Sustaining humans and forests in changing landscapes

Forests, Society and Global Change

5th to 12th November 2012
Concepción - Chile

Conference book

Welcome message

We are greatly delighted to welcome you to the biannual IUFRO Landscape Ecology Working Group International Conference, in Concepción, Chile from 2-12 November 2012. This is the first time that the Working Group has gathered in the Southern Hemisphere, and the local hosts are proud to be the local organizers of this important event.

This Conference is organized by researchers and volunteers from the Faculty of Forest Sciences at the University of Concepción, the Austral University of Chile, and the Catholic University of Temuco.

This year, the framework for the 2012 Conference is dedicated to "Sustaining humans and forests in changing landscapes: Forests, society and global change". We certainly believe that delegates have strong arguments, based on scientific research, to raise concern on the need to manage and conserve forests for people in a context of global change. We also believe that attendees recognize that changing landscapes represent a challenge to sustain human welfare.

The 2012 IUFRO LE Conference brings together more than 300 delegates from 51 countries of all continents. The presentations are related to the topics of biodiversity conservation, forest management, spatial patterns, ecological processes, ecosystem functions and services, landscape restoration, climate change, socioeconomic connections, and urban and land-use issues. In this event, delegates will be able to exchange experiencies and knowledge through various venues such as pre-conference courses, field trips, publication of short manuscripts in BOSQUE journal, symposia, oral and poster presentations, and post-conference field trips.

We are quite sure that you delegates will have a productive exchange and discussion on forest and landscape ecology whilst you enjoy your stay in a global biodiversity hotspot. We hope that this Conference provides an important career impact in a place like southern Chile where forests compose and shape the landscapes.

Enjoy the Conference! Welcome to Concepción!

Cristian Echeverria
Chair of the IUFRO Landscape Ecology
Conference Organizing Committee

Messages from the Chair

It has been several years since we, the committee of the Landscape Ecology Working Party (WP) of the IUFRO, discussed the possibility for a conference in South America. The reason is because not only have we not had a meeting within the continent and know relatively little about its landscapes, but also because of the rapid increase in both the number of individuals and organizations and their enthusiasm. This is also well-reflected as South America holds the highest membership within the International Association for Landscape Ecology (IALE). I am confident that you will feel the high morale in this regard during the meeting. Here, we have to thank the leaders of this conference for their interests and commitments that started in early 2010. I know that amounts of work and challenges for this conference are significantly more than those of the past.

The scientific community faces pressing issues, mostly at a global scale. These include the rapid changes of the global climate, energy crisis, invasions of alien species, ecosystem degradation, conservation of biological diversity, fragmentation of virgin forests, pollution of our environment, high demands for natural resources, etc. Landscape ecologists are in the center of these issues by providing sound solutions for the policy makers and societies (i.e., human perspective). There is no doubt that landscape ecology's global perspective promises a bright future. These challenges have determined the theme of this conference: Sustaining Humans and Forests in a Changing Climate.

Previous biannual conferences have been held in the United States, Japan, Italy, Canada, China, and Portugal. In the last decade, the WP also paid much attention to publishing the papers presented at our biannual conferences. Several books and special issues based on these conferences have been published. The WP is now soliciting proposals for future conferences. Please contact any of the committee members during the conference to discuss your interests and/or plans.

Unlike other professional organizations, our WP has always been maintained so that members become individuals within a large family, with primary efforts in facilitating the communication and interaction among the members. We do have a permanent Webpage (http://research.eeescience.utoledo.edu/lees/IUFRO/), a listserv to promote communication (iufro8-l@mtu.edu), an online registration page (http://research.eeescience.utoledo.edu/lees/IUFRO/member/), and a committee structure that is composed of regional coordinators and liaisons with the IALE. As of October 2012, there are over 520 members in the WP database. The Landscape Ecology journal continues its support for a special page for us to publish important developments from the WP. To keep our communication beyond this conference, I strongly encourage you to subscribe to a membership via our Webpage and share your experiences, new developments, personnel changes, etc. via the WP's listserv. With your support and the synergetic efforts of all members, I believe that our WP will remain the most active group within the IUFRO.

The WP appreciates the kindness of our sponsors for this conference. We also owe a lot to the members of the Organization Committee, the Scientific Committee, and the Scholarship Committee for their quality work over the past 24 months. Without the financial and in-kind support of many organizations, we would not be able to have this great conference.

Jiquan Chen
Chair, IUFRO 8.01.02

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IUFRO Unit 8.01.02 Landscape Ecology
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Universidad Austral de Chile
Universidad Católica de Temuco, Chile

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Daniel Rozas, Universidad Católica de Temuco.
Fernando Drake, Universidad de Concepción, Chile.

Pre-Conference Training Courses

Course 1: Guidos: landscape pattern and connectivity analysis.

Speaker: Dr. Peter Vogt, European Commission, Joint Research Centre, Italy.

Guidos implements new techniques for the morphological analysis of landscape patterns that allows classifying the landscape at the pixel level into a set of mutually exclusive pattern categories related to fragmentation and connectivity. It can also be used to generate inputs for Conefor Sensinode. In addition, Guidos includes a variety of generic image analysis and processing tools, a complete GIS environment and statistical software for post-processing, and a graphical application for map publishing in GoogleEarth. It is being used by a variety of organizations, for example the European Commission and the USDA Forest Service.

Course 2: Analyzing landscape connectivity through Conefor Sensinode: methods and applications.

Speaker: Dr. Santiago Saura, Universidad Politécnica de Madrid, Spain.

Conefor Sensinode (www.conefor.org) is oriented to support decision making in landscape planning by identifying the key habitat areas and linkages for the maintenance or restoration of landscape connectivity, as resulting from recent developments on graph theory and habitat availability (reachability) metrics. It is also suited to evaluate the impacts of landscape change on connectivity. It has found a wide variety of applications ranging from USA to China and from Spain to Brazil.

Course 3: Economic valuation of environmental services and ecosystem restoration.

Speakers: Dr. Felipe Vásquez and Mr. Ignacio Schiappacasse, Universidad de Concepción, Chile.

Ecological restoration of forest ecosystems is regarded as an effective way to increase both biodiversity and the provision of ecosystem services. Nonetheless, the next future restoration projects will only find support if they are clearly linked to sound socioeconomic research. In this context, it is especially significant to value the benefits arising from restoration efforts. The challenge stems from the fact that the majority of these benefits are spread over a wide variety of stakeholders (both in the public and private spheres), and that these benefits are mainly non-marketed goods and services. This training course aims at analyzing the main economic methods applied in non-market valuation, with focus on the valuation of restoration projects.

Course 4: Restoration of forest biodiversity and ecosystem services in agricultural landscapes. Concepts and applications.

Speaker: Dr. Jose M. Rey Benayas, University of Alcala, Spain.

This training course aims at documenting the evidence of global ecosystem degradation and how ecological restoration is capable of mitigating such degradation, with focus on forest ecosystems in agricultural landscapes. We will show that restoration projects can be effective in enhancing both biodiversity and ES, but that conflicts can arise. Restoration in agricultural landscapes falls within two types of intervention, namely "wildlife-friendly

farming" and "land sparing". Wildlife-friendly farming includes e.g. the transformation of "simple" crops and pastures into agro-forestry systems and restoring or creating target elements to benefit wildlife and particular services without competition for land such as the introduction of living fences. Land-sparing in the farmland context involves restoring or creating non-farmland habitat at the expense of agricultural production – e.g. woodland on arable land. We suggest "woodland islets", an intermediate approach between secondary succession following land abandonment and farmland afforestation, as an approach to designing ecological restoration in extensive agricultural landscapes, particularly in low productivity environments.

Course 5: Morphometric and watershed vegetation description assisted by LiDAR technology.

Speakers: Dr. David González Lanteri, Dr. Andrea Andreoli Brasca and Carlos Jorquera Stuardo, Universidad de Concepción. Chile.

This course aims at developing skills to generate morphometric descriptions of the watershed and vegetation using terrestrial LiDAR data and aerial photographs, aided by ArcMap program. The course is taught in two days of 8 hours each in a specialized laboratory. Each user will have access to a properly equipped computer with all programs and data requirements. The course instructor will provide at the beginning of the course, a folder with the specific course content and the data files in CD, in this way each user will have the background to develop the practical activities of the course, and also to replicate the procedures latter on, when the course has finished.

Course 6: Dinamica EGO applied to landscape dynamics modeling.

Speakers: M.Sc. Letícia Santos de Lima and Dr. Britaldo Soares Filho, Universidade Federal de Minas Gerais, Brazil.

Dinamica EGO has increasingly drawn the attention of many scholars worldwide, who have applied this freeware to various modeling studies (www.csr.ufmg.br/dinamica). The course aims to introduce the potential of Dinamica EGO freeware modeling platform for environmental studies, focusing on landscape dynamics. Dinamica EGO provides a complete set of tools to develop landscape dynamics modeling, from analysis of landscape structure to the simulation of spatial patterns of change and model validation. By simply dragging and connecting data operators in a model diagram, its friendly graphical interface allows for the design from the very simple static spatial model to very complex ones, which can ultimately involve nested iterations, multi-transitions, dynamic feedbacks, and multi-region and scale approaches.

Conference Field Trips

There will be simultaneous field trips in the conference. Buses will leave from the main gate of the Sonesta Hotel according to the following program:

Field trip 1: Management of *Nothofagus* forests and forest plantations in the Pre-Andean zone of Nevados de Chillán

Guide: Dr. Fernando Muñoz and Dr. Francis Dube, Universidad de Concepción, Chile.
Departure: 8:15 hrs; Return: 20:00 hrs.
This is a 2.5-hour trip from the Coastal Range to the Andes Range, passing by the Central Valley in the Bio-Bio Region. From Concepción city, you will travel through a large matrix of forestry plantations to arrive at the Central Valley. Then you will travel to the pre-Andean zone where you can observe the Nevados de Chillán, a chain of mountains located in the heart of the Andes Range. We will visit managed and unmanaged secondary forests of Nothofagus forests located along an elevation gradient. Also, you will visit a managed forest plantation of exotic species owned by one of the largest forest companies in Chile.

Field trip 2: National Reserve Nonguén: conserving and restoring forest ecosystems and their services

Guide: Dr. Burkhard Müller-Using and Dr. Andrea Andreoli. Universidad de Concepción, Chile.
Departure: 8:30 hrs; Return: 18:00 hrs.
A 30-min trip to the recently created protected area "National Reserve Nonguén". This 3,000 ha Reserve is characterized by possessing one of the last natural forests surrounded by a matrix of forestry plantations and housings. The Reserve provides different ecosystem services such as water supply, timber, erosion control, and recreation. The Reserve contains pristine areas of old-growth forest, *Nothofagus* secondary forest, and forest plantations of exotic species. Initiatives of restoration between local scientists and the Forest Service (CONAF) have been recently established in the Reserve under the approach of Forest Landscape Restoration, and a hydrometeorological network survey has been established to assess the importance of natural forests in regulate water supply. One of the key ecosystem services provided by the Reserve is the provision of water to various towns of the metropolitan area.

Field trip 3: Meeting the millenarian Araucaria forest

Guides: Dr. Eduardo Peña and Dr. Anibal Pauchard. Universidad de Concepción, Chile.
Departure: 8:00 hrs; Return: 20:00 hrs.
A 3-hour trip from Concepción to the National Park Nahuelbuta (nahuel=tiger, buta=big in indigenous Mapuche language), located in the Araucania Region of Chile's Coastal Mountain Range. The park is a sanctuary for *Araucaria araucana* (monkey puzzle trees), with specimens dating back 2,000 years. The trip will finish at the Piedra del Aguila (1,379 m a.s.l.) This place offers a terrific view of the park's exuberant and pristine natural wonders, the immensity of the Pacific Ocean to the west, and an impressive chain of Andean volcanoes to the east. The park also provides habitat for the Mountain lion (puma), the pudu deer, Darwin's fox, and the Magellanic woodpecker, among other species. The area surrounding the park has been heavily transformed to forestry plantations and agricultural land. The landscape thus contains a biogeographic island immersed in a sea of human-induced land uses.

Field trip 4: High conservation value forest on the Nahuelbuta Coastal range
Guides: Dr. Pablo Ramírez de Arellano.
Departure: 8:45 hrs; Return: 20:00 hrs.
You will go along the foothill of Nahuelbuta Coastal Range where Chile's most extensive industrial forest plantations are concentrated. The same area has one of the highest level of endemism in Central Chile. You will visit two examples of high conservation value forest owned by a forest company: one small patch of endemic tree Gomortega keule surrounded by forest plantations and a large fragment (30,000 ha) of araucaria old growth forests connecting to Nahuelbuta National Park (Quebrada Caramávida). We will walk through the habitat of many rare and charismatic species such as Darwin´s fox, Darwin`s frog, Magellanicum woodpecker, the small marsupial "monito del monte" and the giant terrestrial snail.

Post-Conference Field Trips

Post-conference field trip 1: "Conserving native forests in private lands in the Valdivian Rainforest Ecoregion"

Guide: Dr. Laura Nahuelhual, Universidad Austral de Chile, Organizing Committee.

You will visit four private protection areas (PPA) in the coastal Range near Valdivia city, in the Los Ríos Region in southern Chile. These areas vary widely not only in terms of size (20 ha to 60,000 ha) but in terms of their owners (NGO's, timber companies and small land owners), the forest type under preservation (ancient forests of *Fitzroya cupressoides*, coastal forest of *Aextoxicon punctatum* and broad-leaved evergreen rainforest), and conservation goals (biodiversity and ecotourism).

In the first day of the field trip you will visit three PPA: i) Oncol Park owned by Celulosa Arauco timber company, ii) Punta Curiñanco owned by a CODEFF (a local NGO), and iii) Senderos Los Melies owned by Mr. Pascual Alba. This day you will hike the three areas with a unique view combining forest and ocean and will also get to know the rural landscape and local communities. The second day you will visit the Reserva Costera Valdiviana where ancient trees and an exuberant rainforest are preserved by The Nature Conservancy and other organizations. You will cross the Corral Bay by ferry boat and visit *Fitzroya cupressoides* forests located in the area protected by TNC.

Departure from Concepción to Valdivia city on Friday 9th November 2012. Return to Concepción on Monday 12th November 2012.

Post-conference field trip 2: "Excursion to millenarian monkey-puzzle forest in the Conguillio National Park, Andes Range"

Guide: Dr. Fernando Peña Cortés, Universidad Católica de Temuco.

Conguillío National Park is located 117 km from Temuco city and it covers an area of 60.832 ha. Conguillío means "water with nuts" in Mapudungun, the indigenous language. Among its main attractions are the Llaima volcano, at 3,125 m a.s.l., uncontaminated crystalline lakes and lagoons of volcanic formation, and unexplored ancient native forests. This park is also known as "the umbrellas", due to the peculiar shape of the millenary Araucaria trees (also known as Monkey puzzle trees).

The park offers diverse services such as camping and picnicking, seven trails for trekking, educational trails, and rustic cottages. All these areas are surrounded by a unique, pristine and impressive natural area called Araucanía Andina. During the field trip, we will visit lakes and lagoons inside the park. Also, we will take two trails called "The Araucarias" and "Sierra Nevada". The last one goes up to the summit of the mountain where you will enjoy a marvelous view of the Conguillío lake and the Llaima volcano.

ZDeparture from Concepción to Temuco on Friday 9th November 2012. One night in Temuco city and two nights at the Conguillío National Park. Return to Concepción on Monday 12th November 2012.

CONFERENCE ABSTRACTS

Keynote speakers

Dr. Jianguo (Jingle) Wu
Dean's Distinguished Professor of Landscape Ecology and Sustainability Science, School of Life Sciences & Global Institute of Sustainability, Arizona State University, Tempe, Arizona, USA. Editor-in-Chief of Landscape Ecology since 2005, and Editorial Board member for Ecological Economics, Frontiers in Energy, Landscape and Ecological Engineering, Acta Ecologica Sinica, Chinese Journal of Applied Ecology, and Biodiversity Science.

Landscape Ecology and Landscape Sustainability Science

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Landscape ecology is the science of understanding and influencing the relationship between spatial pattern and ecological processes on a range of scales in space and time. Spatial heterogeneity underpins the principles and practices of landscape ecology, and the ultimate goal of this science of heterogeneity is achieving landscape sustainability. In the past 30 years, landscape ecology has made tremendous progress in theory, methodology, and applications. In this talk, I will discuss the key research topics that give the field its identity and vitality, the major advances in these topics during the recent decades, and future directions as the field continues to mature. The main focus of this presentation will be on the following questions: What is landscape sustainability? What does sustainability really mean for a given landscape? How can we make the concept of landscape sustainability operational in research and practice? How can we measure landscape sustainability? How is landscape ecology related to the science of landscape sustainability? What are the key research questions to move landscape sustainability science forward? These are challenging questions whose importance goes beyond the realm of landscape ecology. Global sustainability cannot be achieved without most, if not all, landscapes being sustainable. Sustainability science will not be "actionable" or operational before we adequately understand the human-environment interactions in landscapes that link local activities and global patterns.

Dr. Rosimeiry Portela

Ecological Economist/Senior Director in the Global Change and Ecosystem Services group of the Science and Knowledge division at Conservation International (CI). She leads a team of researchers working on a variety of biophysical and economics modeling techniques to estimate provision, benefits and values of ecosystem services at multiple scales.

From Theory to Practice: The Science and Field Implementation of Ecosystem Services

Rosimeiry Portela
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I will address Conservation International's research portfolio on mapping, valuation, planning and monitoring of ecosystem services, as well the organization field experiences on conservation of biodiversity and ecosystem services. The talk will provide a sample of cutting edge, innovative research, such as the recently-released Ocean Health Index, an indicator to assess the health and benefits of the ocean, as well as research on the role of ecosystem services in adaptation strategies against adverse effects of climate change. It will also highlight field conservation efforts such as the organization's global portfolio on incentive agreements, climate mitigation as well as the Pacific Oceanscape, one of the most ambitious, innovative, and collaborative marine initiatives on Earth.

Dr. Britaldo Silveira Soares-Filho
Coordinator of the CSR (Center for Remote Sensing) and serves on graduate Analysis and Modeling of Environmental Systems. His topic of research is on landscape dynamic modelling, particulary the development of land use change simulation models and environmental assessment and regional planning.

Modeling the cornerstone concept of Landscape Ecology

Britaldo Silveira Soares-Filho
Department of Cartography, Universidade Federal de Minas Gerais, Brazil.
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Understanding the interactions between structure, function and dynamics of landscapes with human dimensions is the core aim of Landscape Ecology. In literature, however, a large number of studies have focused primarily on untangling the imprints of ecological processes on the landscape through the use of spatial metrics, since these processes are very complex to represent numerically and require extensive field data. In addition, studies on the interactions between landscape structure and function have generally been limited to analyzing the effects of spatial patterns on biota survival and dispersal. Yet the growing need to value ecosystem services at multiple scales is demanding a change in the scope of Landscape Ecology studies to increasingly develop and apply models capable of representing in a spatially explicit manner environmental processes. Not only are these models key to investigate the principles of Landscape Ecology, they also allow ex ante evaluation of the losses of ecosystem services and goods due to human-induced environmental changes. As a result, a variety of models linking land-use, ecology and climate sciences are becoming widespread. Conversely to the tradition in climate modeling science, the community of landscape modelers, including a rising number of newcomers, is seeking more than ever modeling platforms with friendly graphical interface that also deliver high computer performance. Here we highlight an application of Dinamica EGO freeware to modeling tropical understory fire as a unique opportunity to investigate, in an integrated fashion, the cornerstone concept of Landscape Ecology, i.e. how ecological processes relate to landscape structure and dynamics.

Topic: Ecosystem functions and services in changing landscapes

Symposium: The impact of land-use and land-use change pattern on the provision of ecosystem services.
Organizers: Sandra Luque, IRSTEA - National Research Institute of Science and Technology for Environment and Agriculture, France.Christine Fürst, TUD, European Land-use Institute (ELI), Germany.

Assessing and comparing risk to climate changes among locations and species habitats: implications for ecosystem services.

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Forests provide key ecosystem services including supporting, provisioning, regulating, and cultural services. Most services are linked with constituents of human well-being including materials needed for a good life, security, health, and good social relations. With both climate change and land-use change, these services change, with certain services benefited and others not. For example, a forest conversion to agricultural land may increase in the provisioning service of food generation, but decrease in many other services. With climate change, forest changes are usually more subtle in that changes in species interactions, and eventually composition may occur. These forest, hence ecosystem service, changes may occur slowly over time or punctuated by disturbance events such as those directly or indirectly associated with a changing climate. We present an approach to compare risk from climate or land-use change among species through a risk matrix, which shows species that need to have strategies developed, evaluated further, or watched. Risk is defined as the product of the likelihood of an event occurring and the consequences or impact of that event. In the context of species habitats, likelihood is related to the potential changes in suitable habitat at various times during this century, gleaned from our atlas of climate change for 134 trees and 147 birds of the eastern United States (www.nrs.fs.fed.us/atlas). Consequences are related to the adaptability of the species to cope with the changes, derived from literature. We show examples that depict a wide range of risk for several tree and bird species.

Key words: climate change, risk assessment, ecosystem services, habitat suitability.

Ecosystem services and spatial scale: the challenge of integrated territorial planning

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The emergence of sustainable forest management policy has expanded the desired range of ecosystem services from mainly provisioning and regulating to include also cultural and supporting (or habitat) services. Focusing on the boreal forest biome, the objective of this study is to compare the necessary and observed levels of integration of land use and land cover information for planning and management of different ecosystem services across different spatial scales in different sectors using forest landscapes. We studied policies and territorial planning processes in Swedish and Russian case studies regarding provisioning (sustainable harvest levels of wood and bioenergy), regulating (protective functions, carbon sequestration, water), supporting or habitat (green infrastructures) and cultural (recreation and aesthetics for human well-being) services using replicates of >1,000,000 ha areas in each country. The results indicate that the impact of land use and land-use change affect the provision of ecosystem services in different ways across spatial scales. We also found a clear rank order with respect to the scale mismatches in planning from provisioning, cultural, and regulating to supporting or habitat services. Integration of different sectors' territorial planning and management at the scales of trees in stands

for wood and bioenergy production, stands in landscapes for cultural, and landscapes in ecoregions for regulating and supporting or habitat services, is urgently needed. Further, there is a need to improve the availability and use of spatial data at multiple spatial scales and over time. We conclude that collaborative place-based learning processes need to be initiated.

Key words: boreal forest, ecosystem services, land use, territorial planning, social learning.

Estimating two centuries of forest landscape changes at different spatio-temporal scales: Pressures vs. Mitigation

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Information on land cover and land-cover change is believed to be one of the benchmark data sets which requires a common approach across countries because of its value as an environmental change indicator. French forest areas largely increased over the last two centuries. In a world of shrinking forests worldwide, Europe is expanding its forest area through afforestation. Knowledge is needed on forest stand changes, as this represents an important challenge for shaping future forest management policies. Given the relationship between the space and time scales appropriate for observing different aspects of patterns and processes, the understanding of forest dynamics can only be perceived on a scale of tens to hundreds of years. In this meaning, ancient maps (Ordnance Survey maps of France) and modern imagery represent important ancillary information to reach this goal. We present an example on the French Alps, considered a hot spot of biodiversity for Europe and also part of a LTER worldwide network. We developed a methodology to i) provide an evaluation of landscape alterations and changes, and also to ii) improve scenario development that has direct application to improve forest management, conservation, and mitigation measures. One of the most important challenges for future research will be to integrate research across different scales, including spatio-temporal scales, within an interdisciplinary and multidisciplinary framework. The work opens questions regarding the need for a comprehensive adaptive forest management under changing environmental conditions to improve timber production as well as forest biodiversity.

Key words: land-cover changes, spatio-temporal scales, driving forces, afforestation, biodiversity.

Acknowledgements: Thierion, V. Parmentier, C, Cordonnier, T., Luque, S. Irstea/Cemagref - National Research Institute of Science and Technology for Environment and Agriculture, Mountain Ecosystem Unit, France.

Land-use and landscape pattern: how to integrate both in the assessment or regional ecosystem service provision potentials

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This presentation introduces the software platform GISCAME which was designed to assess the impact of land-

use and landscape pattern changes at the meso-scale. GISCAME is a software platform including a hierarchical multicriteria assessment framework in which information on the impact of land-use pattern and its changes on the provision of eco-system services is iteratively aggregated. This includes (a) an indicator-based qualitative assessment of the impact of land-use classes in their local site and proximity context, and (b) an assessment of the additional impact of the land-use pattern by a set of landscape metrics. Based on selected case studies, we demonstrate that ignoring landscape structural effects in estimating regional potentials to provide aesthetically valuable landscapes with functioning ecosystem processes would lead to a systematic error. Landscapes with the same share of major land-use classes such as forestry or agriculture, but with different spatial pattern are either over- or underestimated. Furthermore, we could prove that replacing land-cover classes by land-use classes which use regional management knowledge (silvicultural planning + forest inventory; agricultural statistics) is an essential request to come to a sound estimation of regional ecosystem services provision potentials. In our case studies, opportunities to optimize the landscape pattern based on land-cover classes were limited. Integrating land-use knowledge and landscape structural aspects gave the basis for a detailed analysis on how to improve regional services provision under consideration of realistic opportunities to restructure the pattern of agricultural and forest land-use types which link land management knowledge with spatial planning.

Key words: GISCAME, ecosystem services, land-use & land-cover classes, landscape metrics, impact assessment.

Acknowledgements: We wish to acknowledge the German Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) for supporting the RegioPower project (22019911 (11NR199)) in which the case studies were made.

Payment for ecosystem services in Brazil: situation and challenges

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Despite Brazil's forceful environmental legislation which has been evolving since the 1930s, the country has not been able to fully achieve sustainable development. The command and control strategies preconized in its laws have been proven to be insufficient. In view of this context and following global trends, some ways to implement economic instruments in environmental management have been discussed since the 1990s. The objective of this study is to present the Brazilian experience in implementing economic instruments as a tool for environmental management and as a promoter of sustainable development. In Brazil, many strategies are being used to implement programs and carry out actions of Payment for Environmental Services (PES), such as: Ecological Sales Tax; Private Nature Reserves; Forestry and Green Grant Programs; REDD projects; Proambiente Program; Water Producer Program; and others. Despite such actions, the lack of some legal basis and adapted governance schemes still represents a limitation; however, several law projects are being discussed in the Brazilian Congress. An example is the one that establishes the Environmental Services National Policy and the PES Federal Program. The need for technical knowledge to support PES policies has emerged as a new challenge, motivating many research projects in the country. As a conclusion, it is important to point out that PES initiatives have multiplied quickly in Brazil and are being used as a complementary tool to promote environmental preservation, the responsible use of natural resources, and gradual processes of sustainable agricultural transition. However, there are still some challenges to be met.

Key words: environmental policies, ecological services, research, ecological processes, governance.

SYMPOSIA

Symposium: Ecosystem Services at a landscape scale. How far have we gone?
Organizers: Antonio Lara and Laura Nahuelhual, Universidad Austral de Chile.

Recovery of the water provision as an ecosystem service from the restoration of native forests in south-central Chile: from small watersheds to the landscape scale.

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Previous studies in the Valdivian Rainforest eco-region have demonstrated the positive correlation between streamflow and the percentage of native forest cover in the watersheds, and a negative correlation with the percentage of forest plantations cover. This evidence was the basis for the establishment of a long-term research program to examine the effectiveness, rates, response times, costs, and other relevant variables of the recovery of water provision (quantity and quality) as an ecosystem service from the conversion of exotic *Eucalyptus globulus* plantations back to native forests. This experiment, including nine small (0.9 - 123 ha) experimental watersheds, is located in Reserva Costera Valdiviana (40Â°S, 73.5Â°) and was started in 2006. After five years of calibration, in February 2011 four watersheds (total 15 hectares) covered with plantations were clearcut and then planted with *Nothofagus dombeyi*, leaving control watersheds without intervention. Natural regeneration of native species is occurring and is being monitored. In the summer of 2012, an additional 30 hectares were clearcut and will be planted with native trees. The results of this study are being used to propose a large-scale restoration plan for native forests in South-central Chile targeted towards the creation of balanced landscapes with an adequate proportion of forest plantations and native forests in the watersheds. This will permit the compatible production of timber and water (quantity and quality) as an ecosystem service.

Key words: ecosystem service, restoration, Valdivian Rainforest eco-region, water provision.

