change is spatially allocated according to the cell suitability. Such models can also be classified as pattern-based (or pixel-based) as opposed to agent-based models (Parker et al., 2003; Mattews et al., 2007) as they do not model human behaviour explicitly. For instance, a global or national demand for agricultural commodities could determine the amount of area required for agricultural crops, which the model would distribute in space according to the relative importance of driving factors, such as biophysical or accessibility factors, in a proxy of human decision.

Several well-known LUCC modelling frameworks (Veldkamp and Fresco, 1996; Pontius et al., 2001; Verburg et al., 2002; Soares-Filho et al., 2002; Eastman, 2009), which were applied to many different geographical contexts, follow this structure (Veldkamp and Fresco, 1996; Pontius et al., 2001; Verburg et al., 2002; Soares-Filho et al., 2002; Eastman, 2009). Creating models using these frameworks is relatively simple, consisting of defining driving factors and quantifying their relation to land use variables, normally using

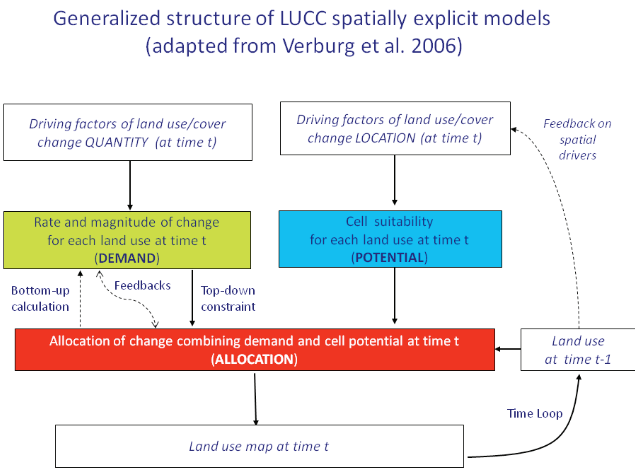

Figure 1. Generalized model structure of spatially explicit land-use change models.

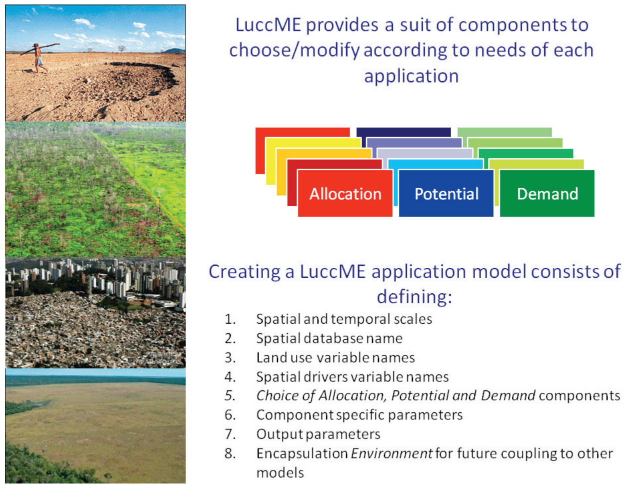

Figure 2. LuccMe-TerraME framework.

some multivariate analysis technique. However, existing frameworks employ a variety of different approaches and techniques (Eastman et al., 2005; Lesschen et al., 2007) which cannot be combined easily to explore the best method for a given application. Besides, in general they are not open-source, so they cannot be modified. In this context, the idea underlying LuccME stemmed from the following questions:

- *Can we design a generic and extensible tool based on the common structure as Figure 1 illustrates?*
- *Can we allow the modeller to combine/explore approaches and techniques proposed by different authors?*

LuccME-TerraME

LuccME allows the construction of new LUCC models combining *Demand, Potential and Allocation Components* according to the needs of a given application and scale of analysis. The components are parameterized through a simple user interface, as Figure 2 illustrates. The framework provides an initial suit of components for discrete and continuous land use variables. Due to the framework modular architecture, new components can be included, and, as being open- source, LuccME makes it possible to modify existing components or to create new ones.

LuccME is built on top of TerraME, a general programming environment for spatial dynamical modelling, which provides an interface to TerraLib geographical database, allowing models to a direct access to geospatial data. TerraME modelling language has built-in functions that make it easier to develop multi-scale and multi-paradigm models for environmental applications.

Integrated models

LuccME was also designed to support the development of land use change models which can be coupled to other models creating integrated environmental models. We encapsulate LuccME models using TerraME features for model coupling (Carneiro, 2006). Therefore, once defined they can be dynamically coupled to natural system models such as soil degradation, biogeochemistry cycles, and others. Multiscale models can be created by coupling TerraME and LuccME models defined at different scales (Moreira et al., 2009).

LuccME models can also be coupled to agent-based models. In parallel to LuccME, we are developing another TerraME extension called LuccABME. Agent based models are a promising approach for representing land use change decision processes, actors interaction, and feedbacks with the natural system (Jansen and Ostrom, 2006). But in comparison to the LuccME approach, agent-based models require more data and field knowledge to create empirical models (Robinson et al, 2006), being usually applied to small area extensions. Currently, we are combining both approaches in our CCST research projects. One example is the GLP endorsed LUA Project (Land Use Change in Amazonia: Institutional Analysis and Modeling at multiple temporal and spatial scales), organized around nested case studies. We use LuccME to construct regional scenarios, through the LuccME/BRAmazonia model. LuccABME is already being used at local (community-level) case studies. We are investigating how to adapt it to an intermediate scale, composed of several municipalities.

In summary, LuccME goal is to make the well-established demand-potential-allocation approach available to a larger audience through a collaborative and open-source framework, which can be useful in many operational projects, while the scientific community advances in the use of agent-based models to represent socio-environmental processes, also for larger area applications.

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Risk, vulnerability and adaptation capacity: a reflection about the non-reducibility of social and bio-physical vulnerability

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Over the last decade, studies on the vulnerability of human and natural systems to climate change and climate variability have gained new momentum in the face of the mounting evidence related to a complex process of Global Environmental Change (GEC) (Alwang et al., 2001; Turner et al., 2003). The latter is a broader phenomenon that embraces the whole spectrum of environmental transformations and within which multi-layered manifestation and drivers clearly relate to the industrial mode of development (not just to human action impacts on the environment per se). Within the challenges posed by GEC the understanding of the two-way relationship between society and the environment is the core element.

Climate change research has been dominated by natural sciences with an emphasis on modelling. Thus, focusing on the impact of land-use cover change on climate patterns and GEC (Simon, 2007), opens a window of dialogue among scientists; those focusing on global land change and those who have concentrated on changes in human, social and economic geographies. More recent scientific findings about the climatic dimension of GEC, widely known as climate change (IPCC, 2007), have added a policy-oriented dimension to the quest of achieving a better understanding of what shapes coupled human-environmental systems' ability to cope with and adapt to climate-related threats.

Within this multi-layered research agenda different disciplines recognise adaptive capacity as a component of the jigsaw that we need to better conceptualise to strengthen our understanding of the dynamics of risk and vulnerability (Brooks, 2003; Denton, 2002; Huang et al., 2005; Sarewitz et al., 2003; Warner, 2007). Across this literature, a remarkable debate concerns the often interchangeable use of the concepts of risk, vulnerability and adaptive capacity, which causes confusion and hinders both the understanding and the contributions from different disciplinary backgrounds and approaches dealing with climate change. The reason for this confusion is that these terms, particularly the vulnerability one, mean different things to different disciplines (Adger, 2006).

This short brief is meant as a contribution towards the clarification of the differences among these perspectives as well as their complementarities. Issues of definition and identification are paramount across disciplines; hence, I will henceforth mostly concentrate on them.

First of all, it should be noted that in order to get to the point of speaking a common language to conceptualize and measure vulnerability, it is necessary to define more precisely what is a system exposed to. Climate-related or socio-economic-related impacts are not the same thing and most importantly, may vary in a considerable way depending on the type of hazard. This is the first obstacle towards a unified definition of vulnerability. Second of all, it is key to define in what way and why different systems are vulnerable to different hazards or threats (and within them, the units of analysis that are selected for measurement); as coupled human-environmental systems are a fascinating conceptual elaboration towards greater complexity in inter-disciplinary science, but hardly measurable as such.

Third of all, as a corollary to the previous point as well as a problem of conceptualisation per se it is important to clear the ground of any doubt about what is a hazard/threat. In fact, a climate threat occurs when extreme values are recorded either significantly apart from the average values of known phenomena such as precipitation, temperature, wind speed, sea level or river flow, or when a combination of these events combines in time and place, either in terms of magnitude or intensity and duration of climatic stress. Lavell (2011) has recently discussed in an extremely coherent manner two elements that complement this definition. First, the fact that within the tradition of disaster risk management recording extreme values in rainfall, wind and other environmental manifestation is not defined as extreme but it is rather normal across scales of measurement. Second, the fact that to talk of extreme values downplays the importance of those events of smaller magnitude; which are therefore assumed as being of a lesser importance. On the contrary, both international and national literature on intensive risk has reiterated the great relevance of this type of events affecting people across longer time spans and greater geographic spatial concentrations, both in terms of accumulated impacts and costs as well as potential disruptors of achievement in well-being and socio-economic development (GAR, 2011; OSSO, 2008).

The definitions of vulnerability resulting from a vast literature review (Brooks, 2003, op.cit., Adger, 2006, op.cit.) tend to identify two different and complementary aspects:

a. Vulnerability defined as the amount (or potential) damage to a system for a given climate threat.

b. Vulnerability as a process (or value) related to the internal conditions or state of a system before facing an event related to a given threat.

As illustrated in Figure 1 these two conceptualizations of vulnerability conceptually reflect two diverging views, which influence the way we measure the vulnerability of a system as well as the type of policy intervention devised to intervene vulnerability itself. In the first case we talk of biophysical vulnerability (or outcome vulnerability), when we want to understand the final results of the impact of a phenomenon in terms of lives, losses and damages. We respond here to the question "how much is the system vulnerable to a threat X or Y?". This latter approach to the conceptualisation of vulnerability largely overlaps with the conceptualisation of risk within the disaster risk reduction (DRR) tradition In the second case, we talk of inherent vulnerability (or social), when our focus is the understanding of the internal factors of a system that make it vulnerable to shocks. In this case we are answering the question "why is this system vulnerable?"

When we look at vulnerability from the biophysical standpoint, the way events are manifested in the short-run determines our course of action, almost necessarily, trying to estimate the odds and manage risk. However, when future climate trends manifest themselves in a different way from what it is expected (or predicted by risk analysis: e.g., floods instead of droughts, etc.), much of what we have done in terms of adaptation becomes or is “at risk” of becoming a source of mal-adaptation. This

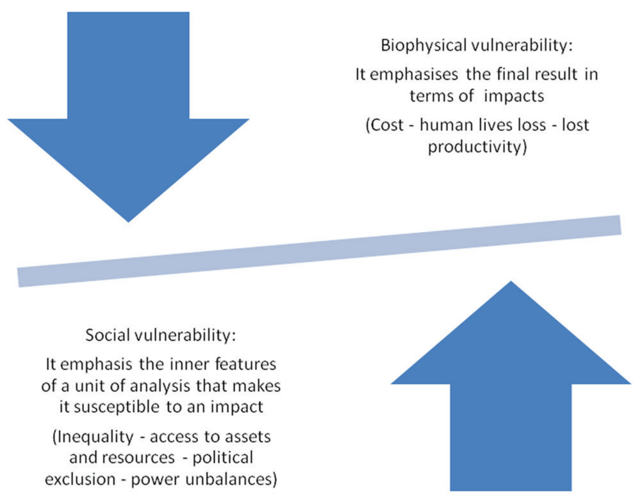

Figure 1. Two conceptualizations of vulnerability: biophysycal vulnerability versus social vulnerability (Source: Author's elaboration).

chance of perspective is first of all a philosophical matter as it entails switching from a focus on risk and capacity to predict damage to another perspective that focuses on resilience within scenarios of uncertainty. Second of all, it is a methodological and policy issue because when we look at the inner vulnerability of systems as a starting point for the analysis we are evaluating the strengths and weaknesses of actions that foster the resilience of the unit of analysis. This is to say that we become less interested in physical exposure, but more interested in understanding what makes for a greater flexibility of a system to adapt to a range of events regardless the exact knowledge of their positioning across plus-minus continuum.

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Project URBISAmazônia: what is the nature of the urban phenomenon in the contemporary Amazônia? Cities, places, and networks in the multi-scale configuration of the urban setting in contemporary Amazônia

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South America has experienced important land use change transitions particularly related to urban conversion. In Amazônia, the urban phenomenon is unfolding as a broader and complex contemporary concept, intimately linked to a wide range of aspects, but hardly expressed in the environmental and climatic official agendas. In such region, cities and towns, industrial plants, large and small ranches, mining camps, and indigenous areas work as nodes of a new urban system. This project aims to provide metrics and representations to track connections between upper and lower economic circuits, in order to define urbanization typologies and trajectories for the region.

"Without cities we would all be poor", said Jane Jacobs, years ago (Jacobs, 1970). Back in 1995, the Brazilian Geographer Bertha Becker had warned us that it was necessary to take seriously the urban agenda if, in any case, we wanted to be serious about environmental policies for the Amazônia region. She coined the term *urbanized forest* in an attempt of being provocative enough in the hope that the times were ready for shaping the debate. Still, many years later, the *urban phenomenon*, as a sound scientific object to be explored for the region, remains neglected by government related financing agencies, NGOs national and international, and also by a fairly share of the academic community dealing only with the "green" Amazônia. And, despite an increasingly important production related to the characterization of the urban fact over the last 10 years, our understanding of the nature of the *urban phenomenon* in the contemporary Amazônia has not advanced.

Recently, Monte-Mór has argued that beyond cities and towns there are various other socio-spatial forms such as mining areas, settlement and/or colonization projects, timber industries, cattle-ranching and farm enterprises, in addition to urban concentrations of commerce and services spread throughout the region. He claims that the complexity of Amazônia's current urbanization requires new approaches to understand the diverse socio-spatial forms and processes being created throughout the territory beyond the old city-country and urban/rural dichotomy. In order to account for all these diversity he brought about the concept of extended urbanization (Monte-Mór, 2004).