Challenges of mapping ecosystem services at the local level: a case study in southern Chile

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Maps of ecosystem services (ES) have emerged as relevant instruments to support decision making regarding landscape planning. Yet, there is much to be developed regarding methodological frameworks capable to assess ES flows and benefits, particularly at the local level. A GIS-based mapping approach was designed to spatially estimate the biophysical output and economic benefits of ES. The approach is exemplified with provisioning (timber and non-timber forest products and food) and cultural services (recreation and phytogenetic heritage) for a case study at the municipality scale in southern Chile. In the biophysical assessment, natural attributes that influence the delivery of ES were mapped as data layers in GIS. These attributes were generated based on field data, bibliographic information, and expert opinion, and were validated by social research methodologies (Delphi methods and focus groups). In turn, economic indicators were used to assess the economic benefits of these flows, with each layer containing monetary values. Critical areas of provision and benefits were

identified, which were mainly associated with forest land covers. These areas were overlapped with deforestation and farm type to identify zones of supply vulnerability. The methodological approach highlights three challenges: i) simultaneously consider the spatial distribution of potential ES flows; ii) adjust potential flows for sustainability criteria, and iii) identify how much flow is or can be translated into current benefits at the local level. This work is expected to highlight research avenues to advance the ES framework as an operational basis for local landscape planning.

Key words: ecosystem services mapping, land-use change, landscape planning.

Assessing buffer functions of native riparian vegetation in forested watersheds as a basis for the design of large-scale restoration of native forests in southern Chile

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Native forests of the Valdivian Rainforest Eco-region in Chile (35º- 48º S) play a key ecosystem-service role in determining water supply and quality. We evaluated nutrient and suspended solid concentrations as a function of streamside native forest width (SNFW) in stream draining eight watersheds located in the Reserva Costera Valdiviana, projected as a long-term ecosystem research site (39° 57` to 40º 12`S). Increases in SNFW had a positive correlation with the runoff coefficient explained by native forest cover. Multiple regression analyses of water quality variables show that, besides precipitation, strip width was a statistically significant predictor of total nitrogen, dissolved inorganic nitrogen, and nitrate-N with beta coefficients of -0.30, -0.34 and -0.40, respectively ($p< 0.05$). The analysis does not show a significant effect for phosphorus. An inverse correlation was also found between streamside native forest width and organic sand, and inorganic and organic silt/clay, with beta coefficients of -0.19, -0.17 and -0.30, respectively ($p<0.05$). We have demonstrated that in watersheds dominated by forest exotic plantations, the width of the streamside covered by native forest had a buffer effect for water yield (quantity and quality). These results support decision-making related to the conservation and management of forested ecosystem and prioritize an approach of large-scale native forests restoration in Chile.

Key words: ecosystem service, riparian vegetation, buffer effect, suspended sediment, decision-making. *Acknowledgements*: IAI CRN II # 2047, Proyecto CONAF 2010/023, MASISA and The Nature Conservancy.

An ecosystem services-based approach for the evaluation of landscape multifunctionality

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Despite the general agreement on antagonist relationships between ecosystems capacity to simultaneously sustain the availability of regulating ecosystem services and agricultural production, it is not clear how these antagonistic

relationships can be compensated by synergistic ones along gradients of landscape composition and configuration (complexity gradients). Here we analyzed the balance of synergistic and antagonistic relationships among ecosystem services (ES) along gradients of grasslands conversion to annual crops and cultivated pastures within a one million ha basin of the Argentine pampas, using a biophysical ES evaluation approach (ECOSER). A synergistic supply of crop production and regulation ES types was found at intermediate grassland conversion levels when relative total ES supply was evaluated at a large spatial scale (32 km * 32 km). Landscape composition and configuration indices showed a complementary capacity to explain spatial variation in ES, but combinations of configuration indices showed a higher explanatory value than composition ones. These evidences about nonlinear variation in total ES in relation to landscape complexity, and its sensitivity to landscape configuration, deserve further attention because of their relevance for land-use planning.

Key words: landscape services, trade off, synergies, multifunctional landscapes.

Bird assemblages as landscape restoration indicators: a case study in afforested sites at Limarí province, north-central Chile

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Revegetation is essential for recovering ecosystem functions in degraded landscapes. Usual restoration assessments consider plant survival, soil erosion, and recovery of some animal taxa. Soil degradation has been attempted to be reversed through governmental afforestation subsidies in north-central Chile, including fences, soil management, and plantations. We assessed avian assemblages as indicators of landscape health in 5 forested sites in the Limarí province, contrasting the nest density and bird richness in fenced and unfenced sites. A number of nests were surveyed during summer and spring 2011 along 10 m wide tracks. Bird species were recorded (watching and vocalizations) along zigzag tracks (sampling seasons: summer 2011-2012, spring 2011). The survey in summer 2011 was after a long drought period, and showed differences in nest numbers between fenced and unfenced sites (mean 50 vs. 18 nests, respectively $p=0.034$), while the spring survey after a rainy winter showed no significant differences ($p=0.082$). Bird species richness was 19 vs. 12 species in fenced and unfenced sites, respectively ($p=0.039$) during summer 2011; no differences were observed during spring 2011 ($p=0.493$) and summer 2012 ($p=0.302$) following a rainy winter. There were significant differences in the number of bird species for site, season, and fencing treatment (ANOVA, $p<0.0001$). *Geossitta cunicularia-fissirostris* was a good indicator of degraded landscapes, while *Patagona gigas*, *Nothoprocta perdicaria* and *Chilia melanura* were associated with longer landscape recovery. *Agriornis livida*, *Phrygilus fruticeti*, *Sephanoides sephanoides*, and *Rhodopis vesper* were associated with intermediate and later restoration stages. We conclude that native birds and the active reproductive processes (nests) are key indicators reflecting ecosystem function´s health.

Key words: landscape recovery, native birds, restoration indicators, ecosystem health, arid lands. *Acknowledgements*: We thank the PRACTICE Project (EU Commission 7FP) for funding the field work; we also acknowledge CONICYT for the main author's doctoral scholarship.

Valuation of the ecosystem functions and services of a forest-based unique landscape: A case study from India

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Jim Corbett National Park (CNP), the first national park to be established in mainland Asia in 1936, lies in the hill state of Uttaranchal in northern India, and covers an area of 521 km^2. Its geographical location, between the Himalayas and mountain foothills with streams, rivers, and ridges crisscrossing the terrain, present Corbett with a remarkable variety of landscapes. The matrix of diverse geological features of Corbett gives rise to an equally varied set of communities of life forms that live in them. Such habitats, along with their resident flora and fauna, form distinct and very valuable ecosystems. The overarching objective of the study was to assess the true and total economic value of the biodiversity resources that exist in the forest-rich landscape, and what would be

the monetary value of ecological functions performed and consequently annual economic benefits derived. The specific objectives were to find out answers to the questions such as: what would be the annual monetary value of gene pool preservation, biodiversity conservation, or carbon sequestration by forests. Methods followed in the two-year study period (2008-2010) include: review of existing literature such as the Management Plan of the Park, generate primary data of productivity where not available through survey and field work; calculate the annual yield with help of Smithies and Howard (1923) Yield Table; assign prices with the help of Travel Cost Method or with the help of Opportunity Cost Approach as a Valuation Technique; analyze primary and secondary data; and culminate the process into the annual monetary value of each of ecological function, carbon sequestration and biodiversity conservation. Results have established that: i. CNP exists with one third for direct value, one third for indirect value and one third for non-use value; ii. Total Economic Value (TEV) annually of the ecosystem functions and services is equivalent to $28.4 million; iii. Annual monetary value of carbon sequestering is $8.64 million; and iv. Monetary value of ecological functions flow is equivalent to $1.6 million per annum. Conclusions infer that Corbett National Park gives a true value of $37.3 million annually to the national wealth, which is almost eight times the accounted value. Also, its contribution to national wealth is much undervalued. Based on the study, models can be developed for assessing total economic value of similar areas. The need is to explain the environmental conservation in terms of economic parameters for better attention of both the policy makers and society at large belonging specifically to developing countries.

Key words: total economic value, Jim Corbett National Park, ecological function, opportunity cost approach.
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Deforestation, climate, and water regimes interactions in the southwestern Amazon

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The southwestern Amazon water regime has been changing in the last decades due to a variety of local and regional processes. Extreme climate events have been happening in recent years, as for example, the droughts of 2005 and 2010, and also floods as in 2009 and 2012. Natural climate shifts, global warming, and deforestation could interact to create a complex scenario. Among these processes, deforestation is expected to have a strong impact on river discharge. If only local effects are taken into account, deforestation usually leads to an increase in river discharge. However, large-scale forest removal could also affect precipitation patterns in a way that the effects on river discharge would be more complex to analyse. Using coupled atmosphere-biosphere simulations, we analysed the effects of large-scale deforestation throughout the Amazon basin on the water regime of the Purus and Juruá sub-basins. According to our simulations, if climate feedbacks are considered, deforestation is expected to have an impact in the dry season length, increasing it up to one additional month. The simulations also point to a possible decrease in the annual mean discharge of Juruá river up to 20% and 18% for the Purus river. However, if the climate feedbacks are not considered, the simulations show that Juruá and Purus rivers would have an increase in discharge of up to 21% and 23%, respectively, considering a scenario of about 40% of forest removal on those sub-basins.

Key words: land use change, deforestation, climate, hydrology, rivers.

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Evaluation of tendencies of change of the vegetative cover of the Cubillos river basin, municipio of Tausa, Colombia, based on the stochastic transition relationships of Markov's chains

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We identified and established the trends of change of the vegetative cover for the Cubillos River Basin, located in the mountainous zone of Colombia, for a period of time of 19 years. From the analysis of SPOT image for the years 1988, 1998, 2004 and 2007, the Basin´s land covers were recognized, initially: forests, paramos, rabble, water bodies, potato crops, and pastures. Later, by means of the creation of Markov's matrices and those of temporal stochastic relationships for every sequence of images, we defined surfaces clusters that allowed us to characterize the configuration and spatial dynamics of the basin´s covers. The analyses of Markov's matrices and the stochastic systems allowed us to establish that forests were the most dynamic coverage in the analyzed period of time, presenting a high number of connections with other covers of the basin. Equally, we identified a trend of loss of the forests' larger fragments and the establishment of zones of hanging discharge. The fragmentation of the forest and its spatial location affect in a negative way the hydrological stability of the basin because the gallery, hydro-regulator forests have been replaced by agriculture. The integrated temporal and spatial analysis of the classes of coverage on the Cubillos´ basin, realized in this work, indicates that it is necessary to initiate the management and recovery process of the forest near the water sources and water margins to achieve a stable eco-hydrology of the basin.

Key words: basin rivers, vegetativecover, Markov's Chains, stochastic relationships, eco-hydrology.

Forest cover and pattern changes in Oluwa Forest Reserve, Southwestern Nigeria

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This study documents the extent of resource use and the level of degradation for consequent land uses. Three distinctive trends were observed in terms of forest and land-cover dynamics. These are forest degradation, deforestation, and regeneration. We integrated a topographical map of 1969 and satellite imagery from Landsat MSS 1972 and Landsat TM 1991 and 2000 with ground truthing and socio-economic surveys to assess changes in forest resource use and land cover in Southwestern Nigeria. The satellite images were analyzed using ILWIS software version 3.4. Based on ground truth data and remotely sensed data, the study area was classified into five categories using the supervised maximum likelihood classification technique, according to Tatsuoka (1971). The accuracy assessment was carried out on the remotely sensed data. A total of 30 points each were selected for this operation and the overall accuracy of 90%, 86.7% and 85%, respectively, was obtained from the three image datasets. Results from this study suggest that resource utilization and land cover change dynamically over time. The study also revealed that the creation of forest reserves to restrict local access and resource use would have been an effective tool for regulating encroachment and logging activities if there was an effective enforcement of regulation. It follows therefore that the major thrust of environmental management should be the protection of the natural living space of humankind and integration of environmental scarcity in making decisions on all economic issues and activities.

Key words: forest resources, land cover, land utilization, multi-date datasets, sustainability.

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Spatial dynamics of forest biomass supply and energy production in Northeastern Portugal

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It has been shown that, despite its low productivity, the district of Bragança offers favorable conditions for the use of forest biomass for energy production. Forests represent 30% of the district's area, while population and energy demand are low which makes energy self-sufficiency based on the use of forest biomass achievable. Forest cover is expected to increase and population to decrease in the near future. The use of biomass for energy production is dependent on spatial factors such as the spatial distribution and productivity of forest stands, the location and size of consumption (urban and industrial), and the infrastructure network. Spatially explicit analyses of biomass supply are required to address critical issues in energy planning such as costs, efficiency, and emissions, and to optimize the location and size of biomass power plants at the region and landscape levels. In this study, we analyzed the dynamics of potential biomass supply and energy production in the district of Bragança with the objective of optimizing location and size of power plants. Forest cover data was combined with biomass yield data derived from allometric models and productivity maps generated from geostatistical methods. Optimization was addressed using GIS network analyses based on the road network, location and dimension of forest stands, and energy demand centers. Results indicated that biomass is indeed a relevant potential source of energy in most of the district. Moreover, spatially explicit optimized locations were obtained, providing the foundations for sound regional biomass energy planning, of particular relevance in a fast-changing landscape.

Key words: woody biomass for energy, forest biomass, maritime pine, *Pinus pinaster*, Bragança.

Assessing potential riparian ecosystem services using historical land-uses in a tropical region

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Riparian environments integrate many ecosystem services related to water, soils, and biodiversity conservation. In tropical regions, these sensitive ecosystems have been historically modified from natural forest to agriculture land, thereby modifying some of their ecological processes. In the last 30 years, countries like Brazil have implemented environmental policies related to conservation of riparian environments. Such efforts allowed regeneration

processes and the establishment of a new ecosystem formed by old forest remnants, new forests, and recent and old deforested areas. For these landscapes, current landuse is not able to explain the ecological processes observed, since some are reflecting historical landuses. In this study, we assessed the historical land-use changes (1962-2008) in the southeast region of Brazil, one of the most traditional agricultural landscapes. Land-use maps were derived from aerial photographs (1:20.000 scale) and parameter calculation was performed on landscape units based (100x100m quadrants) on land-use class proportions of each year. Historical land-use indices were accessed by Forest Change Curvature Profile (FCCP), Land-use intensity index (LUI) and Forest change rates (Q) calculated by LUCAT (Land-Use Change Analysis Tools) considering streams that have up to 2000 ha as contribution area. The analysis was able to classify riparian environments according to their potential for conservation purposes of water (quantity and quality), aquatic environment, soils, and biodiversity (for different taxonomic groups). We conclude that an integrated analysis of historical and current landuse is an improved approach to explain the ecological conditions of riparian environments, and the methodology is useful to assess their potential for ecosystem services.

Key words: riparian environment, landscape dynamics, land-use change, tropical forest, water.

Benefits of diversified cropping systems on yield and biocontrol depend on strength of intraspecific competition: a meta-analysis

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Diverse agroecosystems are important regulators and providers of ecosystem services. Although several studies have investigated the individual ecosystem services provided by these systems, there is a need to quantify whether tradeoffs or synergies exist between multiple ecosystem services. In this study, we conducted a meta-analysis that considered the ecosystem services of biocontrol and yield. We extracted data from research articles that reported the effects of augmenting plant diversity in agroecosystems on both yield and some measure of pest abundance, natural enemy abundance, or pest damage in a paired framework of a less-diverse and a more-diverse agricultural system. We calculated effect sizes as the log response ratio of the per-plant yield or biocontrol measure in diverse compared to non-diverse agroecosystems and determined the mean effect size, considering the additive and substitutive studies separately. We found a significant tradeoff between biocontrol and yield manifested in additive studies, with the addition of plant diversity increasing the biocontrol effect, yet decreasing the yield. With substitutive studies, however, we found a significant synergy. Furthermore, we found that among substitutive studies, there was a significant increase in yield as the ratio of focal crop to secondary crop decreased. Taken together, these results suggest that biocontrol is always improved by an increase in diversity, yet the effects on yield depend on the strength of intraspecific competition. This meta-analysis challenges a common assumption that yield is often sacrificed in more diverse cropping systems and proposes that decreased intraspecific competition can lead to an overall per-plant increase in yield.

Key words: agroecosystem, ecosystem services, biological control, biodiversity, yield.

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Forest cover change and its effect on soil erosion in tropical mountain regions: an example from the Ecuadorian Andes

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Many areas in the tropics are undergoing very rapid change at present due to a rapid increase in population and dramatic changes in agricultural practices. The steep topography, shallow soils, and unsustainable land-use practices following forest conversion often lead to enhanced rates of geomorphic activity including soil erosion, landslides, and increased fluvial incision. The role of human activity in controlling sediment production, transport, and delivery in large mountain catchments is still unclear. To assess the anthropogenic influence on erosion rates, an erosion rate benchmark, against which anthropogenic changes in erosion can be evaluated, is required. Benchmarks reflecting natural erosion rates are usually not provided by conventional sediment fluxes, which are often biased due to modern land-use change, and also miss large, episodic events. In this study, we compare present-day with natural benchmark erosion rates for 37 catchments in the tropical Andes. Erosion rates from cosmogenic nuclides in river sediment establish a natural benchmark of only 150 ±100 ton km^{-2} yr^{-1}, an average over time periods of 1000-100,000 yrs. Present-day erosion rates show large spatial variability, ranging over three orders of magnitude to as much as 15,103ton km^{-2} yr^{-1}. Our analysis shows that several catchments now display erosion rates that are at least 100 times higher than the maximum natural benchmark erosion rate. Land cover strongly controls present-day erosion rates. Our observations indicate that present-day erosion rates in well covered, but anthropogenically-disturbed catchments are comparable with long-term erosion rates for catchments with native forest.

Key words: forest cover change, erosion processes, tropical Andes, restoration.

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Oak (*Quercus robur* and *Q. petraea*) cluster planting: a regeneration technique to establish mixed oak stands and increase ecosystem functions

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Clusters are so called 'nests' or 'groups' that consist of 21 - 42 seedlings planted in an aggregated manner with 0.25 m (nest) or 1 m (group) initial spacing, and with ca. 200 or 100 such clusters per hectare, respectively. We aimed to examine how tree growth, quality, interactions between tree species, diversity, and productivity (stand basal area m^2 ha^{-1}) differed between cluster and row planting. We carried out a mixed effects meta-analysis using original data from 25 trials aged between 7-26 years from Germany, Switzerland, and Austria. We calculated tree species diversity and stand basal area in 7 trials comprising both oak cluster and row planting, established on windthrown or clear-felled sites in southern Germany. Our meta-analysis showed that global effect sizes of tree survival, diameter, height, stability, branch free bole length, and number of potential future crop trees did not differ significantly between group and row planting. However, effect sizes of these variables in nest planting were inferior to row planting. We found trainer tree density in clusters significantly influences tree survival and quality.

Natural regeneration in group planting was significantly higher than row planting; however, total stand basal area (natural regeneration and plantation together) did not differ significantly between group and row planting. Tree species diversity was significantly higher in cluster planting than row planting. Tree species diversity significantly increased productivity in cluster planting. Significant silvicultural and ecological gains could be made, at least for several decades, if group plantings were more broadly pursued for reforestation purposes.

Key words: stem quality, meta-analysis, tree species diversity, productivity, Oak regeneration.

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Reforestation in the Loess Plateau, China: ecological benefits vs. economic input of Grain-for-Green project

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The Loess Plateau is well-known in the world for its severe soil erosion and poor land cover. Since the 1950s, many efforts were made by the Chinese government in controlling soil erosion and improving ecosystem services. However, the results are not as good as expected. In 1999, the Chinese government initiated the Grain-for-Green Project (GGP) aiming at improving vegetation and ecosystem services by reforestation in the loess plateau. Because of the fragile conditions, the consequences of the project are still in debate, including how the ecological benefits and economic inputs of this project are to be examined. In this study, the land use/land cover change in the loess plateau due to GGP was identified by using ETM images, and the ecosystem services on soil conservation, soil carbon sequestration, water resources, and grain provision were estimated. It was found that the services on soil conservation and soil carbon sequestration are largely improved but not the water provision. Grain provision stayed the same although the farmland area was decreased. Further, when the ecological benefits and economic inputs of GGP was evaluated inthe Yanhe river basin in the northern loess plateau, it was found that the efficiency of GGP was much higher in the regions with poor vegetation as compared to highly vegetated areas. The efficiency of GGP is also largely affected by the rainfall pattern. We suggest that much effort should be input to the vegetation-poor and relatively rich rainfall-areas in implementing GGP.

Key words: The loess plateau, reforestation, Grain-for-Green Project (GGP), ecosystem services, trade-off.

Acknowledgements: Financial support for this research comes from the National Natural Science Foundation of China (40925003; 41071122).

Ecosystem services and quality of life in the riparian corridor of the lower Orinoco.Venezuela

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The management of ecosystem services (SE) generated by natural capital (ecosystems and biodiversity) requires work from an integrative and interdisciplinary perspective, i.e., understanding the complex and dynamic

relationship between nature and society. To do so, we must pay equal attention to observing how the changing socio-cultural situation determines the integrity of ecosystems and biodiversity status and how changes in natural capital determine human welfare. The frequently flooded forests located in the riparian corridor of lower Orinoco, among other things, are important for sustaining local fisheries, livelihood, and lifestyle of its inhabitants. These riparian forests have been degraded in areas near major cities by the increase in land use and change of landscapes. The objective of this study is to analyze this change, as the deterioration of coastal ecosystems may be affecting the quality of life of its inhabitants. Documentary research was conducted, to which we posed the following questions: what are the main ecosystem services provided by these ecosystems? What is the relationship between SE and quality of life? How can we understand the vision of social-ecological systems? To ensure the socio-ecological system is sustainable, management policies, land-use planning, and decision making should be aimed at maintaining the ecological integrity of the riparian landscape and defend the cultural roots of its inhabitants.

Key words: ecosystem services, social-ecological systems, human welfare, quality of life.

Understanding the impacts of land use change and human settlements on the ecosystem functions of the Molawin-Dampalit Sub-watershed through participatory approaches

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The Molawin-Dampalit subwatershed, a part of the Mt. Makiling Forest Reserve, is important for its high biodiversity and is a major source of water for the surrounding municipality of Los Baños. An initial rapid assessment of patterns and drivers of land-use changes aimed at developing an understanding of the interactions between land cover, economic intensification and river-catchment functioning in the Molawin-Dampalit subwatershed was done through the conduct of Participatory Rural Appraisal (PRA) approaches in upstream, midstream and downstream communities. The three study sites underwent various land use changes driven by demand for food, livelihood and settlement area; policy intervention; and the need for sustainability of agricultural systems. The upstream and midstream sites underwent land use change from forest to agroforests and agricultural areas. The lakeshore site underwent major land use change from agricultural to mainly settlement area due to rapid increase and dense human population. The current main issue in the upstream site is the lack of livelihood sources while landslides and flashfloods were the main problems in the midstream site. In the lakeshore site, the main issue is the decline in the productivity and quality of fish caught from the lake due to uncontrolled dumping of toxic, domestic and household wastes into the lake. Various solutions were proposed by the communities to address these various livelihood and environmental concerns. This study demonstrated the effectiveness of PRA approaches in involving the local community in understanding the environmental problems they face and crafting solutions to address their issues.

Key words: tropical rainforest, land use change, participatory rural appraisal, environmental degradadtion, Molawin-Dampalit subwatershed.

Acknowledgements: The authors wish to acknowledge the cooperation of the local communities in the conduct of the PRA activities in the three study sites, the support of the Local Government Unit of Los Baños, Laguna.

Assessing ecosystem function by soil quality and primary productivity with hyper-spectral remote sensing in desertified dry-lands, Israel

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The objective of this paper is to evaluate the functional state of managed semi-arid ecosystems by hyperspectral remote sensing (HSR) using soil quality and net primary productivity (NPP). The managed ecosystems include: rain-fed afforestation, water harvesting afforestation, and intensive and traditional grazing systems in the northern Negev, Israel. We monitored soil quality, NPP and landscape patterning on a small spatial scale by HSR and common laboratory and field methods. Based on spectral data that show a significant capability to predict soil properties and primary productivity using the VNIRA (0.4-2.5 μm) strategy, we upscale the data analysis to a large area. We adapted the assessment of soil quality as proposed by Cornel University. The soil quality variables that were tested include biological, chemical, and physical indicators (total of 14 indicators). The vegetation variables that were tested as indicators for ecosystem state were: above ground biomass, plant cover and density. As to the relationships between field and HSR, a high correlation (R^2=0.89) was found between in-situ biomass measurements and spectroscopic-derived NDVI. The use of hyperspectral spectroscopy to evaluate landscape pattern by classification methods, such as patch cover, patch density, and patch size distribution, revealed a significant difference between land-uses. The soil assessment provides a comprehensive tool to perform critical environmental function at relatively modest cost and help target management. The use of HSR to evaluate soil indicators shows a promising tool for several soil quality indicators and with both cost and statistical power advantages.

Key words: managed land-use, ecosystem function, net primary productivity, soil quality, hyperspectral remote sensing.

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Study of macrofauna of some forest systems in Algeria

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The study of the soil macrofauna in forests of Tighaghar, Beni Slimane, and El Maddad were sampled by the method of direct manual sorting of cylindrical tubes of 10cm x 20cm. The groups represented are the earthworms, gastropods, the Fourmies, Arachnids, beetles, Chilopoda, Diplopoda, Hymenoptera and Lepidoptera larvae. Oligochaete species sampled are represented in three families, eight genera and ten species. This stand is characterized by considerable heterogeneity in different bioclimatic zones with high concentrations in the wet. However, there is a lack of diversification in the arid bioclimatic stage.

Key words: forest, macrofauna soil, diversification, arid bioclimatic zone.

Implementation of a hydrological model to estimate the effects of land-use change on water yield in the northeast of Portugal

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Land-use change affects hydrological processes through changes in evapotranspiration and surface and subsurface water movement in the landscape. Concern in the Mediterranean region has grown recently due to the prospects of a reduction in precipitation and the occurrence of large periods of drought, potentially affecting human communities and biodiversity. Land-use change at the watershed scale is therefore both a key water management and conservation issue. Our research consisted in the implementation of a hydrological model in the Upper Sabor river catchment, Northeastern Portugal, to evaluate the impacts of land-cover change on hydrological processes, namely water yield. Our research question was how landscape change will affect water yield in the Upper Sabor in the near future, considering change of the type and rate observed recently. This catchment was chosen to represent landscape composition and configuration in a changing mountain area of the Mediterranean region where types and rates of land use change are known in detail for the last 50 years. SWAT (Soil and Water Assessment Tool) was the model chosen to address the research question. The implementation of SWAT consisted of data gathering, preparation and database development: elevation, land use/land cover, weather, soils and land management practices. Model validation was done considering data on streamflow between 1990 and 2008. The effect of land-use change on water yield was analysed by comparing land use in the watershed during the validation period of time with projected land-use patterns based upon observed trends.

Key words: landscape change, hydrological model, SWAT, Sabor watershed, Portugal.

Above-ground growth and carbon sequestration in secondary *Nothofagus betuloides* forests in South Patagonia, Chile

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The aim of this research was to estimate the above-ground carbon sequestration at the stand level and in various tree components (leaves, branches, stems) of two secondary *Nothofagus betuloides* stands located in the península Antonio Varas, south Patagonia (51.8°S, 72.7°W; 50 m. a.s.l.). Two secondary *N. betuloides* stands were selected for the study (mean stocking density of 1.88 trees ha^{-1} and mean basal area of 55.3 m^2 ha^{-1}). To estimate the tree carbon accumulation, a destructive sampling method was carried out. A total of 32 trees were harvested, and then trees were separated into the following components: leaves; branches; and stem components including sapwood, heartwood and bark. Above-ground biomass and volume were estimated with already published equations. The annual diameter, height, and volume growths of the trees were estimated in 1.77 mm $year^{-1}$, 27 cm $year^{-1}$ and 0.004 m^3 $year^{-1}$, respectively. At the stand level, a mean increment of basal area of 0.68 m^2 ha^{-1} $year^{-1}$ and 7.3 m^3 ha^{-1} $year^{-1}$ in volume were estimated. The annual above-ground biomass increment was 5 t ha^{-1} $year^{-1}$. On average, the sapwood carbon content was 47.1 %, the heartwood carbon content was 47.9% and the leaves carbon content was 48.1%. At the stand level, a total of 127.7 t ha^{-1} of carbon was estimated, with the highest proportion in the stem (105 t ha^{-1}), 20 t ha^{-1} in branches and 2.7 t ha^{-1} in leaves. The mean annual increment carbon storage of the stand was 2.4 t ha^{-1} $year^{-1}$.

Key words: *Nothofagus betuloides*, second-growth forest, forest biomass, carbon sequestration.

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POSTERS

Multitemporal evaluation of change in the ecosystem services of water supply and regulation in the municipalities of Maullin and Ancud, southern Chile

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Hydrological processes support ecosystem services (ES) which are essential for human welfare. Land use and cover change (LUCC) alters these processes and therefore the provision of the ES that ecosystems provide to society. We analyzed the evolution of flows and the spatial distribution of the ES of water supply and water regulation, relating these changes to LUCC in the main watersheds of the municipalities of Ancud and Maullín in southern Chile. Using Landsat images (TM and ETM +) from 1985, 1999, and 2007 and spatial analysis of LUCC, we found that between 1985 and 2007, forest cover decreased from 125.9 ha to 103.2 ha (22% of the original forest cover) at an annual rate of 1.05%. The main direct drivers of forest loss were: degradation through logging, agricultural expansion, and exotic plantation establishment. Subsequently, we modeled water supply and regulation for each watershed with a physically based distributed hydrological simulation model (SWAT- Soil and Water Assessment Tool), using cubic meters per unit time supplied by each sub-basin as the indicator of ES flow. Given LUCC trends and dynamics, the spatial and temporal variations of watersheds' land cover generated a decrease in mean monthly flows of around

15% for the study period. This finding supports the role of native forests in maintaining water supply and regulation. This initiative is the first attempt to map the ES of water supply developed in Chile and provides new insights for decision making about water resources conservation and planning.

Key words: ecosystem services, water supply, land use and cover change, southern Chile.

Acknowledgements: Institute of Earth Sciences and Evolution, Faculty of Sciences, Universidad Austral de Chile and National Commission for Scientific and Technological Research - CONICYT.

The degradation of ecosystem services on forest communities of Central Russia due to forest fires in 2010 (on the example of Vladimir region)

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The concept of "ecosystem services" being included in environmental management is relatively recent. Traditionally, fees for use of forest communities include payment for provisioning services, such as timber production by forests. However, other types of ecosystem services: regulating, supporting, and cultural, are not paid. Forest cover of the Vladimir region is higher than the average for Russia (51.2% vs. 45.4%, accordingly). The basis of forests is conifers, dominated by the genus *Pinus*. The fires of 2010 greatly changed the volume and quality of the forest ecosystem services. It affected the people's welfare, including changes in health (level of respiratory disease due to inhalation of smog), limitation of access to resources (the prohibition of entry into the forest to relax, and hunt for mushrooms and berries), reduction of individual and social security (the threat of fire inside the house), and the changing of social relations. The fire damage, which was in Central Russia, was largely determined by a combination of extreme temperatures and poor management of forest ecosystems. This combination led to the degradation of ecosystem services from all groups (the destruction of timber, climate regulation, the formation of soils, and the aesthetic value of landscapes). Actual costs for suppression of forest fires in the Vladimir region amounted to 50.3 million rubles in 2010. Direct damage from forest fires in the area, according to official statistics, is 230 million rubles. Unfortunately, methods for calculating damages in Russia do not include indirect losses, including the cost of essential ecosystem services that burned out natural areas provided to people.

Key words: ecosystem services, Russia, Vladimir region, fire 2010, indirect damage.

Liana's coverages in an edge forest x pasture and its effects on natural regeneration – the case of a semi-deciduous forest fragment in Piracicaba, SP-Brazil

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The Atlantic forest originally covered about 15% of the Brazilian territory. The pressure from the spreading population led to the conversion of millions of hectares of forests to cropland areas, resulting in a profound

biome fragmentation. These forest fragments mostly measure less than 10 ha and are located predominantly inside private farms, where it is surrounded by agricultural crops. Natural regeneration is a great indicator of perpetuation capacity of species in different environments. This study aimed to analyze the condition of arboreal natural regeneration of a fragment of an Atlantic Semideciduos Forest located in the municipality of Piracicaba-SP, Brazil. Twelve radial transects with dimension of 1x50m (subdivided in five parcels of 1x10m) were installed from the border to the center of the fragment. All arboreal species within one meter height were quantified in each parcel. In four transects of 10x50m, canopy coverage and liana's participation were evaluated by repeating the measurement five times every 10 meters. It was found a slight tendency to increase the regeneration density towards the center of the fragment. Canopy coverage had a positive effect on the arboreal regeneration density. Liana's coverage didn't have any significant effect on regeneration. However, this information cannot be assumed as an indication of forest preservation and conservation of species. It is necessary to evaluate the young trees that manage to overpass the barrier of lianas.

Key words: vines, edge effect, liana's coverage, canopy coverage, Atlantic forest.

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Modeling impacts of land-use changes in sediments and nutrients on lake basins of southern Chile

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Araucanian lakes are characterized by an oligotrophic condition, namely high quality waters and abundant wildlife. Yet another feature of these basins is that they have a high dynamism in the conversion of existing land use -- high rates of deforestation and land clearance for agriculture which are of concern because the fertilizers, based on phosphorus and nitrogen, are transported to water bodies, which over time, could generate high levels of eutrophication. This paper will analyze trends by using satellite images and a spatially explicit model to assess the relationship between land-use change in 25 years, rates of sediment export (tons/ha/year), and the load of pollutants such as phosphorus and nitrogen (mg/L) in two basins-lakes. We also assessed different scenarios of deforestation in areas of excessive slope to assess its impact on hydrological components. The results show a positive relationship between the change in land use and increased levels of suspended sediments and pollutants in the outflows of studied basins. Work is expected to provide information on the current state and future of the relationship of land-use change - hydrological components (sedimentation and water quality) which will be essential to support decision making for conservation and watershed planning.

Key words: Araucanian lakes, land-use change, pollutants, suspended sediments, eutrophication.

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Environmental impacts of the land-use dynamics in the western slope range of Nahuelbuta

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The changes in land use have had devastating effects on most of the world's ecosystems. In Chile, the process of change in land use has been associated with large economic cycles, generating social and environmental impacts at the national and local levels. The landscapes of humid ecosystems of the Nahuelbuta Range have been strongly modified by the incorporation of forestry. The objective of this work is to evaluate the social and environmental implications of these changes. With spatial analysis techniques, Landsat satellite images 2000 and 2010 are interpreted in order to rebuild a land cover to make up the landscape of the western slopes of the Nahuelbuta Range (Providence of Arauco). This allowed us to compare and identify natural and anthropic factors that influence the spatial distribution of changes in the study area. The highest percentages of change during this period were the result of forest plantations and agricultural areas. By contrast, the largest declines were experienced by the beaches, dunes, meadows, wetlands, and native forest. We discuss the environmental and social implications of these changes in the landscapes of the Nahuelbuta Range.

Key words: Nahuelbuta range, land-use change.

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Landscape forest area and edge effects on pollinator diversity and abundance in blueberry fields in Southern Chile

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During recent decades, agricultural intensification has reduced the proportion of non-cropped habitat in many rural landscapes, as well as the area of suitable habitat for beneficial insects such as pollinators and natural enemies of agricultural pests. We examined the effect of retaining non-cropped habitats on pollinator diversity and abundance in eight blueberry fields in the central valley of Southern Chile during spring 2011. Area of forest as well as other land-cover types surrounding each blueberry field was measured at different spatial scales, ranging from buffer distances of 100m to 3500m. Pollinator diversity and abundance were estimated based on visual observations and yellow pan traps. The association of landscape factors and pollinator diversity or abundance was evaluated using a Spearman rank correlation test. The amount of surrounding forest habitat had no significant effect on queen bumblebee abundance at any scales but was significantly ($p<0.05$) positively associated with pollinator diversity at buffer distances of 2000 to 3500m. Queen bumblebee abundance was significantly associated with the amount of forest edge within buffer distances of 1500m and >2500m ($p<0.05$). This positive association with forest edge probably reflects the proximity of crop pollen and nectar resources to suitable shelter habitat.

Key words: forest edge effects, crop pollination, bumblebees.

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Impact of the perturbation by "champeo" activity on the grasslands of the rural community "Villa de Junín"

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The succession process of the vegetal formations of puna grass and bofedal was evaluated within the lands of the rural community "Villa de Junín" in the National Reserve of Junín, Perú. Both types of vegetation were impacted by vegetal extraction under the traditional modality called "champeo", which has an objective to use the biomass as fuel. Floristic composition and vegetal coverage of the perturbed vegetal formations were evaluated, finding out that the puna grass diversity was reduced almost in one half considering initial values, while diversity reduction in the bofedal was even greater. The floristic composition evaluation allowed the identification of *Ranunculus flageliformis*, *Carex ecuadorica,* and *Werneria pygmaea* as pioneer species in both vegetal formations. This study showed that the puna grass has an ordered succession sequence, that allowed identifying attractors before and after the perturbation, while the bofedal showed a discontinuous process; this suggests a less predictable behavior which is more dependent on the dynamics of environmental variables. Finally, after three years and ten months of field study post the disturbance, it was possible to recognize that the puna grass was able to recover its diversity and coverage faster than the bofedal.

Key words: puna grass, bofedal, succession, biomass fuel.

Evaluation of the Scarabaeoidea superfamily (Insecta: Coleoptera) as surrogates for anthropogenic disturbance of Amazonian forests: study case in the Amacayacu National Park, Colombia

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We evaluated whether beetles of the Scarabaeoidea superfamily may be used as surrogates of anthropogenic disturbance of amazonian terra firme rain forests, in order to provide guidelines for monitoring strategies of the Amacayacu National Park. In three different levels of anthropogenic disturbance (i.e. low, medium, high) 12 transects were established, four in each intervention level, to caught all beetle species. Three interception traps, two light traps, three pitfall and four carpo-traps were used per transect as well as manual catch. In total, 593 individuals belonging to 92 species, 44 genera and 7 families were collected. Scarabaeidae (n=232, 27 spp.) y Melolonthidae (n=206, 41 spp.) were the families with the highest number of individuals and species, while Aphodiidae y Geotrupidae exhibited the lowest. The most abundant species per family were Ateuchus sp. (33.2%) from Scarabaeidae, Cyclocephala verticalis (43.7%) from Melolonthidae, Ceratocanthus amazonicus (66.7%) from

Ceratocanthidae y Chaetodus asuai (96.8%) from Hybosoridae. Results showed that the number of species and individuals increased with anthropogenic disturbance. The Margalef and Shannon indexes also revealed that the highest richness and equity occurred in the high-disturbed site, respectively. Melolonthidae exhibited the highest number of exclusive species per gradient, while Scarabaeidae shared most of its species. Ten species were recorded in the three disturbance levels, 26 in two and 56 were exclusive to one level. Of the most abundant species Chaetodus asuai (Hybosoridae) presented a significant decrease in the number of individuals as disturbance increased, while an inverse relationship occurred for Cyclocephala verticalis (Melolonthidae). For Astaena sp. (Melolonthidae) and Tomarus gyas (Melolonthidae) a high number of individuals was recorded and were exclusive for one forest site (low and high disturbed forest, respectively). We discuss the use of richness and diversity as indicators of disturbance, while we highlight abundance of particular taxa as a better metric for disturbance.

Key words: Amazon forest, beetles, ecological integrity, Hybosoridae, indicators, Melolonthidae, Scarabaeidae.

Topic: Forest landscape restoration

Symposium: Experiences in Restoration Ecology in LatinAmerica
Organizers: Cecilia Smith, Instituto de Ecología y Biodiversidad (IEB), Chile

Ecological restoration of islands in Latin America: advances and challenges

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The Juan Fernández and Galápagos Archipelagos are biological hotspots and global conservation priorities. Biodiversity is threatened in both archipelagos by invasive species. Invasive mammals are novel predators and herbivores, decimating island species without evolved responses to these pressures, while invasive plants encounter novel conditions to establish and expand their distributions. Resulting from invasive species, the majority of endemic forests of Juan Fernández are predicted to disappear within 50-80 years, while a similar outcome is predicted for forests of Floreana, Isabela and Santiago Islands, Galápagos. Invasive species eradication is desirable in most cases, eliminating threats and continuing costs of control, while providing conditions for recovery by native species. Plant eradications have been possible within the Galápagos Archipelago for species with certain characteristics, and similar programs began in Juan Fernández. However, invasive plant removal programs active on both Juan Fernández and Galápagos Archipelagos do not keep pace with the expansion of some invasive species. For example, annual advances of invasive plants are approximately 20 times the area controlled mechanically in Juan Fernández. Facing similar dilemmas with widely established invasive plant species in Galápagos, management agencies are exploring biological control as eradication is infeasible. Management programs to eradicate animal invaders such as rats, rabbits, goats and pigs have been successful within these archipelagos, and planning is underway to remove mammals from additional islands under increasingly complex scenarios. Addressing multiple invasive species in one campaign provides cost savings and minimizes undesirable ecological interactions resulting from changing population sizes of invasive and native species.

Key words: Juan Fernández Islands, Galapagos, conservation, invasive plants, invasive animals.

Networking efforts to support large-scale restoration

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Ecosystem restoration in Brazil has shown great advances over the last 20 years. Planting tree saplings according to highly diverse designs has well succeeded in returning ecological processes to somewhat degraded areas. Despite the good results, well-known successful restoration has been restricted to a few regions, to a small group of researchers, and to a few ecosystems types. Restorationists working on ecosystems elsewhere are lacking access to information on successful restoration actions. On the other hand, the low cost-effectiveness of planting forest saplings has motivated people to propose alternative solutions. For the last five years, networking has been underway to gather restorationists from all over both Brazilian ecosystems and regions. In 2010, a group of 15 restoration researchers decided to create the Brazilian network for ecological restoration (REBRE). A first meeting gathered a group of 25 researchers and students who identified nine great gaps in the knowledge of ecological restoration in Brazil. The first gap was how to control invasive exotic species in a cost-effective way in the restoration process. In July, 2011,

the website of the REBRE was launched, and restorationists in general have been invited to become members. A discussion forum has proposed the topic of how to effectively control invasive species in ecological restoration. The interactive debate involves, to date, 130 members, and has already resulted in two important proposals: the organization of a Brazilian Symposium on invasive species control in restoration actions, and the building of partnerships to develop a network research on that topic.

Key words: REBRE, invasive plants, tropical forests.

Challenges for forest landscape restoration in Mexico

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Forest landscape restoration seeks to improve both human livelihoods and ecological integrity by restoring natural capital for the provision of ecosystem services and stimulating multifunctionality in landscapes. Mexico is a highly diverse territory from both the natural and cultural point of view. The country encompasses about 2 million km^2 and it is among the top five countries of the world for endemism of both vascular plants and vertebrate species. However, Mexico's forests are threatened by habitat loss due to degradation and fragmentation, unsustainable and illegal natural resource use, and global change. It has been estimated that 50,000 ha/year of forest (making reference only to temperate and tropical forests and shrublands) have been lost in the period of 1976-2000. Mexico's land use is dominated by secondary vegetation; as of 2002, only 38% of the original tree vegetation cover remained, and the most affected was the tropical forests. The scenario is even worse if we consider that 40-60% of these forests are secondary forests. As a national response, Mexico's government has implemented reforestation programs, and according to the FAO report of 2010, Mexico increased the surface dedicated to reforestation from 350,000 to 3,203,000 ha between 1990 and 2010. In this talk, a diagnosis of the practice of ecological restoration applied to Mexican forests will be presented. The opportunities and challenges to restore Mexican forested landscapes will be discussed. Financial limitations, land tenure, legislation, social organization, and conflicts will be related to the challenges faced by restoration practitioners.

Key words: ecological restoration, deforestation, watershed management.

Passive and active techniques may enable plant restoration in central Chile

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Knowledge about the role of different factors affecting the success of plant establishment is crucial to plan passive

and active restoration actions. In semiarid ecosystems, the stress produced by seasonal drought as well as other factors such as herbivory, exotic species, and nurse plants may be important for plant establishment. We have performed different experiments in the semiarid region of central Chile to examine the role of different factors affecting plant establishment and the suitability of passive and active strategies for restoration. In terms of passive restoration, we have observed that seed dispersal may occur massively nearby remnant fragments of native forests. Excluding herbivores facilitates strongly natural recruitment of native herbs and woody species. However, some factors, such as the herbaceous layer, inhibit germination of woody species. Instead, presence of pioneer native as well as exotic woody plants may facilitate natural recruitment of native woody species as well as herbs. In terms of active restoration, survival of planted seedlings is higher in more humid habitats, even though these habitats are near the elevational limit of distribution. More rainy years improve seedling survival but this depends on the species. The success of planting under nurse shrubs depends on the nurse species and annual rainfall. In contrast to germination, the herbaceous layer seems to positively affect seedling survival. Exotic herbivores are generally detrimental for seedling survival. We propose that applying active as well as passive restoration techniques based on this knowledge would enable restoration in central Chile.

Key words: mediterranean-type climate, ecological restoration, plant-plant interaction, mammal herbivory, Sclerophyllous forest.

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State of the knowledge of restoration ecology in Latin America: status, challenges, and opportunities

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The practice of ecological restoration is a crucial activity to increase biodiversity and recover ecosystem functions in modified human ecosystems. A wide range of research effort is required to address restoration challenges, and literature on the topic is extensive. The expanding number of papers about restoration ecology has been subject to many reviews and assessments that have drawn conceptual frameworks and assessed progress on the practical front. However, all these reviews have been made at a global scale or mainly centred in the Northern Hemisphere. Until now, there is a lack of evaluation of the state of knowledge of restoration research in Latin America (LA). However, LA is the richest region of the planet in terms of its biodiversity sustained by the abundance of its ecosystems and reflected in the cultures and people that live there. This talk will present an assessment of the scientific discipline of restoration ecology carried out in this region. In general terms, we will examine what proportion of the academic literature on restoration research is focussed specifically to develop a basic understanding about restoration ecology. Specifically, we will identify which are the countries of LA leading the basic research in restoration ecology, which are the main topics and strategies addressed by this research, the methods employed, the spatial scale of the studies, and the most studied ecosystems. We will situate our results in a global context, which will allow us to identify the main weakness and strengths of the research conducted in LA.

Key words: basic research, restoration ecology, restoration strategies.

Assessing the current extent and recent loss of dryland forest ecosystems in Latin America

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Understanding of recent and historical changes in forest cover, as well as the drivers of these changes, is crucial for developing approaches for the conservation and restoration of forest ecosystems. We used satellite remote sensing data, GIS, and multivariate statistical modelling to assess the current distribution and drivers of change in dryland forests, a worldwide highly threatened ecosystem, and historical changes in land use/land cover since the mid-1970s in selected study areas located in Mexico, Chile, and Argentina. Forest loss was consistently detected in all study areas, ranging from annual rates of -1.7% in Central Chile to a negligible -0.12% in the Central Valley of Chiapas, with an average annual rate of -0.78%. Deforestation was most consistently associated with agricultural expansion, but this change sometimes involved an intermediate step consisting of the degradation from forest to shrubland and grassland preceding cropland gain. Interestingly, the change in forest extent was explained by a unique combination of variables in each study area and the same variable may have either a positive or a negative effect in the different study areas, i.e., in different ecological, socio-economic, and cultural contexts. In all study areas, the probability of an area experiencing forest loss was higher on gentle slopes. We conclude that land use intensification and limited natural regeneration continue to threaten dryland forest cover in many regions of Latin America, but that deforestation rates have diminished in the recent past compared to trends in the early part of the twentieth century.

Key words: deforestation, drivers, Latin America, tropical dry forest.

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Tree species richness, does it play a key role on a forest restoration plantation?

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The Brazilian Atlantic Forest is considered one of the worlds' biodiversity conservation hotspots. Today there is less than ten percent remaining; therefore it is vital to restore these ecosystems. There are many ways of achieving restoration's main goals, but there is a lack of ecological studies that analyze tree species richness as a variable; thus, this study's goal is to investigate if there is a difference between a forest restoration in a gradient of tree species richness that varies from 20, 60 and 120 species, by using the leaf litter as an indicator. Every month for one year, the forest litter was collected from litter traps that were previously installed. Results revealed that stands produced forest litter by the increasing gradient of species 5,370; 5,909 and 6,432 $kg.ha^{-1}.yr^{-1}$. The statistical analyses revealed no significant difference among them; therefore this 6-year old forest plantation restoration so far shows no difference on litter production by the tree species richness.

Key words: Brazilian Atlantic rainforest, forest restoration, landscape ecology, tree biodiversity, forest litter production.

Assessment of structural connectivity and potential networks for functional forest restoration in central Chile

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Land cover and its configuration in the landscape is a crucial component for biodiversity, which depends on networks of specific habitat of sufficiently large patches to support the movement of species. Central Chile, a world biodiversity hotspot, has experienced intense transformations of the natural vegetation cover, and has suffered from ongoing fragmentation processes. Land-use changes, in combination with a pronounced topography, are increasingly leading to an isolation of scattered forest patches on high elevations and steep slopes, and therefore to a reduction of structural and functional connectivity. To identify patches with high relevance for forest connectivity and critical areas for functional forest restoration aiming at increasing connectivity, a two-step approach has been applied. Firstly, structural connectors and spatial pattern of forest fragments were analyzed through habitat availability metrics using the morphological spatial pattern analysis. Based on existing land-cover maps, we determined the most important forest patches, core areas, and linear connectors. In a second step, a network analysis was applied using ConeforSensinode Software to evaluate the most important patches concerning their contribution to connectivity. The results show that the study area in Central Chile consists of two separated networks of remnant forest patches mainly in the Central mountain range, which are divided by an intensively used valley. For evaluating restoration purposes, the inclusion of shrubland into pattern and network analysis has improved overall connectivity indices and seems to be an indispensable component for developing functional habitat corridors.

Key words: connectivity, forest restoration, spatial patterns.

Forest transition and its impact on water and sediment fluxes in degraded Andean catchments

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The effect of forest cover on water yields has been demonstrated for small catchments where natural vegetation was removed and/or replaced by plantations. Little is known about disturbed ecosystems where forest plantations have been established on highly degraded land. In this paper, we analyse the hydrological response to forest cover change for a degraded Andean catchment. The land cover analysis (1963-2007) indicates different pathways of change: deforestation, reforestation, and spontaneous recovery. There was a net average loss of native forests of ca. 45.5 ha y^{-1}, and 74% of the total deforestation resulted from conversion from native forests to agricultural land. The total area of bare landdecreased by 28 ha y^{-1}. Time series analyses of streamflow and rainfall data (1979-2007) indicate that the removal of native forest (by -22%) has contributed to the increase in annual water yield, through an increase in annual baseflow by 25mm. The maximum daily runoff decreased by 5 mm despite higher daily rainfall. The observed decrease in peakflows cannot be explained by clear-cuts of native forest, as its effect on surface runoff generation is limited. This reduction is related to reforestation of degraded lands to exotic forest plantations as well as spontaneous recovery of vegetation. Sediment yield (1979-2007) strongly decreased. Reforestation and spontaneous revegetation of badlands significantly altered the overall sediment budget. Vegetated buffer zones

in active gully systems led to a stronger reduction in sediment delivery to the river system as compared to the reduction in sediment production by overland flow.

Key words: vegetation restoration, forest transition, hydrological response, degraded Andean catchment, time series analysis.

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The peri-urban forest: an opportunity to recover diversity and forest function

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High deforestation rates in tropical countries continue to reduce forest cover and habitat quantity and quality. However, in some places, the forest is recovering and expanding, thereby offsetting the biodiversity and ecosystem service losses due to deforestation. In order to characterize the forest recovery, a land use and land cover analysis was done using aerial photographs of a peri-urban watershed in the Andes region of Venezuela. The quality of the changes was assessed using landscape indices and hemeroby indicators. The major changes indicate a recovery of about 15% of the forest area on abandoned pastures and on steep slopes while in the valley bottoms, urban areas expanded. The results also showed that forest patches were aggregating and pastures were fragmenting. The reduction in hemeroby resulted in a slight recovery in both secondary forest and shrubland structure and plant composition. Non-native species were found in all LUC categories. Although the expansion of forest area in the last half century is clear, the corresponding growth in urban areas, the intensification of land use, and the impact of non-native species could hinder the recovery of abandoned land to original cloud forest.

Key words: forest recovery, landscape ecology, Andean cloud forest, peri-urban forest, hemeroby.

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Rehabilitation of degraded landscapes through area exclosure in the Central Rift Valley of Ethiopia: the case of Mountain Adulala

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Woody species population structure and dynamics, soil seed bank, and herbaceous and grass biomass were studied in exclosure area of Gara Adulala from 2003 to 2007 to evaluate the status of the rehabilitation of the site. A total of 20 indigenous woody species, dominated by tree species *Acacia gerrardii, Acacia tortilis, Dichrostachys cinerea* and *Acacia senegal*, were recorded in the area. The number and type of species over the five years remained the same whereas the number of stems per hectare showed a steady increment until the fourth year. The overall pattern of

population dynamics showed a marked increment in the number of stems in year 5over year 1, but with no clear pattern in the middle years. *Acacia gerrardii, Dichrostachys cinerea* and *A.senegal* showed a similar pattern with the overall structure, however, *A. tortilis* showed a decrease in number in the last year. The overall number of seedlings and saplings per hectare of the woody species varied from 496 to 1070 and from 513 to 1217, respectively over the five years. The sources of regeneration for many of the species were sprouts, and there was strong recruitment of seedlings to saplings. The soil seed bank in the first year was represented by only herbaceous and grass species. A significant increment in herbaceous and grass biomass was obtained in the last two years when compared to the first year. We conclude that population structure varies over the years due to climate, and competition among sprouts and individuals for moisture and nutrients.

Key words: area exclosure, regeneration, population structure, seed bank, biomass.

Acknowledgements: We are very grateful to Adulala community for they permitted us to carry out the study for five years on their communal lands. We would like to appreciate the scientists of the National Herbarium of Adulala.

Identifying restoration strategies to diversifying native tree species growing on cattle systems in a tropical agricultural landscape

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The landowners are the key of any successful conservation or restoration project in agricultural landscapes. They change and shape landscapes through each land use settled and type of management applied, so we have to include their perceptions and necessities in our conservation goals. We focus our research on the cattle systems, which cover around 40% of the Province of Hueytamalco (Mexico), a tropical region highly fragmented, and dominated with agricultural landscapes. We want to promote diversifying native tree species growing on the pastures, but first, as part of the work presented here, we identify the most important conditions which facilitate or restrict the adoption of native tree species in the cattle systems in the region. With this objective, we conducted semi-structured interviews with 20 livestock owners which control more than 1600 ha (more than 25% of pastures in the region) and 7 open-interviews of key informants about livestock management in the region. We identified different types of cattle systems in the region; each one required a special strategy to promote the adoption of native trees species. The main characteristics dividing cattle systems are the objectivesfor production, ranch and pastures extension, labor costs, and type of land-uses in the ranch. Our results show that the recovery of riparian vegetation and the promotion of native timber trees are restoration strategies with high potential acceptance in the cattle systems in the region. These techniques could increase the connectivity and maintain biodiversity in pasture fragments.

Key words: tropical cattle systems, native trees adoption, agricultural landscapes.

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Forest landscape restoration - investing in people and nature: a case study from India

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India is one of the 16 mega-biodiversity nations, despite being very densely populated. The total forest cover, which constitutes about 68 million hectares or 20.64 % of the country's area, plays a significant role in biodiversity protection, environment conservation, landside prevention and soil preservation, headwater conservation, material production (timber, food, etc.) and poverty alleviation. But the forest ecosystems are hugely challenged, e.g., nearly 300 million cattle graze in the forests, which is 9 times higher than the carrying capacity of the forests. About 40% of the population depends on fuel wood for energy, and large forest areas are affected on account of annual fires. Close to 30 to 40% of livelihoods of forest communities come from non-timber forest products. It is an ongoing struggle to balance the need for conservation with the need for development. It has caused the degradation of the forest landscape which needs to be restored. In 1980, the Forest Conservation Act was passed, which focused on ensuring environmental stability, restoring the ecological balance, and preserving the remaining forests. Over the years, several approaches have been initiated. Most notable is the Chipko movement where the local people embraced the trees to save them from cutting by the loggers and, plantations through agro- and social forestry etc. Now, over 100,000 local groups, including Joint Forest Management Committees, Van Panchayats, and Village Councils, protect about one third of India's forest areas. The nation today has established 597 Protected Areas covering 1.56 million hectares or 4.75% of the geographical area of the country. Restoring forest landscapes is for the benefit of people and nature and contributes to reversing the trends of forest loss and degradation.

Key words: forest degradation, development, ecosystem, environment conservation, livelihood.

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Reforestation and natural succession as tools for restoration on abandoned pastures in the Andes of South Ecuador

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Ecuador is one of the global hot spots of biodiversity. Nevertheless, it faces high deforestation rates and unsustainable land use, resulting in a substantial and growing amount of degraded land, which needs to be rehabilitated for productivity and biodiversity purposes. We present the results of a reforestation experiment within a gradient of three successional phases after abandonment of pastoral use. Six native species were tested against two exotics. Furthermore, we analyzed the regeneration potential from the soil seed bank and monitored the development of the diversity of woody species in the natural succession at the different sites. Our results show that dependence on natural regeneration for forest recovery cannot be an acceptable solution for forest users, due to the low speed of recovery and the insufficient species composition of the regeneration. Planted seedlings of native species are able to cope with the harsh conditions if they are selected according to their adaptation to the environmental characteristics of the respective planting sites.

Key words: biodiversity, native species, landscape restoration, natural regeneration.