In his view, from cities and towns to commercial and service centers, industrial plants, large and small ranches, small settlements, rubber estates, mining camps, and even indigenous areas work as nodes in an urban system with multiple centralities. The nodes linked through different flows establish a set of interconnected multi-scale networks which rearticulate the regional space based on the local, regional and global forces.

In this context, the urban infrastructure and the social services were extended from the metropolitan regions to the medium size cities and from these to the small towns and its villages, districts, and all other new socio-spatial arrangements, producing a re-configuration within the regional space that goes beyond the old city-country and urban-rural traditional dichotomy models. Logistics and mining, in particular, have shaped the *upper circuit* of the regional urban economic activities which has been established and consolidated. Its actors and their strategies, and its structures and connections, have conditioned the patterns and processes in a mobile urban frontier, strongly characterized by their connectivity relationships.

However, these conceptual projects did prescind of an understanding of the *lower circuits* of the regional urban economic activities (Santos, 1979). These nodes, cities, villages, and others human settlement nuclei are not seen as strategic in the regional development-environment debate. As a consequence, the urbanization processes have had only tangential presence on the agendas for public environmental and climate policies in the regional space. It is essential to reclaim the debate on the possibilities of the Amazônia urbanization as a key element in re-envisioning a new model of regional development.

Against this background, the main goal of the URBISAmazônia project is to qualify and to fill the gaps in our understanding of the structure and functioning of the *urban phenomenon* in the contemporary Amazônia within a conceptual framework that supports the *extended urbanization hypothesis*. In that sense, we propose to take this challenge by open a cross-disciplinary dialogue based on field work, landscape characterization, modeling and simulation, putting together a network of eleven research institutions, from the private and public sectors in Brazil. Have joined the project: (a) a group of regional economists and urban planners from CEDEPLAR-UFMG (*Centre for Planning and Regional Development-Federal University of Minas Gerais*); (b) a group of demographers from NEPO-UNICAMP (*Nuclei for Population Studies-Campinas State University*) who will be focused on population and environment issues; (c) computational and statistical modelers from UFOP (*Federal University of Ouro Preto*) and UFPR (*Federal University of Paraná*); (d) urban planners and social scientists from UFPA (*Federal University of Pará*); (e) the tropical forest remote sensing group from *INPE-Belém*; (f) the urban systems, patterns and process group from *INPE-São José dos Campos*; (g) the micro-economists and urban planners from FGV-SP (*Getúlio Vargas Foundation-São Paulo*); (h) NEAD-MDS (*Nuclei of Agrarian Studies and Rural Development form the Ministry of Agrarian Development*); (i) the climate and health studies group from FIOCRUZ-RJ (*Oswaldo Cruz Foundation, Ministry of Health*); and (j) ITV-DS (*Vale*

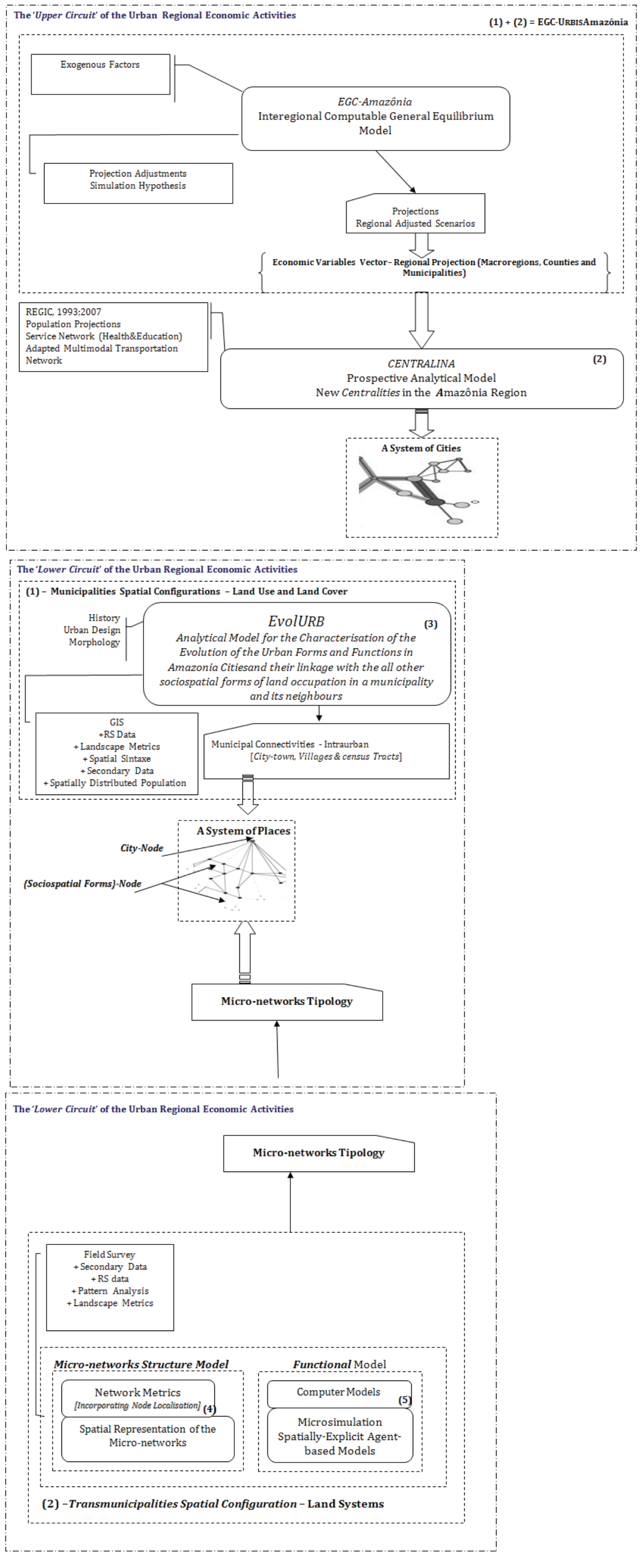
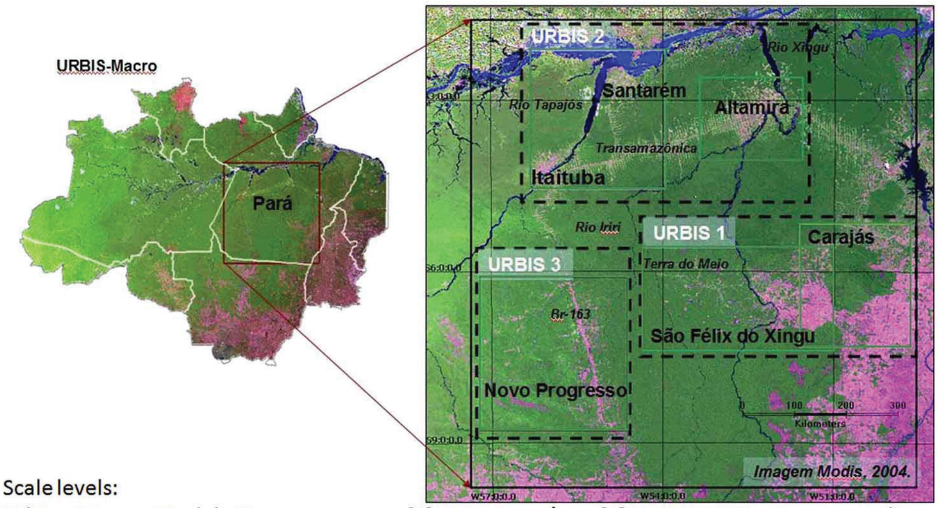


Figure 1. Conceptual framework of URBIS Amazônia, showing the spatial scales across the project. (a) macro scale, (b) meso scale and (c) micro scale.

Technological Institute- Sustainable Development) based in Belém-PA.

In addition, our project recognizes as urgent the articulation between the economic agendas proposed for the region with the network of cities and the micro-networks of traditional villages, communities, camps and small settlements located in areas of potential forest conversion. In this case, instead of being looking only for a *typology of cities* and its related hierarchy, we should be looking for a typology of networks and its possibilities of connections. Finally, we have just started the project in January, 2012. We hope that the URBISAmazônia research outcomes can provide a support for promoting an informed debate over the agendas for public environmental and climate polices across the region which must consider the contemporary *urban processes* taking place in the Amazônia and look for its possibilities as a policy-oriented device.



Scale levels:
Urbis – Macro - Models Macroeconomy – [1] CGM-Amazônia, [2] CENTRALINA - New Centralities and Network Review
Urbis – Meso – Models [1] EvolUrb - Selected areas analysis of urbanisation evolution, landscape metrics development, demographic analysis of mobility/migration and the health services structure and functioning.
Urbis – Micro – Models [1] Micronets - Localities dynamics description and analysis through micro-simulation, ABM and Complex Networks metrics)

Figure 2. Map of Amazônia and local regions selected for the URBISAmazônia project.

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Infrastructure, Institutions and Land Cover Change: A Comparative Analysis in the Southwestern Amazon

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Institutions such as land tenure set rules for land use, which influences land cover change. Driving forces such as infrastructure can modify land use and land cover. However, infrastructure may yield contrasting dynamics in land cover trajectories among lands with different tenure rules. We draw on land tenure and land cover data from the Brazilian state of Acre in the southwestern Amazon, where land tenure is highly diverse, to evaluate the land cover change. Deforestation in distinct types of land tenure areas does indeed differ, which raises further questions about the importance of tenure rules for land cover dynamics.

Infrastructure upgrades bring numerous, rapid, and complex changes to regions. While new or improved roads can stimulate economic growth via regional integration, they also fragment habitats and thereby reduce biodiversity, and may also result in social conflicts as competing interest groups contest land claims.

In the Amazon, improvements in infrastructure frequently foreshadow the expansion of land settlement and land use, resulting in land cover change. While deforestation often occurs along the roadsides, land cover change is also likely to vary insofar as land tenure rules differ; road impacts on land cover may thus be modified via the operation of institutions tied to land tenure. Where land tenure rules are more restrictive for land use, deforestation may be relatively limited, even in highly accessible areas by roads. In this sense, strong land tenure rules may permit land cover resilience to road impacts.

We focus on the southwestern Amazon, specifically the tri-national frontier where Bolivia, Brazil and Peru meet. Also called the "MAP" region – named after the states that comprise the area, **M**adre de Dios (Peru), **A**cre (Brazil), and **P**ando (Bolivia) – this is an area that remains largely forested. Paving of the Inter-Oceanic Highway thru the state of Acre and into Peru has accelerated land cover conversion. However, land tenure diversity in Acre may also yield differences in deforestation.

We draw on a land cover data set consisting of Landsat images for the MAP region at multiple points in time, combined with a land tenure map for Acre that outlines the boundaries of lands with different tenure rules. We applied standardized protocols for image processing in order to make comparisons across space and time in the MAP region. Geometric correction with 45-60 ground control points per image yielded a root mean square error of 0.5 pixels. We masked out water and clouds and classified the images as forest and non-forest using bands 4, 5, and 7 along with derived data products. Further details of the image acquisition, processing, mosaicking and classification are available in Southworth, et al. (2011).

The land tenure map comes from the Government of Acre's Ecological-Economic Zoning Plan (Governo do Estado do Acre, 2006), which includes maps of Acre's land tenure types, including settlement projects (for agriculture), agroforestry poles (for intensive land use), agro-extractive settlements (for forest management), and extractive reserves (which permit only 10% deforestation). In 2008, we visited 25 of these and other types of land tenure areas for interviews with community leaders. We systematically sampled communities in different tenure types within 20 km of the Inter-Oceanic Highway by distance from Rio Branco, the capital of Acre (Figure 1). We visited 9 settlement projects, 3 agroforestry poles, 4 agro-extractive settlements, 6 rubber estates (in an extractive reserve), and 3 other types of areas. More details are available from Perz, et al. (2011).

Here we compare land cover in those communities by land tenure type. Table 1 presents estimates of forest and non-forest land cover as of 2010 for the 25 tenure areas we visited. Overall, most land remained in forest, with roughly 38% of land having been cleared by 2010. However, forest clearing varied among tenure types within the area of influence of the Inter-Oceanic Highway. Settlement projects for agricultural production prevail along the corridor and were roughly 50% cleared. Agroforestry poles, which are small and feature intensive land use, exhibited 68% clearing which accords with expectations. By contrast, areas with more restrictive tenure rules had proportionally less area cleared. Agro-extractive settlements which emphasize forest management had only 24% of their land cleared. Similarly, rubber estates in the extractive reserve had less than 6% clearing. This falls within the 10% deforestation limit.