Six years of natural regeneration after clearcutting in areas of Atlantic Dense Rain Forest, in southeastern Brazil

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The Atlantic forest that covers much of the landscape of southeastern Brazil is being threatened by agricultural activity. This study was conducted at Fazenda São José (995.8 ha), in order to analyze the diversity, richness, density, and biomass in areas with these treatments: (P) forest clearcutting with pasture implanted and abandoned six years ago, (N) forest clearcutting without management and abandoned six years ago, and (F) native forest. For the 1st stratum (DAP > 15 cm), we used five plots of 20x20m and for the 2nd stratum (DAP >5 cm and height >1.5 m), we used five plots of 2x20m. The analyses were performed using the BioEstat 5.0. We recorded in (P), 2 species in the 1st stratum and 7 in the 2nd stratum; in (N), 14 in 1st and 25 in the 2nd, and (F), 102 in 1st and 58 in the 2nd. The H' in F (both stratums) was higher than that found in (N) and (P). In both the areas (N) and (P), the 2nd stratum showed greater diversity and density that the 1st, but lower biomass. For the 1st stratum, all variables showed significant differences ($p < 0.01$) between treatments F vs. N, and N vs. P. In the 2nd stratum, density and biomass in the treatments (P) and (F) showed significant differences ($p < 0.01$). This demonstrates that natural regeneration of N was faster and better than in P.

Key words: Atlantic forest, restoration ecology, Biodiversity conservation.

Interaction of density and nitrogen levels on growth of *Ziziphus spina-christ*i seedlings

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Ziziphus spina-christi is one of the most important woody trees distributed in semi-pure stands in Saudi Arabia. This study was conducted under greenhouse conditions to study the effect of two nitrogen levels and five plant density levels on the intraspecific competition between *Z. spina-christi* seedlings in a growth period of 7 months. Plants were grown in pots (15.5 cm * 15 cm) in a density of 1, 2, 3, 4, and 6 plants per pot under two levels of nitrogen. Plant height, diameter, leaf area, total chlorophyll ab, total dry weight, and root to shoot ratios were measured and/or calculated. Results indicated that there was a reduction in most growth parameters with increasing numbers of plants per pot. The reduction was higher for plants grown in low nitrogen, compared to plants grown in high levels of nitrogen. The intensity of intraspecific competition increased with density but it was surprising that at the low level of nitrogen, dry weight per plant in pots containing 1, 2, and 3 plants exceeded dry weights for plants grown at the high level of nitrogen at the same density. At the low level of nitrogen, more resources are allocated toward roots, which enable the plant to acquire nutrients, and where the root to shoot ratio increased with increasing density as compared to seedlings grown at high level of nitrogen. The results of this study verify the importance of intraspecific competition on increasing root: shoot ratio under the lower level of nitrogen.

Key words: *Ziziyphus spina-christi*, nitrogen, density, intraspecific competition, Saudi Arabia.

The various uses of forestry products in Gaube of Kuje area Council of the federal capital territory Abuja, Nigeria

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Guabe is one of the farmland villages in Kuje Area Council of the Federal Capital Territory, Abuja, Nigeria. Most of the populace is farmers and traders. Forests are numerous in different areas in Guabe. The people therefore use the opportunity to use the forestry products for cooking purposes, buildings, construction, making ends meet through marketing, and sales. Different pictures were taken to ascertain the various uses and farm and home visits were also made to administer different questionnaires and get their various opinions on problems associated with the use, profitability, and income generation purposes. This paper presents the various information and results and how other international countries could benefit from the best methods being used to the effect.

Key words: Gaube, forestry products, different information.

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Passive restoration assessment as a conservation strategy for vegetation structure and floristic compositionin National Reserve Río de los Cipreses, VI Region, Chile

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National Reserve Río de los Cipreses (VI Region, Chile) was established in 1985, in order to protect a portion of the mountainous Mediterranean ecosystem from productive activities prevailing in the area, such as mining and ranching. The aim of this study was to determine the utility that the National Reserve has had on the natural recovery of this ecosystem, compared with the surrounding land and the features it should have. To this end, we selected a vegetation floor, which represents the structure and composition the forest should have in the present, without human action. We sampled a total of 32 points, within and outside the Reserve, in which information was obtained about the vegetation structure, anthropogenic disturbances, environment, and floristic lists. The similarity between the evaluated communities was determined by statistical analysis. The results indicate that outside the reserve, there is a higher level of disturbance and less diversity of flora regeneration than communities located within the Reserve. The latter were closer to those observed in the early stages of ecological succession. In conclusion, the set-up of the reserve has helped the establishment of ecological processes, by reducing the interference generated by livestock. This indicates that passive restoration of ecosystems can be a useful alternative in the foothill areas of central Chile.

Key words: passive restoration, Mediterranean ecosystem, mountainous ecosystem, ecological succession.

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Facilitation in plant communities: the role of the Ouricuri palm tree to maintain biodiversity in the Brazilian Caatinga

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Plant interactions strongly influence community structure and play an important role in regulating the composition of communities. Most of the semiarid region of Brazil's north-east was originally covered by the Caatinga biome. The xerophytic Caatinga vegetation has been extensively removed, with the land being abandoned after intensive use for cattle grazing and farming. In the areas undergoing natural regeneration, some species appear to play a key role in the maintenance of the associated fauna and flora. This study examines the biological diversity associated with the Ouricuri palm tree (*Syagrus coronata* (Martius) Beccari) in areas undergoing natural regeneration in the Brazilian northeast region. Data were collected in three areas of 0.5 hectares each that were situated in places with high densities of palm trees. All individuals above 0.5 m in height were counted. Data were analyzed using t tests in order to measure the effect of the Ouricuri palm tree on the abundance and richness of species. Seventeen young arborous species were totaled. In addition, 83 herbaceous and undershrub species were counted on the ground. There was evidence of an increase in both the richness and abundance of species in the places inside each sampled area in which there was *S. coronata* ($t=4,28$ and $p<0.001$ for richness, $t=3.35$ and $p=0.001$ for abundance). Therefore, the use of nurse plants should be considered in forest restoration projects in the Brazilian semiarid region as an alternative strategy to increase the survival of seedlings and the success of propagules.

Key words: arid land, nurse plants, *Syagrus coronata*, Brazil, dry forest.

Restoration of central European coppice forests through utilization

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In Central Europe, traditional management of oak coppice forest was abandoned at the beginning of the last century, leaving large tracts of forest developing into aged coppice stands. Recently renewed interest in coppicing has developed in many European countries because of the increasing importance of fuel wood as a substitute for fossil fuels and the preservation of coppice forests as a historical landscape element and habitat with high nature conservation value. However, there are uncertainties about the re-sprouting ability of large and old oak stumps. In this study, we determined the re-sprouting ability of sessile oak (*Quercus petraea* (Mattuschka) Liebl.) stumps 80 to 100 years after the last coppice cut. Stump mortality and re-sprouting intensity were analyzed in relation to three different harvesting methods (cutting heights), browsing intensity, vitality of parent trees, and stump parameters. On average, 16% of all sessile oak stools died within two vegetation periods after coppicing. Stump mortality was higher in unfenced areas compared to areas protected against browsing. Two vegetation periods after coppicing, numerous new stump sprouts were recorded. Growth of the new sprouts was mainly influenced by browsing. Our results indicate that the re-sprouting ability of 80-100 year old oak trees originating from former coppice management is still high and little influenced by harvesting methods. However, browsing must be controlled, as with any other form of forest regeneration, if coppicing is to be applied successfully.

Key words: coppice, re-sprouting, regeneration, mortality, *Quercus petraea*.

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Influence of the biodiversity on the production of litter in reforestation, Anhembi, SP. Brazil

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The Atlantic Forest is renowned for its endemic species, biological diversity, and its degradation. Therefore, it is considered one of the world conservation hotspots. Because of this importance, it is necessary to accomplish forest restoration. Due to the complexity of forest ecosystems, it is necessary to test different diversities of tree species. We analyzed forest restoration on an originally degraded pasture area. The trial varied on the number of tree species with 20, 60, and 120. The accumulated soil litter was sampled during the dry and wet seasons. A wooden frame of 0.25 m² was thrown randomly on each plot three times. The litter was collected, dried, and weighed. The results showed that the 60-species trial had the most litter accumulated on the floor for both seasons, being 103.8 kg ha^{-1} in the dry season and 68.4 kg ha^{-1} in the wet season. Relating the results with the trial of higher diversity, 120 species, the trial of 60 species produced 9.8% more in the dry season and 5.7% more in the wet season. It also showed that there is a direct relation between the water deficit, natural events, and litter deposition. To understand better the difference of the results, a further study is needed, to qualify the litter by compartments: reproductive, stems, and leaves, to verify if there is a relation to the phenotypic characteristics of each trial, weather, and litter mass ratio.

Key words: biodiversity, reforestation, litter deposition, Brazilian Southeastern Atlantic Semi-deciduous forest.

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Restoration of riparian corridors: eight years monitoring the diversity of soil ants in a Colombian Andean rural landscape

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Restoration of degraded areas involves the recovering of biological dynamics and structure in relation to a reference ecosystem. A landscape restoration process, involving 156 species of native plants on six corridors was carried out at Filandia (Quindío) in 2003. This study tested whether the mixture of restored native plant species can provide habitat for forest ants. Ants were sampled in five vegetation covers: four six-year-old restored grassland areas, three eight-year-old restored exotic Gymnosperm forest areas, six riparian forests, four large forest remnants, and four grasslands. Intensive soil ant samplings were made in 150m long transects in each of the 21 areas. A total of 9156 ants, belonging to 150 species, were collected in 967 sampling stations. Large forests and riparian forests were the richest areas. Species richness in the restored areas fluctuated over the years, very similar to the richness of grasslands, without observing an increasing trend. Forest species begin to appear after eight years in the Restored Gymnosperm forest areas. The results suggest that these restored areas have not yet reached the level of development needed to keep the ground ant community. Many of the recorded species are generalists and widespread species in the landscape. Soil-related habitat conditions, dynamics of the litter, and the presence of highly competitive dominant species may be limiting the establishment of the ants of forest in restored areas.

Key words: Restoration, rural landscape, Colombian Andean, soil ants.

Acknowledgements: Research Institute of biological resources. Alexander von Humboldt, Colciencias, Univalle.

Diversity of hunting ants in sub-Andean rural landscape of Quindío-Colombia

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Ecological restoration is a conservation strategy implemented extensively by conservation authorities for the first time in the Colombian Andean landscape. This strategy seeks to recover the reference ecosystem structure and function, which can be evaluated through hunting ants diversity, as they have high habitat requirements, are at the top of the food chain, and are environmentally sensitive. Their presence indicates the complexity of the structure habitat. This study evaluated changes in the hunting ants after seven years in a fragmented forest in subandean Filandia (Quindio). In 2010, the hunting ants of ground and litter were sampled intensively in five vegetation covers: grassland open (Grass), restored areas from grassland or forest plantations (R.Grass and R.Forest respectively), Riparian forest (Riparian), and Forest. Environmental parameters were measured. Forests and Riparian showed the highest richness (16, 10 respectively) while R.Forest: 7 and R.Grass: 4. *Gnamptogenys bisulca* was the most frequent, followed by *Pachycondyla aenescens*. The temperature and soil compaction grouped Grass and R.Grass covers and with them *G.andina* and *Hypoponera opacior*, while the humidity and litter grouped Forest and Riparian covers and the most hunting ants. The restored areas have not reached a level of similar development to natural ecosystems, but R.Forestal after seven years have forest species like *G. bisulca* which indicated a recovery process toward the reference ecosystem. The history of land use as well as environmental variables could be decisive in the presence of hunting ants.

Key words: hunting ants, restored area, andean landscape, *Gnamptogenys bisulca*.

Acknowledgements: Universidad del Valle, Colciencias.

Effect of nutritional regimens on seedling quality in *Quillaja saponaria* (Mol.): implications for post-planting survival in semiarid Mediterranean ecosystems of central Chile

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The use of native trees for compensation and forest restoration purposes has increased significantly during the last decade in Chile. Among these trees, *Quillaja saponaria* (Mol.), an endemic species to the central area, has been one of the most used. However, the high mortality following planting, due to low seedling quality, reduces the normal establishment of this species across Mediterranean semi-arid areas of Central Chile (32° - 33° S latitude, 71° S longitude). In order to improve the seedlings' quality and survival, the objective of this work is to evaluate, during one growing season, the effect of the use of controlled-release fertilizer (CRF) on root growth potential, nutritional content, and localization in tissues and photosynthetic efficiency. Preliminary results show that treatment with CRF affected root volume, leaf nutrient content, and photochemical efficiency, compared to conventional fertilizers. The results could be attributed to a lower electrical conductivity in the rhizosphere with CRF treatment, allowing further growth of the root system. The development of seedlings' quality and field performance attributes could increase the survival and initial growth rates under drought conditions.

Key words: seedling quality, survival, field performance, mineral nutrition.

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Restoration of abandoned and fallow land patches in forest fringe areas of semi-arid regions in Kanakapura Taluk, Karnataka, India

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The forest-fringe areas constitute an ecotone between forests and agricultural lands that cover a large contiguous area. It consists of diverse land-uses such as degraded forests, fallow lands, marginal dry-land, and productive irrigated farms. Once a diverse ecotone, it is now a scattered remnant of trees with little existence of biodiversity. The conservation efforts of such an ecotone has been limited and followed a sectoral approach. In this context we initiated our study in four forest fringe villages of semi-arid regions in Kanakapura. We interacted with seventy-five farmers and documented data on density, diversity, and distribution of tree species in the agricultural lands and made a list of species present, and those preferred by farmers. New propagation and nursery technologies were developed for slow growing indigenous multipurpose tree species, and established diversity-rich agroforestry farms by planting multipurpose tree species through farmer-training programs and field visits. Restoring the land with biodiversity-rich agroforestry systems rejuvenated the land and its resources, and helped in moving towards sustainable agricultural systems. An ecologically sustainable restoration of the abandoned and fallow land patches is one of the immediate and effective remedies for livelihoods improvement, climate change mitigation, and biodiversity conservation in agro-ecosystems. Implementation of such land restoration practices in forest fringe areas will have multiple short- and long-term social, economic, and environmental benefits with varied levels of relevance to the local, national, and international context.

Key words: agroforestry, semi-arid region, multipurpose trees, biodiversity, conservation.

Acknowledgements: Would like to thank the farmers of four villages who continue to nurture the land and the trees, and eke out a livelihood from their farms. They generously shared their time, insights and knowledge.

Variation of seed and seedling characteristics of *Jatropha curcas*according to its provenance in south western Nigeria

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Investigations were carried out to assess the levels of variability in fruit and seed characters, germination and early seedling morphology of *Jatropha curcas* from five provenances within South-Western Nigeria (Ondo, Ogun, Ekiti, Oyo and Osun). Germinated seedlings and cuttings were grown in top soil and sub-soil for 16 weeks. The growth parameters measured included lateral branch length, number of leaves, and biomass. Analysis of variance showed that there was no significant difference among the germination of seeds collected from all the provenances. Ondo provenance (S1L) had the highest germination percentage (62%) followed by Ekiti provenance (53%) while the least provenance was Oyo (32%). Significant differences were observed on all the parameters measured among the provenances ($p < 0.05$). Seedlings and stem cuttings from Ondo (S1L) and Ekiti recorded the best performance when grown on top soil. S1L had the highest mean leaf numbers (13.4), mean leaf area (48.40 cm^2) and biomass (3.25 $gmonth^{-1}$). For stem cutting, S1L also had the highest mean for the lateral branch length (12.4 cm) and number of leaves (13.4), followed by S3L with 12.1. Ondo (S1L) and Ekiti Provenance (S3L) seem to be superior to other provenances in the characters studied. The result showed the importance of adequate soil nutrient composition and good soil physical properties for improved growth performance of seedlings and stem cuttings of *Jatropha curcas*.

Key words: variation, characters, growth performance, traits, soil.

Acknowledgements: The authors gratefully acknowledge the contribution of the Department of Forest Resources Management, University of Ibadan, Oyo state, Nigeria.

Topic: Climate change impacts and mitigation

Symposium: The effect of land-use change on greenhouse gas emissions in the Tropics and Subtropics
Organizers: Kristell Hergoualc'h, CIFOR, Indonesia / Ruth DeFries, Columbia University, USA.

Direct and indirect effects of fires on the carbon budget of tropical forest ecosystems

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Fires in tropical forest ecosystems represent an important threat to carbon stocks, biodiversity, and human health. Here we estimated direct fire emissions associated with deforestation and forest degradation for South America, Africa, and Southeast Asia during 2001-2010 using burned area and active fire observations from the MODerate resolution Imaging Spectroradiometer (MODIS) and the Global Fire Emissions Database version 3 (GFED3) biogeochemical model. Using the GEOS-Chem atmospheric model, we then quantified the contributions of these emissions to interannual variability in atmospheric carbon dioxide and methane over the last decade. We also separately considered remote fire effects on tropical ecosystem function by means of long range transport of fire aerosols. For this analysis of indirect effects, we used the Community Earth System Model (CESM) and performed two 50 year simulations with and without aerosol optical depth-optimized GFED3 emissions. We then examined the impacts of these fire aerosols on regional climate and ecosystem carbon fluxes. We found that gross primary production (GPP) decreased in tropical forest across Equatorial Asia and Africa. In the Amazon GPP decreased in the west, but remained neutral or slightly increased in the east. We also considered how changes in atmospheric aerosols influenced solar radiation, diffuse light, precipitation, soil moisture, and surface air temperatures. We found that fire-emitted aerosols slowed the Hadley Circulation and reduced precipitation over tropical forests on all three continents. These negative impacts on forest productivity were partly offset by reduced air temperatures and increases in diffuse light.

Key words: Forest productivity, fire, tropical forest ecosystems.

Greenhouse gas emissions associated with land-use change in tropical peat swamp forests

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Tropical peat swamp forests (PSF) are very important reservoirs of carbon (C) and their increasing degradation and conversion may contribute to climate change. Yet the effect of land-use change (LUC) on emissions of greenhouse gases hasn't been well quantified. A meta-analysis comparing soil CO_2, CH_4 and N_2O fluxes before and after LUC indicated that peat swamp forest conversion didn't consistently affect soil respiration rates (Hedges g of 0.3 ± 0.4, P = 0.45), slightly reduced soil emissions of CH_4 (Hedges g of -0.4 ± 0.2, P=0.04) and slightly increased soil N_2O emissions (Hedges g of 0.2 ± 0.1, P=0.01). The absence of an overall effect of LUC on soil respiration could be explained by a compensation of the LUC cases where soil respiration increased by those where it decreased, and by a simultaneous drop in root respiration and rise in soil heterotrophic respiration in the land covers replacing the PSF. In the case of PSF conversion to oil palm plantation, the change in the balance between annual peat C gains

(from litterfall and root mortality) and annual peat C losses (from heterotrophic respiration, CH_4 flux, land-clearing fires, and soluble and physical removal) before and after LUC gave an estimate of peat C loss of 39.6 ± 12.8 Mg CO_2 ha^{-1} y^{-1}. Corresponding increased N_2O emissions amounted to 0.2 ± 0.1 Mg CO_2eq ha-1 y-1. Over 25 years, this conversion represents a loss from both biomass and peat of 1572 ± 341 Mg CO_2 eq ha^{-1} or 62.9 ± 13.6 Mg CO_2 eq ha^{-1} y^{-1}.

Key words: carbon dioxide, methane, nitrous oxide, meta-analysis, deforestation.

Land-use change in livestock systems and its impacts on greenhouse gas emissions

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Livestock systems are the largest land-use system on Earth. They occupy a third of the global ice-free surface. They are organized in heterogeneous production systems ranging from pastoral and mixed crop-livestock systems to industrial systems. They also contribute significantly to global economic and social development supporting the livelihoods of at least a billion poor people. In the process of providing these benefits, livestock emit around 15-18% of global greenhouse gases. The highest GHG emissions from the livestock sector are estimated to come from CO2 emissions from land use change from direct conversion of forests and other natural habitats into pasture land, and from land clearing for growing crops as animal feed, mostly for pork and poultry production. This paper discusses mechanisms such as sustainable intensification, exploitation of livestock yield gaps through technological change, schemes for carbon sequestration and others. A review of mitigation potentials from recent integrated assessments is also presented and discussed in relation to potential constraints for the adoption of mitigation practices.

Key words: mitigation, livestock systems, greenhouse gases.

Land-use change effects on soil emissions of N_2O in the tropics and subtropics worldwide: a meta-analysis

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Land-use change, especially forest conversion to agriculture, is an important contributor to worldwide anthropogenic greenhouse gas emissions with an estimated emission around twenty percent. Next to CO_2 and CH_4, N_2O is an important greenhouse gas; its global warming potential over 100 years is 300 times larger than that of CO_2. Considering the current population growth, (sub)tropical forest regions are under pressure of deforestation and degradation, resulting in a possible further increase of greenhouse gas emissions. In order to be able to mitigate these emissions, we need solid knowledge about emissions due to land-use change and their underlying processes. This study aims at quantifying how soil N_2O emissions are affected by land-use change in the (sub)tropical regions of the world. Of 333 peer-reviewed publications on N_2O emissions carried out in the region of interest, 70 were selected because they included a before and after land-use change. The land-use change types considered were forest conversion to agriculture, pasture, logged forest, burned forest, tree plantations, agroforestry, and fallows. A distinction was made between wetland and non-wetland ecosystems.

A meta-analysis statistical approach was used to compare the fluxes before and after land-use change and to evaluate an overall effect. Relationships between N_2O fluxes and environmental factors (soil moisture, temperature and nitrogen input through fertilization, nitrogen fixation or litter fall) were also investigated.

Key words: land use change, nitrous oxide, meta-analysis, tropics.

Symposium: Sustainable landscapes in a world of change: tropical forests, land-use, and implementation of REDD+
Organizers: Yude Pan, US Forest Service, USA / Richard Birdsey, US Forest Service, USA.

Carbon densities of tropical forest types and implications for sustainable forest landscapes

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There are various ground-based but often small-scaled studies in tropical regions for measuring forest carbon stocks and changes. FAO also publishes periodic reports with data of forest areas and carbon stocks based on statistics provided by different nations. However, most reported estimates are countrywide or region-wide, without detailed information about carbon stocks in different forest types, which can vary by orders of magnitude due to diverse climate and topographical conditions. Thanks to recent advances in remote sensing and LIDAR technology, a high resolution tropical forest biomass map was recently developed. In light of this new information, we applied the FAO forest type map and NASA`s MODIS forest cover map to produce new estimates of carbon densities for major forest types in the tropical regions. We compared the new estimates with various measurements and reported data, including the average values recommended for use by the IPCC. The results indicate that the remote-sensing LIDAR based biomass estimates in tropical regions are reasonable when categorized by forest types and compared with other data. This set of carbon density data for tropical forest types is the first of its kind developed with a globally consistent methodology. The data are particularly useful for assessing the impacts of forest degradation and sustainable forest management at local scales. For instance, forest degradation and carbon loss caused by fuel-wood collection has greater impacts on dry forests with lower C densities than humid forests because of higher population in nearby regions. They provide the basic information critical for developing international climate mitigation policies such as UN-REDD.

Key words: tropical forest types, carbon density, remote sensing LIDAR, forest degradation, UN-REDD.

Long-term trends in deforestation and recovery of tropical forests

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Rates of deforestation in the tropics have generally increased over the last ~300 years, and the associated emissions of carbon have increased as well. The relative contribution of tropical deforestation to anthropogenic carbon emissions, however, has declined over the last few decades because of the rapid rise in annual emissions of carbon from fossil fuels. At present, tropical deforestation accounts for 10-20% of total anthropogenic carbon emissions,

the range resulting from different estimates of deforestation and uncertain estimates of carbon stocks in the forests deforested, both of which may be obtained more accurately with existing satellite data. The annual net loss of forest area in the tropics, as reported in the 2010 Forest Resources Assessment, decreased from 11.55 million ha yr-1 for 1990-2000 to 8.62 million ha yr-1 over the period 2000-2010. In contrast, initial results from the FAO/JRC (2011) survey show an increase in tropical net deforestation rates from ~8.2 million ha yr-1 1990-2000 to ~10.0 million ha yr-1 2000-2005. It is unclear which estimate of deforestation is more accurate. Over the period 1990 to 2005 or 2010, the two estimates are within ~10% of each other. The potential for tropical forests to either lose or sequester carbon is high, especially as gross rates of forest loss and gain are higher than the net loss generally reported. Gross rates of carbon emissions and uptake are ~3 times larger than net emissions, and offer the opportunity to help stabilize the concentration of CO_2 in the atmosphere over the next 10-50-years.

Key words: tropical deforestation, carbon emissions, REDD.

Why should tropical wetlands be part of the climate change mitigation strategies?

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Tropical wetland ecosystems, including peatlands and mangroves, are known to provide a number of ecosystem services including the storage of large quantities of carbon belowground. The accumulation of organic substrates over thousands of years creates these carbon-rich ecosystems that are now attractive for inclusion in climate change mitigation strategies. Peatlands cover about 3% of the earth's land area, but store as much as one-third of all soil carbon. In Southeast Asia, where 70% of the World's tropical peatlands reside, the emission is around 60 t C/ha/y due to conversions. We estimate that mangrove deforestation generates emissions of 0.02 to 0.12 Pg carbon per year, or as much as around 10% of emissions from deforestation globally, despite accounting for just 0.7% of tropical forest area. This paper describes our ongoing studies to assess carbon stocks and changes across tropical wetlands in order to provide basic information on emission factors and activity data required for monitoring, reporting, and verification of carbon in tropical wetlands which does present some fundamental differences compared to approaches in upland forests. The landscape or whole-ecosystem approach is necessary for participation in a market-based scheme under the reducing emissions from deforestation and forest degradation (REDD+) mechanism. Based upon the recent advances in the understanding of the carbon dynamics of wetlands, we find it timely to consider the inclusion of these ecosystems as part of mitigation approaches. Good governance of the ecosystems is required and will be a challenge given the current lack of experience and political support in managing these vulnerable ecosystems.

Key words: peatlands, mangroves, REDD+, governance, vulnerable.

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Change in forest biomass and structural parameters due to human disturbances

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REDD+ has been discussed as a promising climate change mitigation mechanism for tropical countries. The mechanism comprises 5 potential activities, of which forest degradation and stock enhancements are among the most controversial, as methodologies to detect and to quantify degradation have not been defined yet. In this paper, we present an analysis carried out, based on data collected from 2004 to 2010, as part of the Mexican National Forest Inventory. We analysed the data points corresponding to medium and high-stature tropical deciduous, semi-deciduous, and humid rain forest. In each inventory plot, semi-quentitative data on forest disturbances were collected in the field and categorized into 4 impact classes. We correlated the disturbances reported in the plots to forest biomass, basal area, canopy height, and canopy cover. We found a clear relation between the disturbance intensity and the major forest structural parameters that could be used as a basis to define forest degradation in the context of REDD+.

Key words: forest disturbance, forest degradation, tropical mexico, rain forest.

Biodiversity, conservation, and REDD+ in tropical coastal wetlands

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The payments for ecosystem services (PES) are policy instruments based on the assumption that human beings are willing to conserve and manage biodiversity. The Reduced Emissions from Deforestation and Degradation (REDD+) is a financial incentive designed to compensate governments at a national scale in return for demonstrable reductions in carbon emissions resulting from deforestation and degradation and the enhancement of terrestrial carbon stocks. The success of these projects depends greatly on the quality of data when assessing the ecosystem services in a particular ecosystem. Mangrove forests are critical ecosystems in the functioning of coastal and marine environments, and are considered major contributors to the productivity of sub and tropical estuaries as well as regulators of global biogeochemical processes. Recent investigations indicate that mangroves are among the most carbon-rich forests in the tropics, containing on average 1,023Mg carbon per hectare. The objective of this review is to provide a comprehensive overview and summary of information about PES and REDD+ implementation programs in mangrove forests worldwide, highlighting how remotely sensed data can be applied to evaluate mangrove forests biomass and ecosystems services, including their advantages and limitations. The mangrove value and price should vary among different ecological types of mangrove forests as they are impacted by a range of natural and human disturbance regimes within different spatial and temporal scales. This dynamic interaction among forest productivity and disturbances need to be included in a REDD+ assessment to improve the implementation of this type of policy instruments in developing countries in tropical latitudes.

Key words: mangroves, remote sensing, biomass, coastal, tropics.

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Short Manuscripts
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Changes in height growth patterns in the upper tree-line forests of Tierra del Fuego in relation to climate change

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Nothofagus pumilio (Poepp. et Endl.) Krasser occupy the mountain slopes reaching to the upper altitudinal limit of the forests. This extremely stressful environment represents the optimum conditions to study changes in growth patterns due to climate variations. Our goal was to analyze recent changes in stem height growth in forests located in the upper altitudinal tree-line along Tierra del Fuego (Argentina), and establish possible linkages to changes observed in surface temperature during the last decades. Nine locations were sampled, and four plots were measured in each location. Forest structure was characterized, and stem analyses were performed to assess height growth patterns. ANOVAs and classification analyses were conducted using location and time as main variables. Tree-growth height increased with time, e.g. 1.0 cm.year^{-1} during 1870-1959, 2.7 cm.year^{-1} during 1960-1979, and 5.0 cm.year^{-1} during 1980-2010. These differences were significant between periods and locations, and can be related to its geographical situation. Increment in stem height growth seems to be related with the worldwide surface air temperature. A decline in stem height growth registered during the last two decades can also be related with the regional decrease in the mean air temperature. The analysis of stem height growth is a useful tool to evaluate the incidence of climate change over trees growing under extreme environmental conditions.

Key words: tree-line, *Nothofagus,* height growth, climate change, forest structure.

Climatically induced trends of change in floristic composition in forest communities in Northern Baikal Region (Southern Siberia)

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Calculations of the activity indices and species richness of belt-zonal elements of the flora of Baikal region forests have been done in order to reveal the presence of climatogenic changes. The results provided evidence for the weakening status of xerophilic species in the floristic composition of hemiboreal light coniferous forests (with dominance of *Pinus sylvestris* L.). On the contrary, no significant change has been observed in the floristic composition of mountain light coniferous boreal forests (with dominance of *Larix gmelinii* (Rupr.) Rupr.). Besides, it was found that there was an increase in activity of the species of the dark-coniferous belt-zonal group peculiar to dark-coniferous boreal forests (with dominance *Abies sibirica* Ledeb. and *Pinus sibirica* Du Tour).

Key words: flora, forests, climate warming, Baikal region, Siberia.

The 21st century climate change effects on the forests and primary conifers in central Siberia

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Regional studies have shown that winters warmed 2-3 °C while summers warmed 1-2 °C during the1960-2010 period in central Siberia. Increased warming predicted from general circulation models (GCMs) by the end of the century is expected to impact Siberian vegetation. Our goal is to evaluate the consequences of climate warming on vegetation, forests, and forest-forming tree species in central Siberia. We use our envelope-type bioclimatic models of the Siberian forests and major tree conifer species based on three climatic indices which characterise their warmth and moisture requirements and cold resistance, and on one soil factor that charactrises their tolerance to permafrost. Coupling our bioclimatic models with the climatic indices and the permafrost distributions, we predicte the potential habitats of forests and forest-forming tree species in current climate conditions and also in the 2080 projected climate. In the 2080 drier climate conditions, Siberian forests are simulated to decrease significantly and shift northwards while forest-steppe and steppe would come to dominate 50 % of central Siberia. Permafrost is not predicted to thaw deep enough to sustain dark (Pinus sibirica, Abies sibirica, and Picea obovata) taiga. Dahurian larch (L. gmelinii+cajanderi, which is able to withstand permafrost, would remain the dominant tree species. Light conifers (Larix spp. and Pinus sylvestris) may gain an advantage over dark conifers in a predicted dry climate due to their resistance to water stress and wildfire. Habitats for new temperate broadleaf forests, non-existent in Siberia at present, are predicted by 2080.

Key words: climate warming, bioclimatic models, major conifer ranges, Central Siberia.

Comparison of litter traits, litter decomposability, and functioning of the decomposer subsystem in a primary forest and Young Secondary Forest in Sarawak, Malaysia

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We compared quantitative defensive traits of freshly fallen leaf litter, litter decomposability, microbial activities, and litter turnover rate between a primary forest (PF) and a young secondary forest (YSF) in Sarawak, Malaysia. Our goal is: (1) to reconfirm the controlling effects of quantitative defensive traits of leaves on litter decomposability, and (2) to check for their relevance to decomposition in real ecosystems in the humid tropics. Our result showed that for the dominant five species in litter traps, leaf toughness, leaf mass per area (LMA), and total phenolics of leaf litter were clearly higher in PF than in YSF. Concentrations of condensed tannin and lignin also tended to be higher in PF than in YSF. In the litter bag experiments, the CO_2 emission rate was significantly higher for YSF litter than for PF litter both in PF site and YSF site through all the measuring occasions. This was reflected in litter mass loss rate in a complete fashion, demonstrating that decomposability is higher for YSF litter than for PF litter. Thus, the controlling effect of quantitative defensive traits of leaf litter on litter decomposability was reconfirmed by the present study. CO_2 emission rates from the A0-layer was significantly higher in PF than in YSF despite the lower decomposability of PF litter, resulting in a much higher litter turnover rate in PF (1.74) as compared with that in YSF (0.90). Higher water content in PF in comparison to that in YSF must be involved in this situation. In our study sites, site factors apparently exert a stronger influence on the decomposition in real ecosystems ascompared to the litter decomposability or quantitative defensive traits of leaf litter. It is suggested that the relative importance of litter quality and site factors depends on climatic conditions in such a way that the higher the performance of microorganisms, the lower the importance of litter quality.

Key words: litter decomposability, quantitative defensive traits, litter quality, primary forest, Young Secondary Forest.

Forest change and climate change in the New Jersey Pine Barrens: Integrating diverse processes and incorporating spatial, temporal, and taxonomic heterogeneity

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Forest change and climate change represent the intersection of a complex suite of ecological processes. The magnitude of this complexity has often prevented a holistic integration of multiple drivers to forest landscape change. In addition, spatial heterogeneity and spatial interactions across landscapes add further complexity. For example, wildfire and insect outbreaks affect carbon and nitrogen budgets and may be amplified by climate change. In the New Jersey Pine Barrens (NJPB), we used a simulation modeling approach to assess how climate change, insect defoliators, wildfire, and forest management affect C and N cycling. The NJPB are edaphically complex with diverse tree species. We simulated forest change using the LANDIS-II succession and disturbance model. Our results suggest that climate change will not increase wildfire size or intensity. Forest management will have only modest effects on C and N cycling. Gypsy moth, however, may become a major determinant of C and N cycling at short time scales. At longer time-scales, gypsy moth defoliation may accelerate the shift towards oak domination, a substantial deviation from historic conditions. Our projections further indicate

that climate change will increase growth and biomass in drier upland forests but reduce productivity in wetland forests due to soil moisture decline. In all areas, the regeneration declines with climate change. In summary, the NJPB are initially C conservative but there is risk of long-term de-stabilization; understanding climate and forest change requires a tightly integrated approach that spans broad spatial and temporal scales.

Key words: climate change, forest change, C and N cycles, Net ecosystem production, natural disturbances.

Environmental impact, climate change and poverty

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The main idea of this study is to discuss the current environmental crises and their impacts, taking into consideration nature and society. In this arena, the connection between climate change and poverty represents a serious environmental risk to humanity. Climate change and its harmful effects have been increasing every day. The actual environmental crisis and its deep impacts are clearly connected with a kind of economic culture which is based on an extreme consumerism. Indeed, there is a clear consequence between consumerism, environmental impacts, and quality of social life. A lifestyle based on consumerism without limits brings about many environmental problems. In this sense, poverty is the result from an unsustainable world. In order to reverse this condition, it is necessary to produce actions able to mitigate the actual poverty and environmental settings. The choice of strategies to mitigate climate changes must be sensitive to regional and national needs. That is, it is necessary to consider the diversity of each country and place. In this sense, the main argument of this paper is to develop the idea of citizenship communities to face poverty, climate changes, and environmental risk.

Key words: climate change, environmental risk, poverty, mitigation, citizenship communities.

Tree-based strategies to mitigate climate change whilst providing bio-energy, employment, and ecosystem services in the Winelands region, western Cape, South Africa

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The Western Cape has a Mediterranean-type climate and is floristically rich in species but sparsely populated with trees. Large portions have been transformed to agricultural and urban land uses. We studied existing land-use patterns and investigated alternative, tree-based strategies to mitigate against climate change. These strategies include: (1) Establishment of energy generation facilities using biomass from exotic invasive vegetation as feedstock in the start-up phase, (2) Afforesting land with poor agricultural potential or land cleared from invasives with productive, non-invasive genotypes to sustain the aforementioned biomass supply, (3) Treating solid wood products to prolong their life and carbon storage potential, (4) Restoring indigenous forest pockets, and (5) Promoting urban tree planting to increase carbon sequestration. In this paper, we deal with case studies on strategies 1 to 3. The utilization of biomass from invasives is too small to sustain large scale bio-energy generation beyond the start-up phase. Woodlots from non-invasive tree taxa with water use efficiencies exceeding 2 g wood per litre of water transpired can be planted in the area for carbon sequestration, pole crops, and/or for biomass. Case studies show

that the location of woodlots, the species choice on different site types, the initial stand density, and intensive and site-specific silviculture are important to achieve acceptable yields. Selecting genotypes that are fast biomass producers, but which are also suitable for treated poles, provides more economic robustness. Viewed holistically, the proposed land-use changes may stimulate the local economy and create jobs while maintaining ecosystem services.

Key words: carbon sequestration, woodlots, bio-energy, site-species matching, intensive silviculture.

Changes in vegetation dynamics and forest degradation measures for REDD+: the case for the world's largest mangrove

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The Sundarbans is a unique landscape on Earth, which is the largest intact, continuous mangrove forest area, lying at the Ganges-Brahmaputra delta. It is thought to have the highest mangrove biodiversity in the world. But, noted from various studies, sea level rise, increasing intensities of tropical cyclones, changes in degree and level of tidal inundations and rainfall regime, and reduced upstream fresh water flow has resulted to begin forest degradation in this important landscape. To measure degradation, the way forward for UN-led REDD+, we assessed changes in vegetation dynamics (1), impact of cyclones on vegetation cover (2), and status of top-dying due to increasing salinity level in tidal water (3) of the Sundarbans. These objectives were attained through integration of field survey of 113 permanent sample plots, from November 2011 to February 2012, high-quality forest inventory data from 1926 through to 1998, and satellite imagery from 1975 to 2012. Using Landsat MSS, TM and ETM+ and imagery from the RapidEye, GeoEye and IKONOS, we have mapped the Sundarbans by radiometrically normalised, mosaiced imagery from 1972, 1977, 1989, 2000, 2010 and 2011, with ground verification. The results showed a gradual decline in diversity of major forest types from 1926 through 2012, but the inherent dominance of *Heritiera fomes* and *Excoecaria agallocha* has been maintained. Both density and height of vegetation was found to be related to the level of salinity: low in the northern part and high in the southern part. Various degradation monitoring methods for mangroves have also been proposed for REDD+.

Key words: mangrove, vegetation, degradation, REDD+, monitoring.

Acknowledgements: We are thankful to Bangladesh Forest Department, Durham University, and field team members for providing necessary cooperation to complete the challenging fieldwork with success!

The impacts of climate change on protected areas in the Sahel savannah ecoregion of Nigeria

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Nigeria is losing over 351,000 ha of landmass annually, most especially farmlands and water systems, as the Sahara desert encroaches into the Sahel Savannah ecoregion of Nigeria. Worse still, the region represents about 30% of

the nation's entire population and also the poorest people of Nigeria. This study was conducted to unravel the direct and indirect impacts of climate change on the protected areas in the Sahel savannah ecoregion. Information was gathered by an on-site assessment of 8 protected areas in the Sahel Savannah ecoregion, while questionnaires were administered to some of the protected areas staffs. Results indicate that high rates, but indirect impacts of climate change on the protected areas include deforestation, illegal felling, poaching and land-use change in all the 8 protected areas visited. As climate change turns farmlands into sand dunes with associated poor crop yields, the farmers, in turn, encroach into the protected areas, which themselves are short-staffed for proper monitoring. The majority of the people are involved in illegal activities for survival in the wake of harsher climate in the region. Adaptation to climate change that allows for the sustainability of the protected areas must start with a pragmatic review of the Government Policy on Forestry to allow the people own and plant forests and encourage community-based forest resources management. Other adaptation measures include provision of environment- and user-friendly solar powered cooking stoves, sustainable farming systems such as crop rotation, intercropping, sustainable irrigation, organic farming, and agroforestry, as well as diversification of income sources.

Key words: Sahel Savannah, climate change impacts, Sahara desert, Nigeria, desertification.

Sensitivity of Chilean temperate rainforests to changes in rainfall regimes: a process-based, dynamic forest model

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Rainfall changes due to climate change and their potential impacts on forests demand the development of predictable tools coupling vegetation dynamics to hydrologic processes. In this study, we present a dynamic forest model to predict the impact of climate change on the hydrological balance of Chilean temperate rainforests. The developed model includes calculations of forest water fluxes and incorporates the dynamical linkage of rainfall regimes to soil moisture, and individual tree growth. We used the model to analyze forest sensitivity to climate change in an old-growth stand (>500 years-old, unmanaged) located on Chiloé Island, Chile (42°S). We addressed forest sensitivity by evaluating changes in forest evapotranspiration, soil moisture, and forest structure (biomass) under changes in rainfall regimes comparable to future climatic scenarios for this century in the study region. Drier climatic conditions predicted for this century led to changes in the hydrological balance that strongly impacted forest structure. Changes in climatic parameters decreased soil moisture to 32% and decreased evapotranspiration to 15% compared to current values. These changes in water fluxes induced decreases in above-ground biomass up to 27%. The model is a convenient tool for detailed analyses of climate change impacts on hydrological balance of forests. Also, it provides a tool suitable for analyses of the impacts of multiple drivers of global change on forest processes (e.g. climate change, fragmentation, forest management).

Key words: Chile, forest modelling, climate change, temperate rainforest, forest hydrology.

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Potential of indigenous fruit trees in helping local communities in arid and semi-arid lands in Kenya adapt to climate change

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Many indigenous fruit trees (IFTs) exist in Kenya that could be integrated into farming systems to support the nutritional security and income of local communities. These fruits trees could also play a significant role in helping communities adapt to climate change. These fruits are good sources of specific vitamins and other essential micro nutrients, and consumption of a range of species could help prevent a wide range of diseases. Despite their wide natural occurrence in dry areas of Kenya, however, the promotion of IFTs has not been adequately fostered by agricultural and forestry institutions and consequently, they remain underutilized. The current study reports on a survey that was conducted on IFTs in arid and semi-arid lands of Kenya. A structured questionnaire was used to interview 104 household members, consisting of women, men, girls, and boys. Fifty-seven species were documented as useful to local people. Average fruit consumption per person per day of these species was low at around 20 g. Children were the main consumers of these fruits, although adults consumed particular species. A negative attitude on using indigenous fruits by adults was a major factor limiting consumption. Fruit seasonality also limited their consumption. Wild habitats were the main sources of these fruits, with planting on farmland rarely practiced. There was protection of existing wild trees in the agricultural landscape. The study shows that wild fruits can contribute significantly to the adaptation to climate change.

Key words: indigenous fruits, adaptation, local communities, ASALs.

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Conservation farming village: an approach to enhance resiliency of sloping land farming communities in the Philippines

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The Conservation Farming Village (CFV) aims to help upland farmers improve their economic conditions by strengthening their capacities to manage the natural resources, thereby protecting their communities against environmental degradation while sustaining their sources of livelihood. The program adopts the community-based participatory approach to technology development, promotion, and utilization, and a multi-level technology promotion mechanism that will capacitate local extension/change agents. The program includes the empowerment of farmer volunteers, enabling them to become the vanguards of sloping land resources by providing them with skills and knowledge in food, wood, and fiber production and resource management. It also taps the active leadership and participation of the local government units (municipal, barangay) in carrying out program activities down to the village level such as extension work, community organizing, and facilitating market linkages and other support services. And it provides technical expertise and guidance of a state university/college in the province or nearest the site. A total of 16 farming villages having more than 100 farmer volunteers and 400 adopters participated in the implementation of CFV in 5 provinces in the Philippines. Establishment and/or strengthening of existing village organizations were done to facilitate marketing services and livelihood support systems. Farmers now have diverse sources of income and products owing to the adoption of agroforestry, and have promoted soil

and water conservation. The program has also facilitated active participation of community members and enhanced the capability of local governments in organizing and supporting conservation farming villages in 5 provinces in the Philippines.

Key words: conservation farming, climate change adaptation, resilient upland farming communities, community-based upland development, localized technology adoption.

Acknowledgements: This program is funded by the Department of Science and Technology of the Philippines and is jointly implemented by researchers from selected universities, local governments and local communities.

Interactions of thinning and stem height on the drought response of radial stem growth and isotopic composition of Norway spruce (*Picea abies*)

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Radial stem growth and isotopic composition of growth rings are commonly used to quantify the effects of droughts on trees. However, often these parameters are only measured at one stem height, e.g. 1.3 m, and it is not known how representative this is for the whole stem. This study investigated radial growth at four stem heights and wood δ13C and δ18O at two heights of co-dominant Norway spruce trees from heavily (HT) and moderately thinned (MT) stands to assess whether thinning influenced the 2003 drought response of stems at different tree heights. Annual basal area increments (BAI) and stable isotopes in earlywood and latewood were compared between thinning treatments and among stem heights. For BAI, correlations with climate were analysed as well. The response of radial growth and isotopic composition to drought was similar at different stem heights in HT trees, but varied with height in MT trees, which were also more sensitive to climatic variations. Recovery of radial growth after drought was more rapid in trees from heavily compared to moderately thinned stands, except for the topmost height. BAI at 1.3 m provided good estimates of the volume growth response to drought for the whole stem, but not for its recovery. The faster recovery of radial growth at 1.3 m of HT compared to MT trees after drought was not accompanied by differences in recovery of isotopic composition. However, this is likely to be related to differences between treatments in remobilization of stored C and in tree structure.

Key words: drought, thinning, stem analysis, carbon/oxygen isotopes, *Picea abies*.

Monitoring the changes in the distribution of the mangrove species of the Sundarbans using satellite images: A consequence of sea level rise

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The Sundarbans contain the largest mangrove forest in the world. Height, growth, and ecological succession of different mangrove species in the Sundarbans are closely related with salinity. The salinity of the Sundarbans increases from east to west, consequently density, growth, and canopy closure of vegetation decreases from east to west. Low-salt-tolerant species dominate the east, whereas high-salt-tolerant species dominate the western part

of the forests. Salinity of the Sundarbans shows an increasing trend towards the west and is expected to increase further under higher sea-level. This study attempted to classify the distribution patterns of mangrove species using time-series images of Landsat 1992, 1996, and ASTER 2003, and relate that to the salinity trend. Different types of Vegetation Indices, Tasseled Cap Transformation and ISODATA algorithms with maximum-minimum NDVI values for each class separation were tested to determine the optimum methods of classification. The ISODATA algorithm using maximum-minimum NDVI values for each class was found most suitable for classifying dominant species. The classified time-series satellite image outputs showed distribution of dominant mangrove species matched with the changing salinity regime. In areas of increasing salinity around the western Sundarbans, high-salt-tolerant species have replaced the low-salt-tolerant species over the study period. The mangrove species can be broadly classified using the Landsat TM and the ASTER VNIR images and these data are more effective in areas where species distribution is homogenous. However, a variety of mangrove species, which are present in limited areal extent, could not be distinguished in the images possibly because of similarity in their spectral responses.

Key words: sundarbans, mangrove, landsat, ASTER, NDVI.

Understanding deforestation, the link between location, pattern, and process: ideas for REDD+

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Reducing emissions from deforestation and forest degradation (REDD+) has become an acceptable mitigation option post-2012. Deforestation is a complex process influenced by land-use decisions at the local level, and determined by the available resources and the socio-cultural background of the actors as well as by the biophysical characteristics of the landscape. Few attempts exist that include these in the establishment of REDD+ baselines and implementation scenarios. We used three participatory maps (1998, 2004 and 2012) and socio-economic data (2004 and 2009) of the Ipetí-Emberá community (Panama) currently implementing a REDD+ project to explore: i) Are various land use types differentially susceptible to forest degradation and deforestation? ii) Can locational and socio-economic differences suggest driving factors of deforestation and forest degradation? iii) Could this information be used for establishing a zoning system for REDD+? We first modeled landscape change without including the abovementioned factors (first-order Markov model). We then added slope, elevation, average distance from each parcel to a river, road, and to the village, relative wealth of land owner, and household size to assess for possible errors that indicate one or more of these factors. For zoning, we used Marxan with Zones software. This information is constructive for the REDD+. Results indicate that deforestation is not random across the landscape but correlated to locational, biophysical, and socio-economic factors. These techniques are also practical for REDD+ planning and implementation as they increase understanding of areas to prioritize and provide possible interventions to carry out that would satisfy communities needs for forest products.

Key words: REDD+, deforestation, climate change, landscape ecology.

Biodiversity conservation and carbon sequestration of protected areas in two developing countries

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The contributions of Protected Areas (PAs), in two developing countries (Katarnia Ghat Wildlife Sanctuary, India and Eda Strict Nature Reserve, Nigeria), to biodiversity and environmental conservation were assessed in this study. Volume yields, physiognomy structure, and carbon sinks were determined in the PAs. Data were collected from 12 plots (25 x 25m) randomly located in each of the PAs. In each plot, all woody plants were identified and tree growth variables (dbh>10cm) were measured. Biodiversity indices were used for species diversity, analytical formulas for stand volume, and Brown's model for biomass estimation. The diversity, abundance, physiognomy, volume yield, and the family importance of the PAs indicated that they are mature and are repositories of biodiversity. They have the potentials for continuous growth because of the presence of young trees in the lower canopy. The biodiversity indices compared favourably with results from other similar PAs. The above ground biomass and carbon estimation show the roles of forest landscapes in climate change mitigation through CO_2 absorption. The difference in phytosociological characteristics and carbon estimates of the two PAs, with higher values obtained for the Nigerian PA, was attributed to the variation in geographical location, climatic conditions, and soil properties. The perceived challenges in developing countries with forest protection can be mitigated by introducing some institutional policies and the involvement of rural communities in the management of protected forests. These could avert anthropogenic activities and encroachment by rural communities who relied solely on forestland and forest products for survival.

Key words: biodiversity indices, carbon storage, family importance value, *in situ* conservation, anthropogenic activities.

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The impact of climate change on human mobility in West- Africa

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The purpose of this research is briefly explore the following: the nexus between environmental change and human mobility; the implications of environmental change on human mobility; the connection between environmental vulnerability, migration, peace, and stability in areas most vulnerable to environmental change, with a focus on human mobility; how climate change could work as a threat-multiplier from a human security point of view, breeding grounds for conflicts over resources and large population movements; the connections between climate change and forced migration; and managing the environmental issues at local level. Migration is a way of life in West Africa and for centuries, people have migrated in response to population pressure, environmental disasters, poor economic conditions, conflicts, and adverse effects of macroeconomic restructuring. These migrants include temporary cross-border workers, seasonal migrants, labourers, unskilled workers, female traders, and nomads (Adepoju, 1995; 2003).

Key words: Environmentally induced population movements, climate change, migration and human security, connections between climate change and forced migration, conflict over limited resources.

Visible symptoms characterization and histochemical evaluation of native Brazilian species exposed to ozone

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Campinass metropolitan region (CMR) of Sao Paulo, Brazil, presents levels of tropospheric ozone (O_3) potentially toxic for the local vegetation. Ozone can intensify the production of reactive oxygen species as the hydrogen peroxides (H_2O_2) that, if accumulated in the tissues, can activate programmed cell death (PCD) processes, leading to visible symptoms. This study aimed to investigate the effects of O_3 on native arboreus species: *Astronium graveolens*, Anacardiaceae; *Piptadenia gonoacantha*, Fabaceae; and *Croton floribundus*, Euphorbiaceae; present on tropical semi-deciduous forest fragments in CMR. To induce visible symptoms, and to evaluate the accumulation of H_2O_2 and PCD, seedlings were exposed to O_3-enriched air using indoor chambers (70 ppb/h during 57 days); symptomatic samples were also collected on four forest fragments in CMR. Visible symptom characterizations were made and histochemical techniques combining 3,3 '-diaminobenzidina (H_2O_2 accumulation), and Evans Blue staining (PCD) were applied. Visible symptoms of *A. graveolens* were characterized by brownish spots; H_2O_2 accumulation was detected on fumigated and field symptomatic samples while PCD was observed only in the field samples. *P gonoachanta* presented stippling on fumigated and field samples and PCD were detected on palisade parenchyma cells and on stomata guard cells while H_2O_2 accumulation occurred only on fumigated samples. *C. floribundus* didn't show specific visible symptoms or histochemical markers on any analyzed samples. In conclusion, the three species present different types of reaction when exposed to O_3: *A. graveolens* and *P. gonoachanta* are sensitive species showing similar responses on fumigation and field samples and *C. floribundus* is a tolerant species.

Key words: ozone, tropical forest, hydrogen peroxide, cell death.

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Changes in height growth patterns in the upper tree-line forests of Tierra del Fuego in relation to climate change

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Nothofagus pumilio (Poepp. et Endl.) Krasser occupy the mountain slopes reaching to the upper altitudinal limit of the forests. This extremely stressful environment represents the optimum conditions to study changes in growth patterns due to climate variations. Our goal was to analyze recent changes in stem height growth in forests located in the upper altitudinal tree-line along Tierra del Fuego (Argentina), and establish possible linkages to changes observed in surface temperature during the last decades. Nine locations were sampled, and four plots were measured in each location. Forest structure was characterized, and stem analyses were performed to assess height growth patterns. ANOVAs and classification analyses were conducted using location and time as main variables. Tree-growth height increased with time, e.g. 1.0 cm.year^{-1} during 1870-1959, 2.7 cm.year^{-1} during 1960-1979, and 5.0 cm.year^{-1} during 1980-2010. These differences were significant between periods and locations, and can be related to its geographical situation. Increment in stem height growth seems to be related with the worldwide surface air temperature. A decline in stem height growth registered during the last two decades can also be related with the regional decrease in the mean air temperature. The analysis of stem height growth is a useful tool to evaluate the incidence of climate change over trees growing under extreme environmental conditions.

Key words: tree-line, *Nothofagus,* height growth, climate change, forest structure.

Evaluation of productivity in volume and carbon fixation potential in mixed plantations in the Caribbean zone of Costa Rica

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The existing experiences in plantations composed of a mixture of species in tropical zones are scarce, especially with respect to which and how many species are combined, the original distance, and the most appropriate forest management allowing, in a balanced form, the combination of objectives to produce wood for mills and carbon fixation simultaneously. This study included a total of 18 systems of plantations in different mixtures from species.

Altogether, 8 species were tested, of which 4 were native, the rest exotic. For the analysis, the 18 systems were grouped according to the number of species and age, which included between 2 and 4 native and exotic species of ages between 2.5 to 9 years in two zones: Guápiles and Turrialba, located in the Caribbean zone of Costa Rica. The best systems contained the mixture of *V. guatemalensis*, *H. alchorneoides* and *A. hunsteini* species (213.9 m^3/ha total volume) at the age of 9 years, followed by the system of four species (164.8 m^3/ha total volume) at 5.8 years of age. There were significant differences in MAI-VOL by the number of species, systems, and sites. Monocultures reached major productivity in total volume when compared to the main species of the mixed system in study. The information generated and analyzed through the present study can be considered as pioneer in mixed plantations for the production of wood and carbon fixation in the tropics of Latin America.

Key words: carbon fixation, wood production, species mixture, native and exotic species, Mitigation.

Acknowledgements: CENTRO AGRONÓMICO TROPICAL DE INVESTIGACIÓN Y ENSEÑANZA (CATIE) and Reforest The Tropics.

An experimental investigation of volatile organic compounds of rain forest trees of southern Brazil as precursors of secondary aerosol formation

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It has been suggested that volatile organic compounds (VOCs) are involved in secondary aerosol formation (SOA), which, in turn, affects radiative forcing and climate in the boreal region. The most abundant VOCs emitted by vegetation are isoprene and its derivatives, which are highly reactive with ozone, giving rise to sub-particles that cause negative radiative forcing. In the southern hemisphere, the biogenic volatile organic compounds and its effect on aerosol formation are still unknown. This ongoing study has the goal of determining whether VOCs emitted by trees of the Atlantic Forest in Brazil are secondary aerosol formation precursors. We investigated the SOA formation by ozonolysis of VOCs from three tree species (*Astronium graveolens*; *Croton floribundus*; *Piptadenia gonoacantha*). We exposed simultaneously three individuals of each species to filtered-air and O_3-enriched (70 ppb/h) chambers for two weeks. The concentration of SOA (PM2.5) was continually measured inside the chambers. The VOCs collected three times per day were analyzed by CG/FID. The highest concentration of SOA (220 ng/m^3) was detected in the ozone atmosphere, while particle formation was not significantly observed in the atmosphere under plants exposed to filtered-air. The chromatographic profile of VOCs indicated the appearance of new compounds when plants were exposed to ozone, compared to control. Also, the isoprene was detected in higher levels at control (320ppb) than ozone (5ppb) atmosphere, which might be suggesting that this compound participated in the aerosol formation. Our findings can be an indicative that VOCs emission from tropical trees contributes to secondary aerosol formation in the atmosphere ozone enriched.

Key words: volatile organic compound, ozone, isoprene, rain forest trees, aerosol.

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A network of intensive forest monitoring sites for the Americas

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Three demonstration sites in the Mexican States of Hidalgo, Merida, and Campeche are used for research and teaching, developing forest management practices, and forging links to the needs of communities. Tall towers rise from the forest floor to 15 meters above the canopy, providing basic meteorology data and daily estimates of forest carbon uptake and release, the processes that determine forest growth. Networks of field sampling sites around the towers provide estimates of forest biomass and carbon stocks, and monitor forest dynamic processes such as growth and mortality rates. The sites support information requirements for implementing programs such as Reducing Emissions from Deforestation and Forest Degradation (REDD+), enabling communities to receive payments for ecosystem services such as reduced carbon emissions or improved forest management. In addition to providing benchmark data for REDD+ projects, the sites are valuable for validating state and national estimates from satellite remote sensing and the national forest inventory. Data from the sites provide parameters for forest models that support strategic management analysis, and support student training and graduate projects. The 3 sites are linked to a similar U.S. network, and proposed as a model for other countries in Latin America. Linking these sites with similar demonstration sites in Mexico and other Latin American countries can ensure harmonization of approaches and data, and share experiences and knowledge among countries with emerging opportunities for implementing REDD+ and other conservation programs. Collectively, this work can have a positive impact on the world's climate and help sustain healthy forests worldwide.