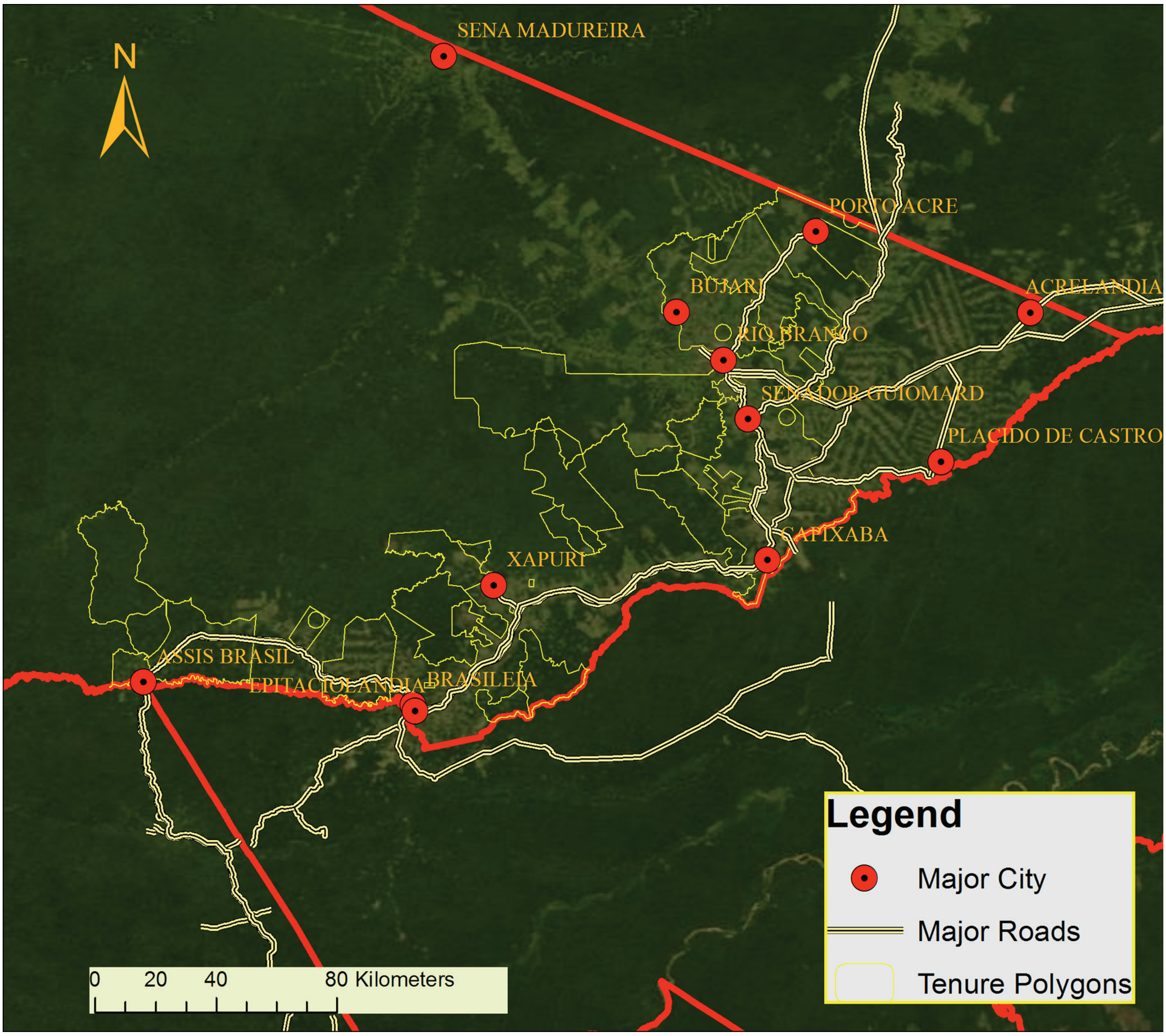

Figure 1. Land Tenure Areas Sampled along the Inter-Oceanic Highway, Acre, Brazil. Source: Qiu, Southworth, Sun, et al., Department of Geography, University of Florida

Table 1. Forest and Non-forest Land Cover by Land Tenure Type, Acre, Brazil, 2010

Tenure Type	Non-forest Area	Forest Area	Pctg. Non-forest
Settlement Projects (9)	347,724	345,906	50.13
Agroforestry Poles (3)	749	349	68.24
Agro-extractive Settlements (4)	35,422	114,152	23.68
Rubber Estates (6) (Extractive Reserve)	11,758	188,073	5.88
Other Areas (3)	15,488	28,749	35.01
All Tenure Areas (25)	411,142	677,229	37.78

As seen in Acre, Brazil, tenure diversity yields differences in the extent of forest clearing. Institutions such as land tenure rules thus modify land use and thus land cover, even in highway corridors where access to land is greater. Analyses of land cover change thus require attention to institutions such as land tenure rules. This includes evaluations of the relationship of land tenure to landscape patterns. There is also longstanding debate over the nature of the dynamics of land tenure itself. Regional integration as via road paving may modify land tenure, entraining complex land cover dynamics. As a result, there remains a need for further research on land tenure dynamics as they influence land cover change.

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Linking models of human behaviour and decision making processes with land system models

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Human actions mediated through the global land system are critical in understanding the functioning of the broader earth system and its response to global environmental change. Land system change not only impacts on the earth system, but also responds to earth system changes through a series of feedbacks. Yet, in spite of this, human actions have the tendency to be considered as external drivers in global-scale, Earth System Models. Where human actions are included explicitly in global models, such as Integrated Assessment Models (IAMs) or macro-economic models, they lack representation of the diversity of human behavioural and decisional processes. A small expert group came together in November 2011 in Crackenback, Australia to discuss how to progress research thinking in this field. This article provides a brief summary of the principal workshop findings.

Workshop outcomes

The workshop was targeted at an audience with interests in improving the scientific tools to support innovative ways of integrating our understanding of the human dimensions of global change within the more physically-oriented, climate system models. Thus, many of the participants were involved in a range of activities from across the IGBP and IHDP projects, notably GLP, AIMES, iLEAPS and the Earth System Governance Project. The workshop was guided by two fundamental research questions:

1. How can we better represent the land system in earth system models?
2. How can we improve models of the global land system by representing human behavioural and decision making processes?

The aim was to explore ideas for analysing alternative development pathways under global change by explicitly addressing decision making structures within global assessments. Such ideas are intended to help develop earth system models in the future that better incorporate human processes by moving away from the traditional top-down strategies of IAM and instead exploring the role of human behavioural and decisional models such as Agent-Based Models (ABMs), and how these might link to Dynamic Global Vegetation Models (DGVMs). The basic premise here is that the application of behavioural models at global scale levels, which include the necessary realism, would improve our capacity to understand the global coupled human-biophysical land system.

The workshop concluded that climate variability and extremes are likely to be important for impacts on land use, but that this is often ignored in land system studies.

Moreover, the indirect effects of climate change on land use (e.g. policies promoting biofuel production on land that would otherwise be used for food crop growth) are potentially much greater than the direct effects. This implies the need for a global approach in the assessment of land system change that integrates with climate assessment. However, the land use realisations of terrestrial vegetation and biogeochemistry models and of land surface models in General Circulation Models (GCMs) are disconnected from how land use change is understood and modelled by the land system community. Thus, the structure of GCMs and their treatment of land use change limit the capacity to undertake land use sensitivity experiments and therefore to understand the relative importance of the land and climate systems in terms of earth system sensitivity.

The workshop identified the important role of governance structures and institutional arrangements in underpinning land system change at a range of scales, but also highlighted the lack of modelled representation of the emergence of institutions and their role in land system feedbacks. Most local scale land system modelling studies treat institutions through exogenous policy drivers, yet at the global scale this is no longer appropriate since institutions are an endogenous component of the earth system. Likewise, technological development has been, and will continue to be, a critical driver of land system change, although very little theorising exists about the development and adoption of technology in land system models.

In treating these types of processes, a new generation of land system models needs to better conceptualise the problems of up-scaling from the local to global and the alternatives for doing this. At the local (landscape) scale, there has been considerable effort in modelling human behavioural and decisional processes based on complex systems principles, e.g. ABM, supported by empirical evidence from social surveys. However, insights from these approaches have yet to be incorporated into global scale analyses. Further development of ABM could seek to better represent agent processes of learning, adaptation and evolution in order to simulate system structural changes at different scale levels. This includes addressing the important role of connectivity across networks (teleconnections through trade, knowledge and migration flows) when addressing the land system at the global scale level. With a new generation of land system models at global scales, and their coupling with earth system models, comes the problem of model evaluation. There is currently a lack of suitable observation and proper theory for evaluating complex systems models.