Key words: Monitoring, REDD+, flux towers, forest management.

Acknowledgements: The authors acknowledge the support of the U.S. Agency for International Development, the U.S. Forest Service, and the Mexican Forest Service.

Methane soil surface flux and methane-driving microorganisms in forest ecosystems underlying permafrost: functioning in a changing environment

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The Arctic and sub-Arctic play a key role in the Earth's climate system, because global warming is predicted to be most pronounced at high latitudes, and one-third of the global carbon pool is stored in ecosystems of the northern latitudes. The degradation of permafrost and the associated release of climate-relevant trace gases from intensified microbial turnover of organic carbon and from destabilized gas hydrates represent a potential environmental hazard. The first results on the methane flux from the soil surface of larch stands for the Central Evenkia ecosystem will be presented. Using closed chamber methods [Wagner et al., 2003], we estimated the methane released daily from soil surfaces during July and August. The methane flux value was from 8.9 to 34.7 mg/m^2/day and depended on the amount of precipitation incoming from the atmosphere to the soil. The potential methane oxidation ability and potential methane production by soil microorganisms were assessed as well. The findings have not demonstrated

a relationship between apparent methane fluxes and the modes and intensities of microbiological processes of methane production and oxidation in the forest soils.

Key words: methane flux, forest ecosystem, methane-driving microorganisms, Sub-Arctic soils.

Acknowledgements: The work was supported by Russian Foundation for Basic Research (RFBR), grants 11-04-01884-a, 11-05-00374-a.

Soil drought impedes understorey beech vitality at their drought limit in oak-beech (*Quercus petraea* (Matt.) Liebl. - *Fagus sylvatica* L.) ecotone, Black Forest, Germany

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Changes in precipitation and temperature during the growing season cause a higher frequency of periodic drought in Europe. Soil drought occurs due to depletion of available soil water. Drought sensitivity is assumed to be a key factor limiting the distribution of beech in Europe. This study aimed to find effects of soil drought on the vitality of understorey beech, in an ecotone of near-natural oak stands and adjacent beech stands, on a rocky gneiss outcrop at Schlossberg in the submontane zone of the Black Forest, south-western Germany. Vitality was measured by crown dieback (CD) and yearly growth. CD was estimated by the percentage of dead aboveground biomass (AGB) as calculated from regression models developed from harvested samples. Yearly growth, expressed as basal area increment (BAI), was calculated from tree-ring analysis. The CD distribution pattern was recorded in different vertical parts of the crown. Soil drought was quantified by available soil water storage capacity (ASWSC) in systematic plots. Beech vitality was negatively affected by soil drought, with a significantly strong negative correlation between ASWSC and dead AGB (Spearman-rho = -0.54, N =42, p <0.001). The lower crown had the highest rate of dead AGB. The survivability threshold to drought stress was found to be 41%. The severe drought year of 2003 had a significantly high adverse effect on BAI. At the drought limit of beech (67 mm ASWSC), soil drought causes partial up to complete CD of understorey beech. Soil drought together with climatic drought impedes the growth and survival of understorey beech in near-natural oak forests.

Key words: beech vitality, available soil water storage capacity, crown dieback, aboveground biomass, basal area increment.

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Validation and calibration WorldClim data in Southern Chile

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A WorldClim climate model is implemented and validated for southern of Chile. WorldClim monthly mean climatological data (temperature and rainfall) are compared to historical mean meteorological observations in the study area. Modeled and observed data show similar seasonal cycles and are spatially correlated but there

are differences in absolute values for the climatological variables under study. With respect to rainfall, there are significant differences between observed and modeled by WorldClim and underestimated throughout the study area, with maximum errors around 120 %. With respect to temperature, WorldClim reasonably estimated maximum temperatures, but in the case of the minimum temperatures significantly underestimated, with maximum errors around 80%. We recommend analyzing and correcting the WorldClim model for the southern of Chile using the meteorological historical available data. In this work we developed additional corrections, based on geographically weighted regression, to be applied to the baseline WorldClim in order to calibrate the historical observed climate variation for southern Chile.

Key words: regional climate modeling, dynamical downscaling, statistical validation, calibration, southern of Chile.

A general framework for the spatial quantification of drought in mountainous areas: an example from Greece with application to vegetation ecology

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In arid, semiarid and sub-humid areas, drought is a key factor for vegetation structure and composition, variability in species richness and distribution of vegetation types. The objective of this work was to develop a feasible framework for the spatial quantification of drought intensity in a mountainous area of central Greece, with semiarid to sub-humid Mediterranean climate. This information was used to address the role of drought in the floristic differentiation of the Mediterranean Greek fir (Abies cephalonica Loudon) forests and determine the drought limits of the different forest communities. For the spatial quantification of drought a Geographical Information System (GIS) was used in a sequence of steps. The different drought components were spatially estimated and combined in a form of a humidity/aridity index. The vegetation was classified and a gradient analysis was performed. Classification trees were used to determine the drought limits of the forest plant communities. A differentiation of the Greek fir forests in mesophytic and xerophytic plant communities was revealed. The drought threshold between the two forest types was quantified and its validity was assessed. Geo-statistical tools are very useful for assessing climatic variables at regional and local scales. Their ability to include topographic features and to incorporate information on the spatial variation of the climatic variables makes them very accurate and reliable in the prediction of drought intensity. The quantification of drought can be very useful in predicting changes in the distribution of such water-controlled forest communities, due to climate change.

Key words: aridity, synecology, GIS-based models, climate.

Acknowledgement: I would like to thank the committee of the IKYDA exchange program for their financial support. Special thanks to Dr. Nikos Alexandris for helping with the climatic analysis.

Climatically induced trends of change in floristic composition in forest communities in Northern Baikal Region (Southern Siberia)

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Calculations of the activity indices and species richness of belt-zonal elements of the flora of Baikal region forests have been done in order to reveal the presence of climatogenic changes. The results provided evidence for the weakening status of xerophilic species in the floristic composition of hemiboreal light coniferous forests (with dominance of *Pinus sylvestris* L.). On the contrary, no significant change has been observed in the floristic composition of mountain light coniferous boreal forests (with dominance of *Larix gmelinii* (Rupr.) Rupr.). Besides, it was found that there was an increase in activity of the species of the dark-coniferous belt-zonal group peculiar to dark-coniferous boreal forests (with dominance *Abies sibirica* Ledeb. and *Pinus sibirica* Du Tour).

Key words: flora, forests, climate warming, Baikal region, Siberia.

Acid rain in Turkey and the effect of Chernobyl accident on Turkey

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Acid rain is rain or any other form of precipitation that is unusually acidic. This form of air pollution is currently a subject of great controversy because of its worldwide environmental damages. For the last ten years, this phenomenon has brought destruction to thousands of lakes and streams in the United States, Canada, and parts of Europe. It has harmful effects on the environment and on structures. Acid rain is mostly caused by emissions due to human activity of sulfur and nitrogen compounds which react in the atmosphere to produce acids. These acids can be carried away far from its origin. This study is aimed to view acid rain and its effects in different sites of Turkey. The results in the literature have indicated that large amounts of acids are transported to these sites. But the data reflect that alkaline nature of the soil and alkaline particles in the atmosphere neutralize the acidity. In this study, human health effects and the physical consequences of the Chernobyl accident on Turkey were investigated. After the Chernobyl reactor accident, Eastern Black Sea coast was one of the heavily contamined regions of Turkey. The radioactive fall-out which occured two weeks after the Chernobyl accident over the North-east region of Turkey had an impact on the tea plantations along with tobacco and hazelnut plantations. The intervention level of radioactivity taken by the Turkish Atomic Energy Authority was sufficiently drastic only for pregnant women and to children of less than one year of age, but for all population of Turkey.

Keywords: Acid rain, air pollution, chernobyl accident, Turkey, nuclear power plant, radioactive contamination.

Topic: Biodiversity conservation and management in forest landscapes

Symposium: The role of long-term research for ecology, management and conservation of the native forests
Organizers: Guillermo Martinez Pastur, CADIC CONICET, Argentina. Stefan Schindler, University of Vienna, Austria. Christopher Anderson, University of North Texas, USA.

Ecological impact of variable retention management in *Nothofagus pumilio* forests through the use of meta-analysis

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Forests are used for multiple purposes, generating conflicts between harvesting and biodiversity conservation. Variable Retention-VR is a management proposal imitating natural processes that can reduce these conflicts. In South Patagonia, a portion of the original stands is maintained as unlogged (30% as aggregated-AR and 15% as dispersed-DR retention) to preserve structural and compositional diversity. Meta-analysis combines several studies to synthetize individual findings. In this study, we assess the ecological impact of VR management in *Nothofagus pumilio* forests using a dataset encompassing a large quantity of published and unpublished research results from long-term plots and performing a meta-analysis. We included 710 variables (113 types along the first 9 years-after-harvesting) measuring different aspects of (i) the abiotic environment (e.g. climate, soil), (ii) biodiversity (e.g. species richness and abundances), (iii) forest structure (e.g. volume), and (iv) forest reproduction (e.g. flowers). We compared the values for primary forests-PF, AR and DR with ANOVAs. We calculated effect sizes by Fisher´s Z-transformation using F values in random-effect models with categorical data using Metawin 2.1 software. The results showed that DR and AR caused a decline in the values of forest structure and reproduction variables, and an increase in the values of the abiotic and biotic variables when compared to PF. As a general pattern, greater changes were observed in DR, while AR showed lower impacts and values more similar to PF. We conclude that variable retention management has significant ecological impact, but that at least in the aggregates, primary conditions can partly be maintained.

Key words: meta-analysis, forest management, conservation, variable retention, Patagonia.

Acknowledgements: Project: Variable retention management in *Nothofagus pumilio* forests of Southern Patagonia: A meta-analysis across 15 years. MINCyT (Argentina) and BMWF (Austria) (2011-2013).

How does forest fragmentation affect biodiversity? A meta-analysis

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The relation between landscape structure and species diversity is a major research topic in landscape ecology, population ecology, biogeography, and conservation biology. Here, we performed a meta-analysis encompassing aspects of forest landscape structure and all groups of organisms. A systematic title search in ISI Web of Science and Scopus databases yielded 200 relevant papers. We assessed how species richness and species diversities were related to patch size, patch shape complexity, and isolation of forest fragments, as well as to the proportion of forest and to the heterogeneity of the surrounding landscape. We compared (i) different systematic and functional groups of plants and animals, (ii) native and alien species, (iii) generalist and specialist species, and (iv) tropical and temperate forest landscapes, and we used the naturalness of the study areas as a covariate. Preliminary results indicate that forest patch size, forest patch shape complexity, and proportion of habitat in the surrounding landscape were positively related with species diversity, while patch isolation showed an ambiguous relation whose strength differed among taxa. Plants were strongly related to landscape heterogeneity, whereas animals were most sensitive to forest patch area. Differences between tropical and temperate forests were hardly detectable. This study contributes to the theoretical framework of the main ecological drivers of global change-related biodiversity loss. Our findings also provide evidence for the choice of landscape indicators of species richness in forest landscapes.

Key words: landscape structure, landscape metrics, species richness, species diversity, systematic review.

Approaches for the restoration of degraded *Pilgerodendron uviferum* forests in North Patagonia

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Three years ago, we commenced a long-term research project dealing with the study of the ecology and restoration of old-growth and disturbed *Pilgerodendron uviferum* forests in the Tantauco Park in Chiloé Island (43ºS). With a multi-scaled approach, we focused research on the following questions: a) whether *P. uviferum* forests can persist in the absence of large-scale, intensive disturbances; b) to what extent can natural regeneration from seeds of remnant *P. uviferum* trees assist recolonization of disturbed forests? and c) How important are microsite conditions for successful restoration planting of *P. uviferum* forests? To answer these, we established 16 permanent plots in old-growth and disturbed *P. uviferum* forests. We also mapped seed trees in disturbed forests at a landscape level (100 ha) and studied the regeneration near seed trees. We established seed dispersal and germination experiments, and 6 disturbed forests were selected to investigate the effect of substrate and light conditions on active restoration through planting. Our initial results show that *P. uviferum* is a stress-tolerant species that can regenerate and grow under conditions of low light and low fertility. In disturbed forests, natural regeneration from dispersed seeds of remnant trees can effectively assist the recolonization of *P. uviferum*. However, at the landscape scale, after high-

severity fires, there are vast areas without seed trees of the species. In this context, a mixed approach of passive and active restoration will be the most effective and efficient option for the restoration of degraded *P. uviferum* forests.

Key words: bog forests, Chiloé Island, forest restoration, long-term research, seed dispersal.

Acknowledgements: To the administration and staff of Tantauco Park for constant help in the field. This research was financially supported by a PhD DAAD-CONICYT scholarship, Georg-Ludwig-Hartig and Futuro foundations.

Integrated watershed management in Llancahue and the role of silviculture to increase ecosystem services

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Llancahue is a 1300-ha watershed 10 km from Valdivia (130,000 inhabitants) that provides drinkable water to this city in south-central Chile. The watershed is covered by Valdivian Forests, including nearly 300 ha of secondary forests and 400 ha of old-growth forests. It was given as a concession for 20 years to the Universidad Austral de Chile from the Ministry of National Assets in 2008. The University´s primary task has been to stop illegal logging and grazing within the watershed from the neighboring "campesino" community of Lomas del Sol. In conjunction with this fundamental step, accomplished after three years of concession, there is also the mandate of opening the watershed for environmental education, all within the context of conserving the forest and the water quality and quantity for Valdivian citizens. To accomplish all these demands, the University has developed an Integrated Watershed Management Plan that will be monitored with an adaptive management approach. The process started with a stakeholder analysis that captured their beliefs, positions, interests, and concerns regarding the accomplishment of the objectives in the concession. During these years, we have developed fine-scale cartography with the support of LIDAR imagery to define use priorities within the watershed. To develop our community-based conservation plan, we have raised information on forest structure, composition, and growth to define the annual area of forest management to work with the stakeholders through ecological thinning aimed to increase old-growth attributes in secondary forests. Opportunities and limitations to move on with this plan will be presented.

Key words: community-based conservation, Valdivian Ecoregion, public-private partnership.

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Ecological aspects of the natural small-scale disturbances and regeneration processes to develop a sustainable forest management in *Nothofagus betuloides* forests

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Old-growth forests dominated by *Nothofagus betuloides* in South Patagonia and Tierra del Fuego are uneven-aged. Natural small-scale disturbances are frequent in these forests. Seedlings and saplings of *N. betuloides* are able to

establish, survive, and grow slowly at low light levels (solar radiation transmittances between 3.6 and 17.6 %), persisting suppressed in the shaded understorey for long periods (more than 100 years). Radial growth patterns on juvenile trees growing at the edge of the canopy gaps have shown that they can grow surrounding very small canopy gaps with low radial growth, and then respond to abrupt increases in gap size caused by disturbances to the canopy. Therefore, these results suggest that *N. betuloides* has greater shade-tolerance. Beneath this context, this work has an objective to show the effects of the canopy gaps on some microclimate variables, regeneration patterns, and ground vegetation to promote a new silvicultural practice in uneven-aged *N. betuloides* forests. The selection method employing a gap-based approach system might be used in order to maintain timber production and the structural richness of these old-growth *N. betuloides* forests.

Key words: *Nothofagus betuloides*, canopy gaps, regeneration, sustainable forest management.

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Can we use our history to model our future? Land-cover change analysis and spatially explicit models as complementary tools for forest management decisions

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Whereas forest practices may condition the dynamics of any given forest for many years, at a regional level, forest cover and productivity is mainly determined by alternative and/or complementary uses of forest land. So regardless of our efforts in managing our forests in a sustainable way, the distribution and condition of today´s forest reflects primarily variables that shaped our historical socio-economic relation to them. Land use/land cover change studies based on commercial satellite data allow us to trace back at least for 40 years of change of forest cover in most regions of the world. Combination of these data with old maps, fire scars, and traditional dendrochronologic studies is helping us to explore further back, to the effects of changes in agricultural practices, population densities, and patterns of colonization by different cultures. Further, digital elevation models and long-term records of regional precipitation, wind, and temperature series allow us to test hypotheses regarding the dynamics of these changes. Spatially explicit landscape models are a much less explored tool for understanding the dynamics of regional changes. We propose that the combination of traditional LULC analysis with mechanistic landscape models may help us understand the short, medium, and long term effects of political decisions regarding land use priorities, conservation, and restoration of forest and forest land. In this presentation, I will combine the results of two recently published studies with unpublished data from forests of Northern Patagonia, featuring future short and medium term scenarios associated with current land-use trends and legislation.

Key words: land use, landscape planning, long-term analysis, spatially explicit modelling.

Acknowledgements: The authors of this study are founded by CONICET and APN. We thank our colleagues from Laboratorio Ecotono for fruitful discussions on this subject.

Effects of forest loss on spatial pattern in a rural landscape: implications for conservation and land planning

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Habitat can be removed from a landscape in different ways, leading to different spatial pattern. Most conservation strategies for fragmented landscapes are based on manipulation of landscape pattern. In this study, we assessed land cover change and its effects on landscape pattern, focusing on native forests in a local-level rural landscape in the Coastal Range of south-central Chile. We analysed satellite images from the years 1986, 1999, and 2008, and estimated the main trends in land use/cover change. We assessed changes in the spatial structure of the landscape using landscape indices. Our results documented a progressive loss of native forest over the entire study period, which is mainly associated with an increase in forest plantations of exotic species. In the period 1986 - 1999, forest loss led to greater patch density, smaller mean patch size and increased mean patch isolation. In the period 1999 - 2008, while continued forest loss again led to increased patch isolation, the other trends were reversed: decreased patch density and, interestingly, greater mean size of remnant native forest fragments. This seemingly unusual trend calls into question how appropriate it is to apply conservation strategies based theoretically on the more common trends in landscape pattern. There may also be an under-appreciated scale effect, in which our fine-resolution findings contrast with the regional-level trends, measured using coarser-resolution data.

Key words: fragmentation, landscape indices, remote sensing, temperate forests.

Acknowledgements: This research was supported by funding from the CONICYT project 74110043, FONDEF project D08I1056, and Dirección de Investigación of Universidad de La Frontera.

SYMPOSIA

Symposium: Connectivity for conservation: methods, tools and management insights
Organizers: Santiago Saura, Universidad Politécnica de Madrid, Spain. Peter Vogt, Institute for Environment and Sustainability, Joint Research Centre of the European Commission. Italy.

How many connectivity metrics do we need and what should they measure?

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Growing concern on the importance of sustaining ecological fluxes over large spatial scales has stimulated the development of a myriad of methods for analyzing landscape connectivity. Users are overwhelmed by a profusion of connectivity metrics. Without any guidelines to navigate in such a densely populated metric space, it is difficult (and potentially arbitrary) to decide how and through which metrics should connectivity be best measured. Many metrics, even if they are apparently different, may provide largely redundant results when indicating the key landscape elements as connectivity providers. At the same time, guiding metric selection only through statistical criteria might lead to highly idiosyncratic outcomes (dependent on the correlation structure arising in each particular data set/case study), which lack of sufficient generality and robustness as to advisable for a wide array of connectivity-related applications. Here we synthesize recent conceptual developments and findings that provide an integrated analytical framework and a concise and commensurable set of metrics for landscape connectivity analysis. Such framework and metric set is supported both by (1) conceptual differences on the roles of habitat

patches and links in the landscape network and (2) statistical findings on the distinctive aspects they quantify for orienting conservation planning. We discuss the practical benefits and applied insights that such framework offers to landscape managers. We conclude with an overview of some case studies that have benefited from its application, particularly when intending to provide a multifaceted but coherent view of the landscape network able to support decision making in changing landscapes.

Key words: landscape connectivity, spatial graphs, ecological fluxes, habitat availability (reachability), conservation priorities.

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GUIDOS: a toolbox to assess connectivity in landscape patterns

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Key landscape features can be parameterized by analysing pattern, connectivity, and fragmentation of image objects. Fragmentation is usually defined from a species point of view but a generic and quantifiable indicator is needed to measure fragmentation and its changes. Recent research introduced Morphological Spatial Pattern Analysis (MSPA) for an intuitive description of image pattern structures and the automatic detection of connectivity pathways. Reliable corridor detection is an important feature in landscape management, ecosystem services, conservation biology, and a prerequisite for network and connectivity analysis based on graph-theory approaches, i.e. Conefor Sensinode. The free software toolbox GUIDOS (http://forest.jrc.ec.europa.eu/download/software/guidos) is designed to provide appropriate tools for the application of recent research studies to scientists and especially newcomers in the field of landscape ecology. The new functions to analyse fragmentation, land cover change, and the detection of key connecting elements are illustrated on a sample data set. A specific focus will be placed on the transition from raster images to network analysis, including the detection and quantitative assessment of key nodes and links. Furthermore, we will illustrate how to use a similar conceptual approach to highlight key connectivity zones for an efficient increase in landscape connectivity. The new tools in pattern and connectivity analysis provide added value in risk assessment studies, landscape planning, and conservation/restoration policies.

Key words: MSPA, connectivity, fragmentation, pattern analysis.

Understanding landscape connectivity from an individual's perspective: spatial hierarchies in movement decisions

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Animals usually face larger ecological costs when gathering information on coarse-grained features than on fine-grained features. An information barrier at the landscape scale could prevent the animals from using and dispersing

to high quality patches, thus reducing the functional connectivity. However, animals can make efficient movement decisions based on within-patch experiences that do not require information about the location and content of patches. I simulated the movement in a landscape with two hierarchical patch levels (patches and sites within patches) and with two levels of patch quality depending on the quality of sites. Individuals switched between two different searching strategies: First, individuals moved randomly between patches only after they failed to find high quality sites within patches (bottom-up mode). Second, individuals established foraging routes through the highest quality patches that they have previously visited, with time for movement between sites depending on the expected average reward in the patch (top-down mode). Although both modes occurred with some frequency, the prevalence of the top-down mode was more successful in term of increasing the long-term gain rate and connectivity between suitable patches. However, when patch size and speed of resource renewal were lowered, an increased prevalence of the bottom-up mode led to a higher connectivity and gain rate. Results suggest that a sharp connectivity decline may result from a positive association between uncertainty in location of suitable patches and reduced resource availability in the landscape.

Key words: information barrier, connectivity, searching strategies.

Understanding the effects of habitat availability on bird occurrence in fragmented landscapes

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Habitat loss and fragmentation are the main drivers of species extinctions in human modified landscapes. In such landscapes, habitat availability is reduced not only due to the loss of habitat cover itself but also due to the loss of habitat connectivity. In general, species occurrence and/or abundance are strongly dependent on habitat connectivity, especially in highly fragmented landscapes. However, measuring habitat connectivity is hard. Empirically, it demands a huge effort to gather individuals' movement data. Theoretically, few indices have demonstrated consistent performances in quantifying habitat connectivity and, in turn, habitat availability. Here, we present a framework aimed to evaluate the effects of habitat availability on tropical forest birds inhabiting fragmented landscapes. This framework includes both data gathering techniques as well as graph theoretical analytical procedures. Overall, we show that short gaps may strongly reduce foraging inter-patch movements, reducing habitat connectivity and, in turn, affecting bird occurrence through changes in habitat availability. Moreover, we show that probabilistic habitat availability indices may be better predictors than binary indices in determining bird occurrence in patchy landscapes. Therefore, we emphasize the importance of using animal movement data to measure habitat connectivity. Finally, we discuss the implications of our results for forest bird conservation, highlighting the benefits of a graph theoretical approach to landscape management.

Key words: habitat availability, gap-crossing, habitat fragmentation, species occurrence, forest birds.

Acknowledgements: We would like to thank CNPq and BMBF for funding this research. We also thank Gregório Menezes for the invaluable help in the field work.

Connectivity analysis for threatened species in forest plantations managed for biodiversity conservation in the Parana Delta, Argentina

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The wetlands of the Lower Parana River Delta are modified, mostly because of the development of forest plantations. These industrial oriented plantations of poplar and willows alter deeply the hydrology and the natural design of the region through human-induced changes. These changes include a gradient from basic ditches for soil drainage and their impacts cover a range, from progressive impoverishment to complete habitat quality lost. As a way to measure these impacts on the native fauna, we analyzed a set of variables that could explain the presence of capybara (*Hydrochoerus hydrochaeris*) and neotropical river otter (*Lontra longicaudis*). The presence condition was used as a succedaneum for habitat quality. Our intention was to verify the remaining habitat zones in the area, and also to check if these habitat zones are used by these species as functional landscape features: habitat patches, stepping stones, and corridors. The presence of these mammals in the areas was determined by camera trap records worked as a countercheck. Our results suggest that some specific plantations areas keep their habitat condition for these two mammal species. However, other areas related with plantations infrastructure, and with restrictions of water river inputs, seem to be very poor habitat quality. Recommendations related with plantations management that should be considered include site and landscape factors such as entry and movement of water management, edge vegetation, proximity to grasslands, and other waterways that could reduce the impact of these forest plantations on the available habitat. We outline some priorities for subsequent research that will further support decision-making.

Key words: forest plantations, capybara (*Hydrochoerus hydrochaeris*), neotropical river otter (*Lontra longicaudis*), habitat quality, plantations management.

Identification of suitable habitat-patches and corridors: Towards an integrative approach for habitat planning and conservation

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Maintaining or restoring landscape connectivity has become a major concern in conservation biology and land planning in particular for amphibians, among other species. Indeed, amphibians' life cycle involves seasonal migrations between terrestrial and aquatic habitats which constrain them to regularly cross an inhospitable, fragmented landscape matrix, making them vulnerable to land degradation and connectivity loss. Faced with the growing need for maintaining connectivity within the patch network relevant to the amphibian spatial perception, the aim of our study was to provide a method based on habitat suitability modelling and graph theory approaches to explore and analyze ecological networks. The study focuses on habitat availability and landscape connectivity (Urban and Keitt 2001, Pascual-Hortal and Saura 2006), under the basis that connectivity is species-specific and should be measured from a functional perspective. The focus is on viable habitat patches, in relation to the ongoing need for large landscape connectivity. We assess planning for amphibians' conservation and distribution patterns with the common frog (*Rana temporaria*). We first used maximum entropy modelling with environmental variables based on forest patches distribution to predict suitable habitat patches distribution. Then, with considerations about landscape permeability, we applied graph theory in order to highlight the main habitat patches influencing

habitat availability and connectivity. Results show that the method appears as a promising tool for landscape planning.

Key words: habitat suitability, landscape permeability, maximum entropy modelling, graph theory, landscape planning.

Symposium: Landscape genetics: tools for disentangling ecological and evolutionary processes.
Organizers: Andrea C. Premoli, Universidad Nacional del Comahue – INIBIOMA, Argentina.

Landscape restoration in *Austrocedrus* drylands using genetic polymorphisms

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Drylands comprise 30% of the earth, and in South America, 94% of dry-temperate lands present some degree of environmental degradation, highlighting the need for ecological restoration. The analysis of geographic patterns of genetic variation in *Austrocedrus chilensis*, a dominant conifer of the steppe-forest ecotone in the eastern Andes, allows us to examine its potential for restoration. We sampled 67 locations in Argentina and estimated population-level parameters to determine the effects of historical landscape change, modeling genetic structure and diversity, using 12 allozyme loci. Genetic diversity decreased southwards in eastern populations, which are marginal for the range of the species and patchily distributed, while high genetic admixture was detected in continuous western populations, possibly reflecting postglacial migrations from northern and eastern sources. Higher inbreeding (FIS > 0.14) was recorded in northern compared with southern populations, attributed to the impact of recent bottlenecks resulting from anthropogenic fires. Gene flow was found to be overall moderate (FST = 0.12). The implications of these results to support restoration actions are: Relatively small, inbred, yet genetically diverse northern populations, should be the subject of passive restoration efforts. The use of local germplasm for active restoration initiatives could increase population size, counteracting inbreeding effects. Predicted climate change gives the opportunity for restoration trials to be established beyond species current ranges into new suitable areas, so experimental common gardens could be established toward the south. This illustrates how information collected ahead of time on intraspecific patterns of genetic variation can effectively support restoration efforts for dryland tree species.

Key words: landscape genetics, restoration, *austrocedrus*, genetic diversity, genetic structure.

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Paleolandscape reconstruction based on DNA sequences of widespread *Nothofagus*

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Phylogeographic analysis of widespread South American *Nothofagus* species in combination with molecular dating and geological data provide the natural setting to reconstruct paleolandscape features and species distribution

patterns, including past population expansions. A total of 156 populations along the entire distribution range of four species of subgenus *Nothofagus* (*N. antarctica, N. betuloides, N. dombeyi, and N. nitida*) which grow predominantly in lowland Patagonia were sampled and analyzed by DNA sequences of three non-coding regions of the chloroplast. Twenty-eight chloroplast DNA (cpDNA) haplotypes were found that were significantly correlated with geographic distance. Molecular dating on the haplotype phylogeny revealed that most chloroplast variants were shared by all species which date back to Eocene-Miocene and long-lasting paleobasins and marine ingressions impeded transoceanic dispersal. A Bayesian skyline plot showed that the lineages of all species suffered a last bottleneck at the limit of Pliocene-Pleistocene, and they expanded after the Great Patagonian Glaciation. These results show that species of subgenus *Nothofagus* consist of ancient lineages that evolved during Tertiary times and that survived *in situ* throughout Patagonia.

Key words: chloroplast DNA, molecular dating, skyline plot, Patagonia, tertiary.

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Ecological niche modeling and molecular markers elucidate landscape patterns in montane subtropical *Podocarpus*

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Phylogeography in combination with ecological niche modeling (ENM) and fragmentation analysis is a robust tool to analyze hypotheses on range shifts under changing climates particularly of taxa and areas with scant fossil records. We combined phylogeographic analysis and ENM techniques to study the effects of alternate cold and warm (i.e. glacial and interglacial) periods on the subtropical montane cold-tolerant conifer *Podocarpus parlatorei* from Yungas forests of the central Andes. Twenty-one populations, comprising 208 individuals, were analyzed by sequences of the trnL-trnFcpDNA region and 78 sites were included in the ENM. Eight haplotypes were detected, most of which were widespread while three of them were exclusive of latitudinally marginal areas. Haplotype diversity was mostly even throughout the latitudinal range. Two distribution models, based on eight bioclimatic variables, indicate a rather continuous distribution during cooling, while under warming, remained within stable, yet increasingly fragmented, areas. As in the case of *P. parlatorei*, cold tolerant taxa from subtropical mountains have probably survived the glacial eras locally in the same, or nearby, areas that it currently occupies without major latitudinal movements. This is consistent with widely distributed haplotypes that suggest local expansion-retraction from long-lasting core areas through time. Although no major range shifts are expected with warming, long lasting persistence of cold-hardy taxa inhabiting subtropical mountains may include *in situ* and *ex situ* conservation actions particularly towards southern (colder) areas.

Key words: yungas, conifers, cold-tolerant, ecological niche modeling, phylogeography.

Genetic tools for landscape analyses: a case study on the widespread *Nothofagus pumilio*

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In recent years, the interest of researchers on landscape genetics has increased widely. This new discipline involves studies which integrate data analysis and methods from landscape ecology, spatial statistics, geography, and population genetics to understand the spatial distribution of genetic variation. Landscape genetics examines the contemporary processes affecting genetic variation incorporating the effects of gene flow rates, population connectivity, and landscape features. We aim to give ecologists a glimpse on genetic tools available for population-level analysis at the landscape scale. We hereby present a case study on *Nothofagus pumilio*, a widely distributed tree species in the austral temperate forests of Argentina and Chile. We combined genetic evidence with landscape features to analyze the survivorship of this species in glacial refugia and possible long-distance migration events that occurred during past range shifts. We assessed nuclear genetic variation on 41 populations collected along the latitudinal range of distribution and we modeled the ecological niche (ENM) in current conditions and during the last glacial maximum (LGM) based on 19 bioclimatic variables. The results of ENM show multiple suitable areas for species persistence during the LGM, even in high-latitude environments. Genetic analyses evidenced similar levels of variation in north and south populations, while intermediate populations presented the highest levels of diversity and population structure, indicating restrictions for gene flow between north and south. Our data suggest that *N. pumilio* has survived in multiple ice-free locations during glacial periods in small populations that have acted as genetic reservoirs to recolonize nearby areas after ice retreat.

Key words: landscape genetics, genetic variation, landscape features, *Nothofagus pumilio*, glacial refugia.

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Landscape conservation in Patagonia: molecular clues to past reconstruction, present analysis, and prediction of future scenarios

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Spatially and temporally dynamic landscapes characterize areas occupied by native forests within temperate and subtropical montane areas. Any widespread species inhabiting such forests most probably consist of populations whose genetic characteristics will reflect past and current natural and anthropogenic disturbances shaping their gene pools. Spatially explicit sampling of natural populations and the use of different molecular markers can help trace historical events occurring at distinct timelines. While the use of slow-evolving genetic markers with a cytoplasmic mode of inheritance may help to elucidate past events, other more rapidly evolving ones such as nuclear markers may assist to interpret contemporaneous processes. In addition, molecular data can be crossed with independent proxy information such as ecological niche modeling and fossil data to understand past and current gene flow rates. Genetic studies were performed on dominant tree species of temperate forests of southern Argentina and Chile and montane subtropical woodlands of northern Argentina and southern Bolivia. These were conducted sampling multiple populations along their total species ranges which were analyzed by nuclear and cytoplasmically inherited markers. In addition, other studies were performed at the local scale in temperate areas to understand species-

specific responses to natural disturbances, i.e. fire and fragmentation. Past events such as changes in climate and disturbances occurring at distinct spatial scales have had a profound imprint on the gene pool of native trees and species responses varied according to their ecological and life history traits. This information can be used to model future responses under changing climates.

Key words: native forest, genetic markers, disturbance, temperate, subtropical montane.

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Short Manuscripts
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A visual perception study in landscapes subject to fires in South East Australia

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Results of a visual perception study of landscapes subjected to prescribed burning regimes in South East Australia provided insight for improving fire management policies by considering the aesthetic dimension of landscapes. Preference and similarity data were collected during a series of photo-sorting interviews using photos as stimuli. Data were analyzed using a mix-method approach finding 10 landscape clusters. These were different in terms of the visual effect of different fire intensities over time and people's knowledge about fire management practices.

Key words: Prescribed burns, landscape aesthetic, landscape management.

Do beavers improve the habitat quality for Magellanic Woodpeckers?

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The effect of the disturbances caused by the American beaver (*Castor canadensis*), introduced to the Cape Horn Biosphere Reserve, on species of birds that are forest habitat specialists is poorly understood. Using telemetry data, we determined which attributes of abandoned beaver meadows have a strong impact on habitat selection by the Magellanic woodpecker (*Campephilus magellanicus*). We detected a negative relationship between the woodpecker habitat use and the fraction of old-growth forest located near these meadows. These results suggest that favorable habitat conditions are generated around small meadows with old-growth forest, because they might increase availability of wood-boring larvae.

Key words: American beaver, *Campephilus*, habitat selection.

The role of land-use visions for protection of forest landscapes: the Białowieża Forest (Poland)

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This work concentrated the issues of use vs. protection that developed in the Polish part of the Białowieża Forest last century, particularly during the post-war decades. Owing to extraordinary natural values, the area deserves very careful protection, however, negative impacts on the landscape have been widely observed. The changes involving perforation and fragmentation of forest cover caused by continuous logging are accompanied by spatial disorder in built areas and their vicinities resulting from tourism development. The aim of the research was to identify the underlying forces of negative tendencies and simultaneously, obstacles to progress in nature conservation of the area. Comparison of views and visions of landuse and management of the Forest showed that great differences in attitudes, applied perspectives, and expectations to the Białowieża Forest exist. The study revealed the importance of a socio-cultural dimension for a current stage of landscape evolution. This influence is connected with a steady pressure on wood exploitation and results, at least partially, from a strong position of forest administration in this area and from specific land-use visions emphasizing economic services of the forest. Noteworthy, actions undertaken across the country and numerous efforts to extend protection of the area have not succeeded so far. It is argued that underestimation of natural values expressed by local communities in addition to weaknesses of the State's environmental law may bring serious hazards to the analysed landscape and affect the whole system of nature conservation in Poland.

Key words: landscape, change, values, Białowieża Forest, Poland.

Forest conservation index and historical evolution in a coastal region: The São Sebastião Island – São Paulo Brazil

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The aim of this study is to identify the current conservation status of five forested watersheds which have been under different human pressures throughout history of São Sebastião Island to assess relations between pressures which have occurred in the past and the current environmental quality. Through maps of land use, landscape metrics, and the development of a Forest Conservation Index, it was possible to identify in watersheds the greater landscape fragmentation, implications on quantity and quality of available habitat, and effects of boundaries.

Key words: landscape change, landscape metrics, indexes.

Carbon budget recovery and role of coarse woody debris in post-logging forest ecosystems of Southern Siberia

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Forest harvesting is a major human-caused disturbance affecting carbon budgets in forest ecosystems. This study was concerned with post-logging carbon pool changes in Scots pine (*Pinus sylvestris)* and Siberian fir (*Abies sibirica*) stands. To understand carbon budget recovery trends following logging, carbon stock and fluxes were measured in stands differing in time since logging. In both Scots pine and fir stands disturbed by logging, the tree phytomass contribution to the carbon budget decreased drastically, whereas the coarse woody debris (CWD) carbon pool exhibited a marked increase. Sixty years following logging, the Scots pine stand carbon storage was almost 70% of that prior to logging and the ratio between the phytomass and soil organic matter was the same as before the disturbance. While the phytomass carbon showed a similar trend in the fir stand of the same age, it was less than on the control stand. In a 50-55-year-old fir stand, 26 years since harvesting, the phytomass carbon recovered only by 15%. Siberian fir and Scots pine logging sites differed in CWD loading and decomposition rate. The phytomass dynamics and CWD loading values obtained suggest that Scots pine stands which have experienced logging are most likely carbon sinks, as was clear from the phytomass production exceeding organic matter decomposition-caused fluxes. Conversely, logged fir ecosystems are likely to be sources of carbon to the atmosphere due to a large CWD loading, faster rate of its decomposition, and slow phytomass increment.

Key words: carbon budget, logging, phytomass, coarse woody debris, decomposition.

Strategic position of integrated systems for agriculture and environment

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The modern concept of product quality implies also a higher demand for environmental preservation along the production process. Latin America countries, because of their abundance of natural resources and high potential for food, energy, and fiber production, are globally important on discussions regarding agricultural production and environment. Global warming is a very important issue and forests preservation, as well as afforestation, play a major role in this context. Low yielding areas of cattle grazing many times do not explore the potential of areas where natural vegetation was already displaced for beef production. Inefficient systems represent also unnecessary greenhouse gases emissions. On the other hand, integrated silvopastoral or agrosilvopastoral systems, also known as livestock-crop-forest systems, being more efficient, do not only reduce total emissions from the systems, but also sequester carbon from the atmosphere. Even though not yet formally recognized in the international carbon credits market, these systems have a great potential and excellent appeal in the voluntary carbon market, since they synergistically put together interests from farmers, industries, government, and civil society, regarding food production and environmental services. Therefore, farmers' awareness about the strategic importance of being pioneers on adopting these systems is essential, since many indications point out a promising market for carbon sequestration and avoiding emissions from more efficient, integrated cattle systems.

Key words: agrosilvopastoral, greenhouse gases, beef cattle, grazing systems, sustainability.

Botanical field surveys combined to VHSR satellite image data for automatic forest habitat mapping in a mountainous forested area in French Pre-Alps

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Monitoring European habitats requires definitions that can be applied consistently across Europe. The identification of forest habitats in protected areas represents a major challenge for conservation of biodiversity. Georeferenced information at the species level is already being collected by many national and international organisations, but methodologies for spatial modelling and mapping European habitats and landscapes are lacking. Currently we do not have quantitative habitat data available that can be suitable for habitat monitoring and reporting at the European level. In this context, the French minister MEEDDM (Ministry of Ecology, Energy, of the Sustainable development and the Sea) has recently initiated the mapping of the whole of French natural and semi-natural habitats within the next decade. It consists of developing a habitat mapping scheme (CORINE Biotopes typology) for mountain forest ecosystems based on Earth Observation (EO) data and ancillary data. Usually achieved through field observations, this paper argues for the need to profit from remote sensing approaches. RapidEye satellite image data and ancillary environmental information, combined with field species data, provided by the CBNA (National and Alpine Botanical Conservatory) were used to characterize ecological conditions of forest habitats. The originality of this methodology lies in developing an object-oriented image analysis, based both on multi-resolution segmentation and classification, and combined with fuzzy logic (CBNA data). The results show that an object-based

approach, in particular automatic segmentation, improves drastically the delineation of habitat units. Finally, the identification of forest habitats with CORINE Biotopes typology (one-digit level) becomes progressively possible through this fuzzy logic approach to integrate ecological conditions.

Key words: habitat mapping, habitat directive EU, geo-spatial monitoring, object-oriented image analysis, fuzzy logic.

The vegetation of Robinson Crusoe Island, where to focus conservation efforts?

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The Robinson Crusoe Island (RCI), Juan Fernández Archipelago (Chile), contains more endemic plant species per area that any other insular system of the world (ca 1.9 sp/ km²). Currently exotic plants invade all habitats on the island. RCI has a high conservation priority for biodiversity; around 75% of the vascular species are endemics in danger of extinction. We analyzed the vegetation types of RCI, describing the role that canopy gaps presented over the replacement of the endemic montane forest by novel formations dominated by exotics. Using published data, we reviewed the main vegetation types of RCI, considering their plant species on IUCN categories, their amount of invasive exotic plants, and the abundance of land-bird species. Most endemic and endangered plant species were located in the montane forest, where exclusively threatened bird species can be found. We further analyzed a montane forest site through six transects (100-240 m long), describing the canopy gap structure. We characterized 46 gaps; most were of endogenous origin (96%) ranging 100-200 m^2 size (39%). Almost 70% of the gaps were invaded by exotic species (> 30% invasives cover).We compared invaded and non-invaded gaps within forest areas. Invaded gaps averaged around 2.5 less native species than non-invaded gaps. Invasive species changed the forest landscape on RCI, forming novel formations dominated by exotics that significantly hampers natural forest regeneration and reduces plant diversity (evenness). Monitoring canopy gap creation to help invasive species control at early invasion stages is recommended, and further restoration proposals will be discussed.

Key words: Invasive species, Restoration, Canopy gaps, Endemism, Juan Fernándezisland.

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Man-animal conflict management in the Himalayas - experiences from the State of Uttarakhand, India, with special emphasis to leopard attacks and crop depredation by wild pigs

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The objective of this study was to evolve suitable management practices for amicable human-wild animal coexistence in forest-dominated village ecosystems. The different traditional and changed management practices of agriculture and animal husbandry and lifestyle in the Himalayan villages in Uttarakhand were analysed to find out the causes of increased man-animal conflict and devise measures to transform from conflict to co-existence.

The main reasons of increasing man-animal conflict were found to be increased fragmentation of forest land, loss of corridors, invasion of alien species like *Lantanacamara*in forest areas, decreased food availability in the forests for wildlife, increased garbage, abandoning of cultivated fields due to out-migration of villagers, changing cropping practices and community dynamics of crop protection, and decreasing folk traditions among village women. The availability of subsidized food grains from the market and provision for ex-gratia compensation for man-animal conflict incidents has further worsened the situation. Man-eating incidences by leopards were found to be more common on children of 5-7 years of age, followed by elder children and women. Most of the incidents were actually accidents rather than proper man-eating cases. General practices like trapping, tranquilising, giving permission to shoot the animal, fencing, etc. have been found to be futile in managing the problem. An integrated approach that includes lifestyle changes as well as changes in agriculture practices and village dynamics, including low-cost local technology, has been proposed to tackle the situation for mutual benefit of wild animals and humans.

Key words: man, animal, conflict, leopard, pigs.

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Maintaining forest structure and function in dynamic swidden landscapes of the Peruvian Amazon

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In tropical swidden agroforestry, recurring fallow periods are essential to maintain soil fertility, forest cover, and high landscape biodiversity. In these systems, substantial variation exists in fallow management amongst farmers which may alter soil properties and species composition. Small landholders re-cultivate sites more frequently than large landholders, who often plant orchards in lieu of forest fallows, creating a mosaic of fallow types and ages across the landscape. We examine the impact of short (3-9yrs) versus long(10+yrs) fallow rotations and prior orchard planting on soil fertility and tree species diversity in re-growing fallows. We interviewed farmers from a ribereños community in Peru to collect field histories on 390 mapped fields and sampled soils and tree species richness in 62 fallows; 18 on prior orchard sites. We use distance metrics and patch area statistics to look for spatial patterns of biodiversity and soil degradation. Soil fertility increased with fallow length but did not differ with orchard history, nor with distance from the community. Rarefaction curves showed that species richness was higher in long rather than short fallows and increased with distance from the community ($p=0.03$) and patch area ($p=0.02$). Within fallows, a biological legacy from planting orchards was detected. Fallows on former orchard sites accumulated fewer tree species (117±18.8CI) after +10yrs than regular fallows (231±22.5CI). Results suggest that fallow management patterns do affect soil fertility and species diversity, with orchard fallows contributing substantially to landscape biodiversity loss. Of mapped fields, 41% had historically experienced an orchard fallow, accounting for >23% of the mapped area.

Key words: swidden, fallow, biodiversity, soils, peasant farmers.

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Plant conservation in *Nothofagus* forests of Tierra del Fuego: the need for different landscape-level analyses.

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Biodiversity conservation is usually implemented only at a regional level in Patagonia (Argentina) and its effectiveness is poorly known regarding other landscape level units (local and stand), since little information exits. Therefore, we studied vascular plant diversity in *Nothofagus* forests and their associated environments distributed throughout Tierra del Fuego Island at three landscape levels. Floristic surveys (richness and cover) were conducted at 535 plots, and 230 vascular plant species were analysed at the (1) regional level, considering 2-3 zones depending on forest types (*N. pumilio*-NP, *N. antarctica*-NA or N. *betuloides*-NB); (2) local level, considering 5-6 vegetation types for each zone (grasslands, peat-bogs, shrublands, NP, NA and NB); and (3) stand level, considering a control-C and different tree retention types (aggregated-AR and dispersed retention-DR) on NP forests at three ranches. Data were analysed using multivariate techniques (nonmetrical multidimensional scaling and multi-response permutational procedure). At the regional level, differences were found for zones considering each forest type (NA > NP > NB). At the local level, forest plant diversity differed from non-forested associated environments in the three zones. At the stand level, harvesting produced changes in plant diversity of NP forests for the three ranches, where C was more similar to AR than DR. Plant conservation strategies in *Nothofagus* forests should take into account these landscape levels, since vascular plant diversity differs within a region (between different zones), a locality (vegetation types), or harvested stands (retention types). Implications of the analyses for management and conservation strategies at different landscape levels will be discussed.

Key words: biodiversity conservation, regional scale, local scale, stand scale, variable retention.

Acknowledgements: To the project PRESTAMO BID PICT 2010-Bicentenario Nº2124 from ANPCyT (Argentina) and to all the people who collaborated with plant surveys since 1999 to date.

Biodiversity and forests in urban environments: examples from Milano (Italy)

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Urban parks, greenspaces and restored areas are essential components of the urban environment because they provide a wide range of environmental and social functions to cities and urban dwellers. Several studies explain how forest structure can influence positively the level of biodiversity for different taxonomic groups (plants, birds, insects). In this work, we analyze three examples in the urban region of Milan (Italy). In the first case we explore the relationship between the urban forest structure and the abundance of certain bird species. We can see how in target bird species, the abundance is directly related to the DBH of trees, and we are able to propose a regression curve that revealed a significant positive correlation between DBH and species abundance: the higher the tree diameter the higher the abundance of the species. The second example is a project based on the restoration of different biotopes in a small municipality located 15 km south of Milan. In particular, new hedgerows and forested

woodlots have been planted and wetlands have been restored with bioengineering techniques. In the last example, we analyze relations between plant diversity and the optimal dimension of forest patches in a suburban area close to Milan (minimal area of 1 – 1.5 ha, optimal area more than 30 ha). Our results provide some useful information for forest managers in order to increase services of urban forests both for social needs and conservation purposes.

Key words: restoration of biotopes, birds and forest structure, plants bioindicator, urban landscapes.

Biodiversity conservation maps using environmental niche factor analysis in *Nothofagus* forests of Tierra del Fuego (Argentina)

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There is a lack of biodiversity conservation strategies in traditional agriculture and forest management of Argentina. A national legislation (26331/07) promotes forest conservation, but biodiversity values are not included in the classification, regarding most of the protection to marginal unproductive forests. In this study, we develop biodiversity conservation maps using environmental niche factor analysis (ENFA) of understory plants in *Nothofagus* forests of Tierra del Fuego (Argentina), and propose its use as a decision tool for conservation strategies at the regional level. We used data of vascular plants based on a survey of 535 sampling plots taken during 2000-2012. Using ENFA (software Biomapper 4.0), we produced a series of spatially explicit habitat suitability models for 35 vascular plants, based on climatic and topographical predictor variables. These variables were chosen after a correlation analysis of 29 original maps. Further, we produced biodiversity conservation maps (software Arcview 3.0) based on the 20 most important vascular plant species (cover + occurrence) for each forest type. Maps showed different qualities along Tierra del Fuego, e.g. *N. pumilio* forests presented higher values in the central-northeast areas, while *N. antarctica* presented higher values in the west, south, and east areas, and evergreen forests presented different qualities between east and west. Potential conflicts with past and present timber and cattle production will be discussed. Habitat suitability models for selected plant species were very effective to develop a decision support system for conservation strategies at different levels (e.g. natural reserves at regional level and local reserves during forest management planning).

Key words: forest management, biodiversity conservation, *Nothofagus*, understory plants, Tierra del Fuego.

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Effects of predatory logging on forest stands and the viability of sustainable forest management in a rural settlement in Central Amazonia

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Illegal logging is among the main economic activities in the expansion frontiers of the Amazon. This work analyzed the effects of illegal and predatory logging on the forest structure and the stock of commercial timber in properties

of a rural settlement near to Manaus, Brazil. Forest resources have been illegally exploited in the locale since the early 1980s after the construction of two highways in the region. Basal area (BA) and aboveground live biomass (ABGB) were estimated for trees >10 cm dbh in 12 properties; the data were compared to the BA and ABGB estimates of pristine forests in two regional sites (BIONTE and BDFFP projects) as well as to the estimates of the Amazonas State. Forest inventory of 40 commercial timber species were carried out on 11 properties in accordance with state law in order to establish a small-scale system of sustainable forest management (PMFSPE). As expected, both the BA (mean ±SD = 23.0 ±4.2; $F_{3,40}=10.42$, $p<0.001$) and ABGB (mean ±SD = 293.2 ±53.3, $F_{3,40}=2.87$, $p<0.05$) were reduced on the illegally exploited properties relative to pristine forests. Nevertheless the stock of commercial timber still allows for forest management in the properties; we found that 41% (123) of inventoried trees and 60% of the commercial species selected could have potential to be harvested within a year. The establishment of PMFSPE in the settlement, while resulting in direct benefits (income generation) to the smallholders, can ensure the recovery of forest after logging (return of previous stocks of biomass) and, therefore, the maintenance of its environmental services.

Key words: forest structure, forest degradation, forest resilience, environmental services, illegal logging.

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Role of afforestation on dry and degraded lands &developmental finance in generating sustainable livelihood and strategies to arrest desertification in India

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Desertification presently is focused global concerns due to its impact of it on nature. WWF- 1998, revealed that approximately 50 acres (22 hectares) of forest are cut down every minute. Livelihoods of 1.2 billion people in 100 countries, including India, are at stake. Desertification and degradation of forest render them in starvation. 135 million people (Ashok 2006) have had to abandon their land, due to desertification; these figures provide sufficient caution to gear up global efforts for combating desertification. UNEP estimated, damage and losses caused by desertification to be $42 billion annually. FAO estimates 30% of productivity lost annually due to desertification and it affects 33% of Asia's population. India, which is a signatory to UNCCD- 1994, when various governments initiated desertification combating measures including, DPAP, DDP Joint Forest Management (JFM), Revolving Fund for Forest Operations (RFFO), Wasteland Development Programme etc. Some of these measures especially JFM and RFFO, have people participation in administration. Results of these programmes yielded desired objectives to a limited extent. Desertification in India is mainly caused by an exploitation of natural resources. JFM has, major features; of inclusion and involvement of people in planning and implementation. RFFO is a strategic move of Administration that eliminated a simplified system eventually contributing for afforestation to arrest desertification. Objectives of this paper are a) to analyze extent and causes for degradation and failure of governments to address the desertification; b) to study role of afforestation on dry and degraded forest lands for providing sustainable livelihood to the dependent communities; c) to evaluate developmental financing efforts of governments and voluntary organizations; and d) to augment strategies to arrest desertification and promote afforestation activities.

Key words: afforestation, financing, livelihoods, joint forest management.

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Agro-ecosystems and farmer forests: A sustainable future land use option for biodiversity conservation and food security: A case study from south India

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The homestead agro-ecosystem and farmer forests are the traditional land-use systems observed in Western Ghats region of India. These land uses are characterized by an intensive integration of forest trees and horticultural crops with a basic objective to ensure sustained availability of multiple products and indirect benefits such as their role in ecosystem services, climate balance, biodiversity conservation, and livelihood improvement. Recently, Kudremukh National Park has been elevated as a Tiger Reserve of the country and also proposed as one of the UNESCO sites. In this backdrop, local people are worried about the rehabilitation outside the park. Hence, this study aims to assess the biodiversity in tribal home gardens and to understand the role of local communities in promoting biodiversity. The agro-ecosystem is dominated by fruit crops (40%), followed by beverages, indicating that local people are meeting significant food needs from agro-ecosystems. The results revealed that both land uses managed by farmers possess more species and biomass than the adjacent protected forests, indicating the willingness of the farmers to conserve the native species. A progressive shift from the traditional exclusive approach to a community-driven, rights-based approach is thus needed in India to protect social and tribal rights in relation to biodiversity conservation and climate balance. In this regard, the government should uphold and institutionalise the traditional land-use systems to be a protected area management system of the country, with appropriate legislation.

Key words: Western Ghats, agro-ecosystems, farmer forests, land use, biodiversity.

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Habitat modeling and coastal landscape connectivity in La Araucanía, Chile: Basis for definition of conservation priority areas of *Lontra provocax,* the southern river otter.

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In Chile, the coastal rim of La Araucanía Region has a land use significantly modified over the last 100 years. This has caused important fragmentation processes in the landscape affecting the levels of connectivity and ecological flows that allow species to survive. An important species in this area is *Lontra provocax* (southern river otter), currently nearing a state of extinction according to IUCN. *L.provocax* is considered an umbrella species of aquatic, riparian, and coastal ecosystems, which means that conserving its habitat will protect a wide range of organisms and associated ecosystems. The aim of this study is to determine potential distribution areas of *L.provocax* and assess the structural connectivity of habitats in order to identify the most suitable sectors for preservation, considering its status as an umbrella species. The method consisted of developing a theoretical model of habitat through the multi-criteria analysis of the most representative variables at the territorial level. Once we identified the suitable habitats, we assessed the connectivity of these in order to prioritize conservation areas. The results indicate that

there are still suitable habitats for the species but the high level of fragmentation affects the area requirements. Regarding connectivity, it is possible to generate corridors between patches of high suitability because the majority of these patches are located in the south of the study area. We conclude that habitat modeling and connectivity analysis is useful for assessing conservation priority sites under one umbrella species approach.
Key words: habitat modeling, landscape connectivity, *Lontra provocax*, umbrella species.
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Species richness maps as friction surfaces to model landscape conservation

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The use of indicators to identify potential connectivity options is one of the priorities for landscape conservation and management. We used species richness data together with a cost distance tool in a Colombian tropical Andean landscape that proved to be a practical and accessible method to assess forest patch connectivity for conservation purposes. The use of field data taken from surveys of forest bird species richness provided accurate information for the generation of friction layers, giving a close-up view of the advantages and impediments that the landscape structure offers to the target group of species. To evaluate conservation actions planned for the study, we compared two scenarios defined as 2001 and 2001+20. Upon these scenarios we applied a bidirectional cost distance approach that assists in the qualitative assessment of the least cost and therefore the most appropriate connectivity route. Using this least-cost route, we modelled the most adequate corridor connecting forest patches in each scenario and compared them to assess the improvement of the connectivity likelihood if conservation efforts in the study area continue until the year 2021. The combination of species richness data and a bidirectional cost distance approach enabled the detection of bottlenecks that hinder the linking process within the landscape. The approach has a great potential to evaluate landscape conservation and management activities, especially in developing countries where resources for conservation are very limited.

Key words: least-cost path, graph theory.

Can Protection Forests ensure biodiversity conservation along with peoples' unprecedented timber demand?