The workshop is likely to lead to a number of outputs and new activities including journal articles, research proposals and follow-up events, and plans are firmly in place to deliver on these ambitions. The workshop was also a good exemplar of knowledge exchange and collaboration across the relevant IGBP and IHDP projects.

Acknowledgements

The workshop participants would like to thank the kind support of the GLP and CSIRO.

Figure 1. Workshop participants (Photo: Nicky Grigg, CSIRO)

GLP Nodal Office on Vulnerability, Resilience and Sustainability of Land Systems, Sapporo

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The GLP Sapporo Nodal Office is currently supported by the IFES-GCOE programme of Hokkaido University funded by the Japan Society for the Promotion of Science, and the Environmental Research and Technology Development Fund (S-9-3) of the Ministry of the Environment, Japan.

The Sapporo Nodal Office assists GLP IPO in promoting and coordinating research on Vulnerability, Resilience, and Sustainability of Land Systems. The vulnerability of coupled human-environment system is a major element of sustainability research. Vulnerability results not only from exposure to biophysical and social perturbations, but also resides in the sensitivity and adaptive capacity of the system experiencing such stresses. Thus, land system vulnerability is studied from an integrated perspective. The overall goal is to improve the understandings of the causal processes of vulnerability, the quality of coping capacity linked to different perturbations, and the role of governance in bolstering resilience.

Update January 2011-December 2011

International Summer School 2011 for PhD students

International Summer School "Understanding coupled natural and social systems; Feedback loops between land-use and ecosystem change" was held at Hokkaido University from June 27 to July 8, 2011. The programme was supported by IFES-GCOE programme of Hokkaido University and co-organized by GLP Sapporo Nodal Office. Hideaki Shibata (GLP SSC member) and Takashi Kohyama (Chair of Operating Committee of GLP Sapporo Nodal Office) were involved as the organizing committee. Eighteen students from 13 countries including Asia, North and South America and Europe participated. The objective of this programme was to provide unique opportunities for PhD students to learn field research and analytical methods of environmental science. Field stations and the long-term ecosystem monitoring system of Hokkaido University provided useful settings for this training. The program included field session at forest, livestock farm and agricultural farm ecosystems at Tomakomai, Shizunai, and Sapporo, poster session, lectures and group discussion. Students discussed current research findings and explored future directions for various research topics on the social and natural interaction including the feedbacks between land-use and ecosystem changes.

Field session at agricultural crop land at Sapporo, Hokkaido University.

For a detailed report, see:http://gcoe.ees.hokudai.ac.jp/inet/?page_id=945&lang=en

International Workshop "Life history regulation of forest trees: towards cross-biome analysis"

The workshop was held on September 2-3, 2011 at Hokkaido University. Takashi Kohyama and Hideaki Shibata played a major role as the organizer with support by the Sapporo Nodal Office. Forest ecosystems with huge biomass provide various goods and services to human society. The response of trees to global change is related to its life history characterized by a set of physiological, allometric, demographic and reproductive traits. This workshop aimed to seek directions of collaborative research activities on the regulatory mechanisms of forest-tree life history. Nine speakers presented latest research over a wide array of research interests and approaches, from molecular-basis of regulation to community assembly. The importance of cross-biome analysis of forest trees for understanding of forest ecosystems was shared among participants and future collaborative research plans were discussed.

ILTER Annual Meeting 2011

Annual meeting 2011 of International Long-Term Ecological Research (ILTER) was held on September5-9, 2011 at Hokkaido University. ILTER is a global network of more than 600 research sites of 43 national networks that focus ecological and socioeconomic research with long-term perspective to evaluate the structure and function of a wide array of ecosystems underenvironmental, social and economic changes. The missions are to improve our understanding of ecosystems and to provide solutions to various environmental issues. The meeting was organized by ILTER and co-organized by Japan Long-term Ecological Research Network (JaLTER), IFES-GCOE of Hokkaido University, Ecosystem Adaptability GCOE of Tohoku University and the GLP Sapporo Nodal Office. Ninety-two participants from 25 national networks participated in science programs (plenary talks, parallel workshop, group discussion, and poster session), symposium, regional meetings and coordinating committee meetings, and field excursion to JaLTER sites (Tomakomai Experimental Forest and Akkeshi Marine Station of Hokkaido Univeristy).. In the science symposium "Vulnerability, Sustainability, and Resilience of Ecosystem" and Coordinating Committee Meeting, was discussed the future direction for global sustainability from the ILTER' perspectives with the strength of network containing a wide array of ecosystems, and strategy, such as collaboration with related international global sustainability research project (e.g.: ICSU, GEOSS, UNESCO, GLP).

For a detailed report, see:http://www.ees.hokudai.ac.jp/gcoe/ilter2011/report.html

GLP Open workshop "Vulnerability, Resilience and Sustainability of Asian Land System"

For the open workshop held on November 5, 2011, SapporoNodal Office invited four researchers from Nepal's Tribhuvan University. The workshop was designed to contribute to the GLP by facilitating exchanges of information on land-use and land-cover change among Asian researchers. Following a theme gaved by the president of Tribhuvan University, a total of nine presenters from Nepal, China and Japan gave talks about the initiatives of Sapporo Nodal Office, research and education related to sustainability science and case studies in Japan, China and Nepal regarding land-use and land-cover change (including the outcomes of joint research conducted by Tribhuvan University and Hokkaido University). The presentations led to a number of additional deliveries and in-depth discussion at a closed workshop held on November 7, and it was agreed that the presenters and other researchers should jointly write articles for publication as a product of the workshop. The event laid the foundations for productive discussions at a symposium on mountainous environments in Asia to be held in Kathmandu in October 2012.

Public Forum about Himalayan Glacier Changes and Disaster

On November 6, 2011, the Public Forum "Glacier Changes and Disaster: Himalayan Perspectives on Global Warming" was held at Hokkaido University as an event of the Sustainability Week of Hokkaido University. The forum aimed to explain the impacts of global warming on Himalayas to the general public in an easy-to-understand manner to 90 people including junior high and high school students participated. It was organized by Hokkaido University with Tribhuvan University, the Sapporo Nodal Office and IFES-GCOE as co-organizer. Dr. Narendra Raj Khanal (Tribhuvan University, Nepal)

Field excursion at Tomakomai Experimental Forest of Hokkaido University. (Photo: KaribuFukuzawa)

Glacial lake in the Himalaya

gave a presentation on Nepal and the Himalayas, and Dr. Teiji Watanabe explained the nature of glaciers and the characteristics of Himalayan glaciers. Glacial lakes are known to cause glacial lake outburst floods (GLOFs) from time to time. These floods often attract media attention worldwide, and Nepal's Imja Glacier Lake in particular is frequently highlighted. Using this lake as an example, Dr. Khanal detailed disasters caused by glacier lake collapse and outlined measures to mitigate related damage and prevent disasters. It was pointed out that despite the importance of communicating the outcomes of research (field surveys) on GLOFs to residents living near glacial lakes, many researchers failed to do so. Other topics discussed included the importance in research of holding workshops in areas near glacial lakes to allow exchanges between local residents and researchers.

Noticeboard

Out, In-going SSC

The Scientific Steering Committee (SSC) of the Global Land Project thanks the outgoing members **Billie Turner II** (USA), **Gilberto Câmara** (Brazil), **Helmut Haberl** (Austria), **Jiyuan Liu** (China), and **Anette Reenberg** – chair (Denmark) for the invaluable contributions and dedication to GLP.

At the same time, we welcome the new five SSC members Erle Ellis (USA), Harini Nagendra (India), Lin Zhen (China), Neville Crossman (Australia), Ole Mertz (Denmark) and Patrick Hostert (Germany).

Erle Ellis is a biologist by education, employed in a department for geography and environmental systems. One of his main research visions overlaps with an important methodological challenge in land-change science: to extrapolate and synthesize findings from local land use studies into a general global picture. One of his important ideas is to "globalize case study research" and synthesis practices: linking researchers and studies across sites towards making globally-representative observations models and forecasts of land change and its consequences. He is also a proven expertise in global mapping of anthropogenic biomes and is participating in a US National Academy of Sciences Project to enhance public understanding of global environmental change.

Harini Nagendra's research interests focus on understanding the human drivers of land use and land cover change, with a focus on reforestation, institutions, and urbanization. Her major area of field research is in South Asia, where she has worked extensively on community and government protected areas in Nepal and India. She also coordinates an extensive program of urban research, focusing on urbanization and its impacts on green areas and connectivity in Indian cities. She has previously coordinated a number of research activities on landscape fragmentation, protected areas, and reforestation through a number of special sessions at global change conferences, special issues of journals, and an edited book.

Lin Zhen has been playing an active role in international collaboration and communication in the Chinese Academy of Sciences over the past years, having established good relations with scientists and organizations from around the world. She works as the Director of the "International Joint Research Centre for Environment and Sustainable Development of Mongolian Plateau". As a researcher in the field of land resource studies, his major expertise is the dynamics of land use change, and the impact of multifunctional land uses. Research activities and management issues expertise which would enable to introduce his experience and knowledge aiming to help other countries to manage their land resources in an effective way.

Neville Crossman's scientific interests centre on quantifying, mapping and valuing ecosystem services and how this can be done with sufficient rigor and robustness to be included in policy and decision making related to land use and landscape planning. Being from Australia, Mr. Neville experience is at regional and national scales, informing local, State and National government policy in that Country. He leads some projects focused on interrelated problem domains, like landscape restoration and revegetation aiming to reduce vulnerability of biodiversity to threats; reconfiguration of irrigation districts to maximize ecosystem service provision; planning and management of environmental water to maximize the health of freshwater ecosystems and its subsequent value to society and the commodification of carbon and the associated land use-land system dynamics and trade-offs.

Ole Mertz has worked with interdisciplinary research on land systems change and natural resource management in developing countries; also with coupled human-environment systems from local to sub-national scale. The adaptation of land systems to climate change and other external or internal factors and the complexities of isolating drivers of local people's adaptive responses. Has already edited many special issues of international peer-reviewed journals, organized international conferences and workshops as well as coordinated a Danish based international research network for environment and development.

Patrick Hostert is a physical geographer with a second degree in GIS and a Ph.D. in Remote Sensing, methodologically focused on spatially explicit data analyses to understand changing systems from local to regional scales. Advanced image processing techniques, such as classification strategies and multitemporal data analysis are major foci of his remote-sensing based research. A particular methodological focus is on hyperspectral imaging and the analysis of spectral high resolution data to facilitate a deeper process understanding from a geo-biophysiological perspective, particularly carbon cycling.

New GLP Chair

Professor Dr. **Peter Verburg** from VU University Amsterdam, the Netherlands, assumed the GLP Scientific Steering Committee Chair position on January 2012. He is a land-use scientist, specialized in spatial analysis and simulation of human-environment interactions, with emphasis on land use and land cover change, ecosystem services and scenario studies. His focus is on the development of methods and models that allow the multi-scale, system-based analysis of interactions between social-economical and environmental processes in land system. Peter Verburg is has developed, within a larger team, the land use change model CLUE which is currently used world-wide for simulation of land use change scenarios and ex-ante assessment of policies.

He is currently head of Department Spatial Analysis and Decision Support at the Institute for Environmental Studies at VU University Amsterdam and a steering group member of the Amsterdam Global Change Institute (http://www.agci.vu.nl).

New IPO Staff

Giovana Espindola is the new Executive Officer at the International Project Office (IPO) of the Global Land Project (GLP). She is a Cartographer Engineer (Military Institute of Engineering - IME, Brazil) interested in remote sensing and GIScience. She received Master Degree in Remote Sensing (National Institute for Space Research – INPE, Brazil) working on remote sensing image processing. Giovana received Doctor Degree in Remote Sensing (National Institute for Space Research – INPE, Brazil) studying the deforestation trends in the Brazilian Amazon over the last decade. In a broad sense, her research interests concern land system science and remote sensing, and more specifically, human-induced land use changes in the Brazilian Amazon. Her focus is to model and understand the interactions between socio and environmental systems.

Camille Nolasco is the new GLP IPO Project Officer. She is an Agronomist, São Paulo State University (UNESP, Brazil). Specialist in Environmental Management of Urban Areas (Federal University of Juiz de Fora-UFJF, Brazil) and Bio-dynamic Agriculture (University of Uberaba-UNIUBE, Brazil). Received a Master in Ecology, with focus on Ecology and Society, from Federal University of Juiz de Fora (UFJF, Brazil), and is a doctoral student in Earth System Science at the National Institute for Space Research (INPE, Brazil). She had been developing researches on Urban Agriculture and its links with Ecology from a broad perspective, involving both natural and social sciences. In the last years, her research concerns laid over the connections between urbanization process, land change and agriculture, with food security and political choices involved.

The most new acquisition is **Célia Migliaccio**, the IPO Assistant, who will contribute on logistics and administrative issues concerning to the IPO functioning and the demands of Global Land Project activities.

New Sapporo Nodal Office Staff

In April 2011, Ms. **Narumi Tsukui** joined the Sapporo Nodal Office as an administrative staff. Dr. **Masae Ishihara**, a postdoctoral fellow of the Field Science Center for Northern Biosphere, Hokkaido University, joined the Office from August, 2011. Currently, she is involved in the "Integrative Observation and Assessments of Asian Biodiversity", a research programme funded by the Ministry of Environment, and her research focuses on the evaluation of human impacts on diversity and ecosystem services of forest ecosystems in East Asia.

GLP Science Plan in Japanese

The Sapporo Nodal Office has published a Japanese translation of "GLP Science Plan and Implementation Strategy". PDF file can be downloaded from their web site: http://www.glp.hokudai.ac.jp/.

Announcements

Call for participants and papers: RegioResources 21

Date: May 21th -23th, 2012

Local: Dresden University of Technology, Dept. of Forest-, Geo- and Hydrosciences, Tharandt, Dormero Hotel Königshof at Dresden, Germany.

RegioResources 21 started in 2012 to establish a permanent cross-disciplinary dialogue on sustainability features in planning, decision and policy making on multiple scale levels.

The conference series intends to provide an overview on the most recent questions and innovative solutions and to facilitate the intellectual exchange and methodological transfer between different disciplines addressed in regional resource management, planning, decision making and policy support.

RegioResources 21 will be organized by Global Land Project and the European Land-use Institute as an endorsed project in GLP.

Deadline for submissions: March 30th, 2012.

More information on:
http://regioresources21.eli-web.com/

GCOE-INeT International Summer School 2012 in Samani – Japan "Sustainability for coupled human and nature"

Date: June 25 - July 3, 2012

Venue: Samani Town and Hokkaido University Sapporo Campus, Japan

The training course for international PhD students "GCOE-INeT International Summer School 2012 in Samani; Sustainability for coupled human and nature" will take place in Hokkaido University and Samani town, Japan. This program is co-organized by the GLP Sapporo Nodal Office.

Human transformation of ecosystem and landscape are the largest source of global, regional and local environment changes, affecting the ability of the biosphere to sustain life. Understanding coupled human and nature are key challenges for scientists to deliver the scientific insights and suggestions to develop the sustainable society under the changing global economy and environment. This summer school provides unique opportunities for Ph.D. international and Japanese students to learn field research, social system and analytical methods. Participants will discuss current research findings and future direction for sustainable coupled human and nature. In the school, participants will approach from local community-based "sustainability for coupled human and nature" by staying in Samani town. The main aim of the program is to encourage the participants to develop future research proposal that includes international perspectives.

Target Students: 10 Ph.D. students from overseas universities, 10 doctoral students from Hokkaido University

Cost: No registration fee is required (Flights, ground transportation and accommodation fees will be covered by GCOE)

Close of Application: March 23, 2012 (Japan time)

Contact: inet-2012@ml.hokudai.ac.

Webpage:
http://gcoe.ees.hokudai.ac.jp/inet/?page_id=1244&lang=en

Rethinking Global Land Use in an Urban Era – Forum

Date: September 23–29, 2012

Local: Frankfurt Institute for Advanced Studies – Frankfurt, Germany

Three important trends are reshaping land use locally and globally: urbanization, the growing interconnectedness and integration of economies and markets, and the emergence of new land-related agents. The magnitude and rate of change in these trends, as well as their simultaneity, requires us to re-think and re-examine land change. Absent from current land change discussions is a framework that examines the tradeoffs between land uses and agents of change at the global scale. These global-scale trends are rapidly changing the nature of land use and the underlying conditions on which decisions about land use are made. In that sense, a re-orientation of land change science that explicitly considers these is necessary. Such a new conceptualization would need to understand the linkages between land uses across geographic space and across time. However, our current approaches limit us to frameworks that ignore the connections between land uses in distant places.

The Forum will contribute to develop new perspectives and tools to better understand challenges and opportunities for sustainable land use in the 21st century. Although the need for this type of dialogue has been expressed by research communities in the natural and social sciences, and by science and policy communities, this has yet to be realized. As such, this presents a unique opportunity for the Forum to bring together not only disparate research communities from the natural and social sciences, but also from different policy and practice communities.

Goals:

To reinvent land change science by integrating new theoretical concepts with emerging real world trends in land use, urbanization, and globalization.

- To understand the growing competition for access to and use of productive land given finite land resources.
- To identify the new forms of distal land connection in the 21st century and their implications for global land use and society.
- To identify the effects of increasing global land connections and competition on local land use decisions and emergent global land governance.
- To identify new agents and practices in global land use.
- To make explicit the normative evaluations (efficiency, equity, justice, etc.) as applied to land use.

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More information:
www.esforum.de/forums/esf14_global_land_use.html

Get Involved

Global LAND Project

Join the Network

To join the GLP Network and receive the GLP e-News and the GLP NEWS, please subscribe at: **glp@inpe.br**

Call for contributions – next GLP News

GLP IPO is now accepting contributions to the next issue of GLP NEWS. If you would like to contribute, please, contact the IPO by e-mail: **glp@inpe.br**

Call for announcements in GLP e-News and Website

We are open to announce events and publications related to GLP science on our monthly GLP e-news or on GLP website. If you want to contribute, please contact us sending an email to: **glp@inpe.br**

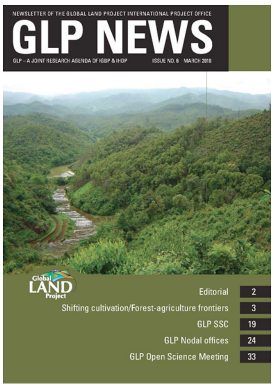
Have your project endorsed by GLP and included in the GLP Website

To have your project endorsed by GLP, please, look at the 'Getting Involved' section in our website (www.globallandproject.org) to application guidelines.

Latest issues of GLP NEWS

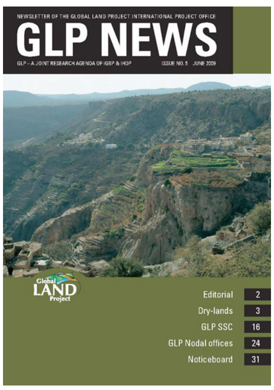
GLP NEWS No. 7 / Mar. 2011

This issue provides a taste of outcomes from 1st GLP Open Science Meeting, (Oct. 2010). Result of collaboration of GLP IPO Denmark, University of Copenhagen and School of Geographical Sciences and Urban Planning, as well as School of Sustainability at Arizona State University. A unique time for consolidation and enhancement of GLP's contacts to some of the leading international land systems science communities of the world, and a great compilation of the most important emerging issues for GLP and GEC Sciences.



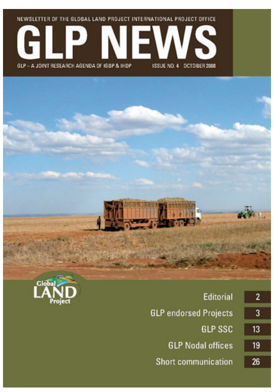
GLP NEWS No. 6 / Mar. 2010

This issue gives a short overview of land-use transitions at forest-agricultural frontiers with empirical examples from Lao PDR, Thailand, the Philippines, Cambodia and Brazil. Moreover, it includes articles from GLP SSC members and GLP Nodal Offices' up-dates.



GLP NEWS No. 5 / June 2009

This volume is mainly with contributions on dryland issues inspired by a GLP workshop hosted in Copenhagen Jan. 2009. In addition you find short communications about other GLP research activities as well as updates from the GLP Nodal Offices.



GLP NEWS No. 4 / Oct. 2008

Content includes articles from a number of GLP endorsed projects and networks, members of the GLP Scientific Steering Committee and from GLPs wider network as well as updates from the three GLP Nodal Offices.

Global LAND Project

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Layout: Carsten E. Thuesen, GEUS, Denmark
Desktop Publishing: Carlos Vieira, Beatriz Kozilek, INPE - Brazil
Printer: Resolução Gráfica - www.resolucaografica.com.br

GLP is a joint research agenda of the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP).

GLP International Project Office is thankful for the financial support from the National Institute for Space Research – INPE, Brazil

Coverpage

Conflitos
Project: Amazônia Estradas da Última Fronteira
(**Photo:** Paulo Santos)

Tucuruí reservoir in the state of Pará, Brazil. Tucuruí dam is the first large-scale hydroelectric project in the Brazilian Amazon rainforest which the construction began in 1975 and ended in 1984. From 1989, private companies were licensed to remove the submerged timber in the reservoir.