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A special arrangement for the protection of some crucial Nepalese forests has been recently endorsed by the government, and has been given a name of Protection Forests. Six forest areas which are important from the biodiversity as well as peoples' livelihoods point of views have been declared, as per the article 4 of Forests Act 1993, as protection forests. The overall responsibility has been given to the Department of Forests (DoF) to manage such forests. The arrangement has been quite different from the long-practiced protected areas management system which was envisioned by the Wildlife Protection Act1961: 1. the new management regime has actually been observed as pro-people and expected to largely address the demand-supply nexus of forest products, where the long-practiced approach of protected forests is basically confined to the strict control of the forests; 2. the new

system tries to ensure the duo-goal of biodiversity conservation as well as production of forest products, whereas the older systemtries toensure species conservation giving less or no emphasis on the reproductive biology of forests; and 3. the new system seeks the dual responsibility of Government as well as local people in the decision-making process so as to regulate the forests and forest products, whereas the old system solely sought the government agencies to control the forests and forest products. A synopsis of the new management regime is somewhere in between the two extreme philosophies of forest management: to leave all management responsibility to the local people vs. to give total control of forests and forest products to the government. Whatever the management regime enforced in forest management in Nepal, the outcomesare largely based on how people actually see the new policy. People have expressed mixed opinions regarding this. Community forests users groups who actually are enjoying full access and withdrawal rights over the forests with full autonomy have been observed perceiving this idea as curtailing of their freedom over the forests. On the other hand, people living far away from the forests see this new policy as an opportunity of equal benefit sharing as they do have equal representation in all decision-making proceses. Being an independent analyst, I can largely explore three major observations regarding the new forest management regime in Nepal - 1. The government's initiation to regulate the ill-practicing community forests in the plain seems somehow logical; 2. A multi-stakeholder approach to this policy has been seen lacking; 3. The government's willingness to conserve biodiversity and meet peoples' needs of timber and fuel-wood is a worthwhile policy decision for the nation. Upon cautious implementation, the objectives of the policy are largely achievable as the reproductive biology of the forests always tends to make a trade-off between biodiversity conservation and silvicultural intervention to augment the forests products.

Key words: Protection forest, Nepal, Sapkota, Biodiversity, Conservation.

Acknowledgements: Nepal Government.

Effects on epiphyte orchids of cloud forest at local landscape scale

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The cloud forest is one of the world's main biodiversity hotspots, but the land changes by the rural communities lead to extinction processes in this ecosystem. Orchids are one of the most beautiful and endangered taxathreatened from extinction, due to the particular and specific habitat relationships. Despite the fact that orchids have been the object of many researches, scarce information exists regarding their response to habitat alteration. The goal of this study was quantify and qualify with the community, the impact of changing landscapes on the abundance/richness of wildorchids in the cloud forest. We sampled transects in six relicts belonging to rural associations of cloud forest in two Andean ranges (west/central cordillera) in Valle del Cauca. Alfa and beta diversity; variables related to tree structure (density, frequency and coverage), and the coverture/use around each relict, were measured. We found new species and differences in abundance/richness among mountain chains. Abundance and richness were related to the tree structure. The study showed a marked decrease in abundance and richness of species near the borders as opposed to the inner areas of each relict, due to tree structure. The orchids abundance at the borders depended also on the surrounding vegetation, with the multi-purpose crops with tree coverture showing higher orchid abundance than other covertures. This finding suggests that changes in land use/cover and tree structure in cloud forest directly affect the diversity of orchids, and this effect maybe greater in endemic species. Management activities are necessary to concentrate/maintenance/transform the land use/cover around the habitat to prevent loss of genetic diversity due to genetic drift.

Key words: boder effect, community, tree structure.

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The influence of local and landscape agricultural intensification on within-farm biodiversity

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Land-use change is considered the strongest driver of biodiversity loss, an alarming fact considering around 40% of the terrestrial land surface is now covered by agriculture. Yet, some agricultural systems can maintain high levels of biodiversity; therefore, it is essential to understand which agricultural components are key to conservation. We conducted a meta-analysis of the literature to determine the importance of local and landscape-level factors in promoting within-farm biodiversity. Using a literature search in ISI Web of Science, we included published studies that compared local management factors (organic vs. conventional, intensive vs. extensive, etc.), compared landscape-level factors (% cropland, % forest, etc. surrounding farms within >200m radius), and measured biodiversity across these conditions. Preliminary results suggest that the mean log response ratio (less intensive/ more intensive) of species richness was significantly greater than zero, indicating that overall richness was higher in less intensive (organic and extensive) compared to more intensive management (conventional) types (mean = 0.34, lower 95% CI = 0.19, upper 95% CI = 0.49). The mean correlation coefficient for the relationship between percent non-crop area (landscape variable) and richness was greater than zero (mean = 0.210, lower 95% CI = 0.097, upper 95% CI = 0.323), indicating landscape effects also had a significant effect on richness. Both local and landscape factors had similar effects on abundance. Thus these results suggest that both local and landscape-level factors are important for the conservation of biodiversity within agricultural ecosystems.

Key words: agriculture, biodiversity, crop, meta-analysis, dispersal.

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Protected areas in the European boreal biome: a century of development toward a green infrastructure?

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To establish protected areas that form functionally connected habitat networks, or green infrastructures, is one of the tools to maintain ecological sustainability. This requires not only adding up the total area of protected areas, but also to understand the objectives of categories of protected areas in different countries and their representation of ecoregions and ecosystems. The boreal biome hosts the highest proportion of the world's remaining intact forest

and peatland ecosystems. However, the globally increasing need of natural resources accelerates habitat loss and fragmentation of natural complexes in many boreal regions. Following the Aichi Biodiversity target, a total of 17% ecologically representative and well-connected protected areas should be secured. This requires expansion of the amount of protected areas in many regions. We compared the development of protected areas in the European boreal biome in countries with different systems of nature resource governance. We analysed development of different types of protected areas, and their amounts, in Norway, Sweden, Finland, and NW Russia from 1900 until the present time. We defined what protected areas have been in favour in each country during the last century and periods with different rates of change in each country, and analysed the representation in different parts of the boreal biome (northern, middle and southern taiga). We discuss how integrated forest landscape management across sectors and scales can improve protected area networks as a part of developing functional green infrastructures.

Key words: categories of protected areas, nature conservation policy, strong protection, medium protection, weak protection.

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Clearcut size and the conservation of wildlife in pine plantations

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Clearcutting is one of the most controversial aspects of plantation forestry. Particularly, the use of very large cutblocks, although more economically efficient, has been deemed environmentally harmful and, consequently, restrictions to the maximum individual clearcut size are common. However, there is limited information on the impact of individual clearcut size on wildlife. I conducted a study to analyze the landscape-wide effect of clearcut size on wildlife in Central Chile. In seven landscapes dominated by pine plantations, I estimated the average diversity and abundance of forest wildlife (birds, small mammals and reptiles) in mature (17+ y old) pine stands. Using information provided by timber companies, I calculated the size of the average clearcut used during the past rotation and estimated its effect on the wildlife variables, using multiple regression analyses (including several covariates). I also estimated the abundance of prairie-scrub species in 30recent (2-5 y old) clearcuts of different sizes, and analyzed the effect of the size of such patches (along with several covariates) on the wildlife variables. Most of the best models showed a significant negative effect of the clearcut size on the abundance and/or diversity of different wildlife groups. Interestingly, for forest species, the shown pattern implies a persistent effect, as calculations of average clearcut sizes included stands cut up to 20 years earlier. For open-area species, these results are intriguing as it could be expected that larger habitat-patches (clearcuts) could support higher population densities (or species diversity).

Key words: pine plantations, clearcutting, wildlife conservation.

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Integrated conservation planning in a timber plantation landscape in South Africa

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The South African forestry industry is built on fast-growing plantations of *Eucalyptus*, *Pinus* and *Acacia* species, most of which occur in the Maputaland-Pondoland-Albany (MPAH) biodiversity hotspot. The diversity of indigenous plants in this region is among the highest in the world, with over 600 globally threatened species. Among the 1 million hectares of plantations in the MPAH are over 300,000 hectares of natural and semi-natural habitat, comprising a mosaic of grassland, indigenous forests, and other ecosystems. The habitat loss resulting from landscape transformation is a major threat to ecological integrity and biodiversity. One of the mitigation approaches used to deal with this issue is the maintenance of interconnected corridors and nodes within the transformed landscape, forming an ecological network. In order to better manage, design, and prioritize resource allocation in the ecological networks, a systematic conservation planning approach has been applied to the plantation forestry landscape. A spatial tool has been created to express the relative conservation values of the unplanted areas and, in combination with forest certification and legal protection, a conservation strategy has been developed which has the potential to greatly enhance biodiversity conservation. The role of systematic conservation planning in an integrated approach to mitigate the impacts of landscape-level transformation is discussed with practical examples. The value of private-public partnerships is emphasized.

Key words: plantations, biodiversity, conservation, ecological network, systematic conservation planning.

Acknowledgements: South African Biodiversity Institute, Forestry South Africa.

Forest certification and boreal biodiversity conservation? Structural and functional connectivity in Sweden and NW Russia

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In Europe, the Russian Federation and Sweden have the largest areas of FSC-certified forests. We assessed the potential of FSC certification for boreal biodiversity conservation in terms of standard content, and outcomes as habitat area set aside and habitat network functionality. First, we compared the biodiversity conservation indicators at different spatial scales in Swedish and Russian FSC standards. Second, focusing on one large state forest management unit in each country, we compared the areas of formally and voluntarily set aside forests for biodiversity conservation. Third, we evaluated the structural habitat connectivity by applying morphological spatial pattern analysis, and potential functional connectivity by using habitat suitability index modelling for virtual species. The Russian standard included indicators for all spatial scales of biodiversity conservation, from tree and stand to landscape and ecoregions. The Swedish standard focused mainly on stand and tree scales. The area of voluntary set-asides for FSC was similar in Sweden and Russia, while formal protection in the Russian case study was three times higher than in the Swedish one. Swedish set-aside core areas were two orders of magnitude smaller, had much lower structural and potential functional connectivity and were located in a fragmented forestland holding. Thus, to understand the potential of FSC for biodiversity conservation, both the standard contents, and its implementation

on the ground, need to be assessed. We discuss the potential of FSC certification for biodiversity conservation with different levels of ambition.

Key words: landscape connectivity, landscape pattern, forest management, forest landscape.

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The Mount Malindang landscape, Mindanao Island, Philippines: plant diversity status and threats

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The landscape of Mount Malindang (8° 27' 06"- 8° 37' 49'' N latitudes to 123° 36' 45"– 123° 42' 54" E longitudes), Mindanao Island, Philippines is composed of five zones, namely: (1) a pristine mossy forest zone (1,701-2, 475 m altitude) at its summit, followed by zones of (2) montane forest (1,401-1700 m), (3) submontane forest (901- 1400 m), (4) colline (401-900 m) and finally, (5) a lowland rain forest zone from 400 m and below. Distributed among these five zones are nine types of vegetation in five composite levels of biodiversity (using Species Richness to Endemic Species index), and as follows: (I) plantation forest 11.2 (low) to 2.2 (low); (II) lowland mixed dipterocarp forest 20.3 (high) to 5.2 (moderate); (III) mossy, N slope -20.8 (moderate) to 4.6 (moderate), mixed dipterocarp - 19.4 (moderate) to 4.5 (moderate) and lowland dipterocarp forest 20.3 (high) to 5.2 (moderate); (IV) submontane forest 28.0 (very high) to 7.6 (high); montane forest, N slope 23.9 (high) to 9.45 (very high) & S slope -29.1(very high) to 10 (very high) and mossy forest, S slope 30.8 (very high) to 8.5 (high) and (V) almaciga (*Agathis philippinensis*) forest 32.7 (extremely high) to 12.8 (extremely high). A total of 1,284 species (26 lichens -2.0%, 85 bryophytes -6.6%, 280 pteridophytes -21.8%, 20 gymnosperms -1.6% and 873 angiosperms-68.0%) was recorded from the entire study area, of which 56 species had endangered and locally threatened conservation status. Despite the still rich plant diversity of Mount Malindang, this mountain ecosystem is continually threatened by indiscriminate utilization of its economically important plant resources as well as by destructive conversion of large tracts of forests to agricultural lands.

Key words: plant diversity, biodiversity conservation, mountain ecosystem, mountain landscape, Mt. Malindang, Mindanao Island, Philippines.

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Effects of past land use and landscape configuration on plant diversity in an agroforested landscape in Canada

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Historical land use and landscape configuration can alter soil properties, seed sources, and spatial patterns of plant dispersal, thus modifying the composition of plant communities for centuries. The main objective of this study

was to evaluate the effects of past land use and landscape configuration on plant diversity in forest patches in an agricultural landscape in south-eastern Canada, where plant communities have been subject to three centuries of intensive land use. We first analyzed the evolution of forest from 1860 to 1990 using historical maps and a novel technique for defining forest change trajectories with a new clustering algorithm (Affinity Propagation). Second, we collected plant species data in forest patches with different land-use histories and different levels of connectivity to surrounding forests through time; effects on plant diversity were analyzed using Non-metric Multidimensional Scaling ordination (NMDS). The forest change trajectory analysis showed that more than half of the forest cover remained stable throughout the entire period. However, three other trajectories showed that deforestation occurred in both 1910 and 1990 and there was also a temporary reforestation period in 1910. The deforestation trajectory could be explained by a general increase in individual farm area for monocultures while the temporary reforestation could result from the abandonment of less productive lands, considering 1910 farming techniques. The NMDS analysis showed a correlation between the species distribution and the landscape configuration in 1910 and 1990, suggesting that past landscape configuration affects present-day biodiversity. Analyses are underway to identify indicator species for these differential histories.

Key words: plant diversity, landscape trajectories, landscape configuration, forest history.

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Sustained yield forestry and sustainable forest management in Sweden and Russia: Does the old concept correspond to new policy?

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The aim of this study is to analyse how sustained yield forestry (SY) is understood and implemented in Sweden and the Russian Federation. First, we analysed the meanings of SY using document analyses and qualitative interviews. Second, the delivered main forest ecosystem services were mapped, as well as different treatments that were applied as parts of forest management: harvesting systems, rules, and regulations. Finally, we discuss the consequences of SY forestry as performed in Sweden and NW Russia, respectively, related to the ability of boreal forest landscapes to support ecological, economic, and social-cultural functions, as envisioned in SFM and other forest-related sustainability policies. The results of our comparative study indicated that the current forest management regime in both Sweden and Russia was declared as being SY forestry, but with different levels of intensity. At the same time, the comparative analyses of different aspects of forest management and planning in the Swedish and Russian forest management units shows a deep discrepancy between policy and implementation of SY forestry. The meaning and implementation of SY forestry in both countries provoke public concerns and debate. In Sweden, stakeholders outside the forest sector are concerned about the negative impact of intensive forest management on forest ecosystem integrity, biodiversity conservation, and rural development. The main concern in Russia is about insufficient management of forest resources which does not provide sustainable economic outcomes for forest industry. Additionally, forestry creates challenges for nature conservation and local employment opportunities.

Key words: forest landscapes, ecosystem services, forest management regime.

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Nurse crops for biomass production and forest landscape restoration, afforestation, or transformation of monocultures into mixed-species forests.

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Nurse Crops are a temporal combination of fast-growing, early-successional tree species and slower-growing, late-successional tree species, aimed at short-term biomass production while simultaneously establishing a vital future forest. By rapidly recovering forest functions such as stand climate, hydrology, and nutrient cycling, the sheltering canopy of Nurse Crops can favour the establishment and growth of sensitive late-successional tree species. Early-successional tree species can be harvested one or two decades after their establishment, while late-successional tree species may remain on site for the course of their rotation period. Hence, Nurse Crops can be a silvicultural approach for afforestation, forest restoration, or the transformation of monocultures into mixed-species forests at a landscape level, thus providing multiple ecological and economical short- and long-term benefits in comparison with ordinary monoculture methods. In addition to the quick restoration of forest functions, short-term benefits may comprise increased species diversity, increased biomass provision for bioenergy production, and reduction of establishment costs attributed to fewer tree seedlings being planted under Nurse Crops. Depending on the management goal, the thinning intensity of late-successional tree species can be reduced as a consequence of lower seedling density, which in turn reduces the nutrient exports in biomass during early thinning operations while facilitating a management goal comparable to ordinary monoculture methods. Here we summarize the major results of our research on the establishment, growth, management, and carbon and nutrient cycles of such Nurse Cops using case studies in temperate forests of central Europe.

Key words: forest restoration and conversion, biomass production, carbon and nutrient cycling, forest landscape, mixed species forest.

Productivity and carbon storage in silvopastoral systems with *Pinus ponderosa*, plantations, and pasture on Andisol soils in Patagonia, Chile

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No information is available about carbon (C) sequestration potentials in ecosystems growing on Andisolsoils of the Chilean Patagonia. This study was undertaken to measure the size of C stocks in three predominant ecosystems: *Pinus ponderosa*-based silvopastoral systems (SPS), pine plantations (PPP), and natural pastures (PST), and examine how clover affects tree growth and stocks of C soil. The C contents of trees and pasture were determined by destructive sampling and dry combustion. Soil samples were taken at 0-5, 5-20, and 20-40 cm depths in order to determine soil C and N. For PPP and SPS, respectively, 38.4 and 53.1 kg tree^{-1} of total tree C were stored aboveground, whereas 21.3 and 23.4 kg tree^{-1} were stored belowground. Tree diameter at breast height increased 1 and 2 cm year^{-1} in PPP and SPS, respectively, and was significantly higher in SPS. Trees in SPS have their growth enhanced by lower tree competition and the additional soil N provided by the leguminous pasture, resulting in larger amounts of C being sequestered. Soil organic C (SOC) stocks at 0-40 cm depth were 193.76, 177.10 and 149.25 Mg ha^{-1} in SPS, PST and PPP, respectively. The conversion of PPP to SPS and PST to PPP resulted in an increase of 44.51 Mg ha^{-1} and

a decrease of 27.85 Mg ha^{-1} in SOC, respectively, at 0-40 cm soil depth. A favorable microclimate (air temperature, soil moisture) has been observed in SPS as well as a synergistic effect between trees and pasture.

Key words: C stocks, N storage, growth, silvopasture, volcanic soils.

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In-stream large wood storage and potential recruitment areas in Chilean mountain catchments affected by different disturbances

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The morphologic effects of in-stream large wood (LW, wood pieces 10 cm in diameter and 1m in length) are studied in stream segments of catchments affected by different natural and anthropogenic disturbances. The investigated watersheds are Pichún (431 ha, under forest plantation management schemes since early 1950´s) near the city of Nacimiento, El Toro (1735 ha, native forests severely affected by a wildfire in 2002) in the Malleco Forest Reserve, Tres Arroyos (907 ha, slope instabilities and highly concentrated flows) in the Malalcahuello Forest Reserve, and Vuelta de Zorra (587 ha, 150-200 years old secondary evergreen forest) in the Valdivian Coastal Reserve. LW storage varies from a minimum of 3 $m^3100\ m^{-1}$ of channel length in Pichún to a maximum of 139 $m^3100\ m^{-1}$ in Tres Arroyos. El Toro and Vuelta de Zorra catchments show intermediate values of 26 and 12 $m^3100\ m^{-1}$, respectively. The main LW recruitment process in Pichún, El Toro, and Vuelta de Zorra corresponds to trees and big branches falling from the floodplain due to snow or windthrow, senescence, or diseases outbreak. At Tres Arroyos, massive inputs of logs delivered by torrential secondary affluents to the main channel build up upon the already mentioned mechanism. A significant relation between LW volumes and the potential recruitment area (in hectares per 100 m of channel length) was found, and explains LW channel storage ($m^3100\ m^{-1}$) in the study stream segments.

Key words: in-stream large wood, mountain catchments, natural and anthropogenic disturbances, wood recruitment processes.

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Non-linear growth functions for ecosystem management and modelling of tree height -diameter relationships for *Gmelina arborea* (Roxb.) in South-west Nigeria

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The tree height-diameter relationship can be used as an important input component in forest growth and yield models, and a description of stand dynamics for ecosystem management. Five non-linear growth functions were fitted to tree height-diameter data of a 21-year old *Gmelina arborea* plantation in Ibadan, South-west Nigeria. The

data consisted of three sets: 2004, 2008 and 2011 on total tree height and DBH. According to the model statistics, the five growth functions fitted the data equally well, but resulted in different asymptote estimates. Modified exponential fit was observed to give the best fit for the three data sets based on least square error, coefficient of determination and significance. The models are: Ht = (R^2 = 36.2), Ht = (R^2 = 37.5) and Ht = (R^2 = 34.7) for 2004, 2008 and 2011 data sets. The predicted values follow the same nonlinear pattern and formed close to the line of best fit without much outlier. The result of this study revealed that the ability of DBH in determining height is not strong enough based on the model's goodness of fit and the model's ability for predictive purposes. Hence, more variables such as age, crown area, and soil fertility were recommended to be incorporated into future predictions of tree height in the study area. Also, the potential tree height-diameter equations should be evaluated and validated for their predictive capabilities across a range of tree diameters. This useful information can help forest researchers and managers select and apply the appropriate models.

Key words: nonlinear model, forest management, diameter at breast height, total height, *Gmelina arborea*.

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Conceptual design of an integrated land-use change model for the Brazilian land-use change frontier

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During the past decade, Southern Amazonia has faced massive land-use changes. These changes are characterized by a rapid growth of the population in combination with a growing trend towards urbanization and extreme deforestation in order to acquire new areas for agricultural or speculative purposes on the one hand, and in order to generate tropical woods for market purposes on the other hand. These trends are accompanied by a constant climatic change which promotes the frequency and intensity of extreme weather events like El Niño and the emergence of forest fires. The main goals of SP11 will be the development and the operation of a regional land-use model which is based on input data specific to the study region. With the help of this model, a scenario analysis up to the year 2030 will be computed. This analysis will incorporate changing socio-economic and biophysical conditions over the modeled timespan. Findings of this study will then be used as an integral part of the Carbiocial DSS to develop and test management strategies that help to reduce GHG emissions and to improve carbon sequestration. The analysis of future land- use change dynamics will be carried out with a newly developed land-use model integrating socio-economic and biophysical drivers of the surveyed region. This new model will be based on the LandSHIFT framework. Here, land-use and land-cover changes are computed with a modified cellular automata approach, which considers the competition between different land-use activities, like settlement and crop cultivation, for the available land resources.

Key words: land-use change, landscape management, biodiversity, social policy, deforestation.

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Woody species diversity and socio-economic importance of Boke salt landscape, a volcanic crater lake in semi-arid drylands of Borana, southern Ethiopia

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Studies on woody plant species diversity and socio-economic importance were conducted in Boke salt valley landscape. To study woody plant species diversity, evenness, richness, and community type, line transects were laid along the four aspects for sampling purposes. A total of 22 quadrats (20 m x 20 m) were sampled. For comparative purposes, 6 quadrats of the same size were sampled from outside the salt house. PRA and semi-structured interviews were conducted for a socio-economic data collection. The collected data were analyzed using PC-ORD, CANOCO and SPSS software. A total of 24 woody plant species, representing 18 genera in 14 families, were recorded. The density of woody plant species was 2622 individuals ha^{-1}. The diversity and evenness indices of the study area were 2.10 and 0.66, respectively. Three plant community types were identified in the current study, namely, Suaeda monoica, Maerua triphylla-Acalypha fruticosa and Hibiscus aponeurus- Solanum somalensis. Soil parameters like moisture content, organic matter, total N, and available P had significant positive correlation with altitude, whereas exchangeable Na, pH-H2O, and electrical conductivity had negative correlation. The salt valley landscape is the sole source of both table salt and black salty mud which are used as a livelihood safety net during drought. About 50,000 ETB was said to be collected from eco-tourists visiting the area. Given the level of poverty and recurrent drought, Boke salt landscape is under intensive human exploitations. Hence participatory resource management is crucial for long-lasting.solutions.

Key words: woody diversity, plant community, environmental variable, crater-lake, succession.

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The role of land-use visions for protection of forest landscapes: the Białowieża Forest (Poland)

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This work concentrated the issues of use vs. protection that developed in the Polish part of the Białowieża Forest last century, particularly during the post-war decades. Owing to extraordinary natural values, the area deserves very careful protection, however, negative impacts on the landscape have been widely observed. The changes involving perforation and fragmentation of forest cover caused by continuous logging are accompanied by spatial disorder in built areas and their vicinities resulting from tourism development. The aim of the research was to identify the underlying forces of negative tendencies and simultaneously, obstacles to progress in nature conservation of the area. Comparison of views and visions of landuse and management of the Forest showed that great differences in attitudes, applied perspectives, and expectations to the Białowieża Forest exist. The study revealed the importance of a socio-cultural dimension for a current stage of landscape evolution. This influence is connected with a steady pressure on wood exploitation and results, at least partially, from a strong position of forest administration in this area and from specific land-use visions emphasizing economic services of the forest. Noteworthy, actions undertaken across the country and numerous efforts to extend protection of the area have not succeeded so far. It is argued that underestimation of natural values expressed by local communities in addition to weaknesses of

the State's environmental law may bring serious hazards to the analysed landscape and affect the whole system of nature conservation in Poland.

Key words: landscape, change, values, Białowieża Forest, Poland.

A visual perception study in landscapes subject to fires in South East Australia

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Results of a visual perception study of landscapes subjected to prescribed burning regimes in South East Australia provided insight for improving fire management policies by considering the aesthetic dimension of landscapes. Preference and similarity data were collected during a series of photo-sorting interviews using photos as stimuli. Data were analyzed using a mix-method approach finding 10 landscape clusters. These were different in terms of the visual effect of different fire intensities over time and people's knowledge about fire management practices.

Key words: Prescribed burns, landscape aesthetic, landscape management.

The capacity of civil society organizations and their networks in community based environmental management

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The CiVi.net project aims to analyse, transfer, and disseminate successful and sustainable community-based solutions with regard to ecosystem service management in Latin America. The main focus is placed on institutional settings in terms of original rules and related governance models which help prevent and resolve tensions arising from a necessary new repartition and use of natural resources. Thereby, the role of civil society organisations (CSOs) within these governance models is in the core of the research. To meet these challenges, CiVi.net takes an action research and case study approach. The project has chosen four case study regions in Brazil and Costa Rica where successful solutions have been worked out. These will be analysed with respect to the following questions: - What kinds of management instruments are used to solve environmental problems and how effective are they? - What kinds of original rules and institutional arrangements are implemented and which economic governance models have been established? - What crucial aspects must be considered when transferring these solutions to other communities that face similar problems? - What is the capacity of CSOs and their networks for contributing to finding, implementing, and transferring such solutions? Based on the findings, CiVi.net wants to facilitate the transfer of successful solutions to at least one other community for each selected case study region confronted with similar environmental challenges. To do so, CiVi.net is developing an ex-ante assessment approach to test the transferability of institutional solutions and of successful governance models.

Key words: ecosystem services, payment for ecosystem services, civil society, biodiversity and forest conservation, community based environmental management.

Organic matter retention and diversity of benthic communities influenced by in-stream large wood in a third-order channel in the Coastal Mountain Range, Chaihuín, Chile

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The influence of in-stream large wood (LW) on the retention of organic matter and the diversity of benthic macro-invertebrates was evaluated at the reach scale in a third-order channel located in the Coastal Mountain Range, Chaihuín, Chile. Three LW volume-poor reaches (7.6 m^3) and three LW volume-rich reaches (261.6 m^3 per 100 m of reach length) were studied. Organic matter retention was inferred from the difference between the number of leaves collected in the downstream end of each reach, and the 200 leaves introduced in the upstream end. Benthic macro-invertebrate diversity and abundance were evaluated from samples collected on the streambed of every reach, employing two equivalent sampling methods. Data was used to determine the taxonomy and calculate the Bray-Curtis similarity index. Mean organic matter retention was 72 and 90% among LW-poor and rich reaches respectively (not significantly different) and showed a strong negative correlation (-95 %; $p < 0.05$) with discharge at the sampling time. Benthic macro-invertebrates were more diverse and abundant in LW-rich than in LW-poor reaches, and the number of species was twice in the former. Bray-Curtis similarity was low (30-40 %) between LW-rich and poor reaches, while it was high (60-80 %) among LW-poor reaches. Among LW-rich reaches, similarity amounted to 35-70 %. Results confirmed the hypothesis that organic matter retention and benthic macro-invertebrate diversity and abundance were higher in LW-richer reaches.

Key words: large wood, benthic macro-invertebrates, organic matter retention.

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Impacts of land-use change on an ancient threatened species in southern Chile: implications for its conservation

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Fitzroya cupressoides (Mol.) Johnst (Cupressaceae), an endemic threatened conifer from temperate forests of southern Chile and Argentina can be found in remnants of native forests located in the Central
Depression of Los Lagos Region of Chile, place where this species was considered extinct, as a result of overexploitation. By means of satellite images, the effect of the land use change in the spatial habitat patterns of four populations was assessed between 1976 and 2007. Both current composition and structure of these populations was also assessed with the purpose of know their current status. A set of 20 X 25 m plots were established for every population under study. Species richness, diameter at breast height (DBH) and regeneration of *F. cupressoides* were recorded. The loss of native forest with presence of *F. cupressoides* reached 50.5% and the habitat loss for the species was of 69%. An average of twelve accumulated species for the four populations was found. Three of the four populations presented viability (above 50.5% of the trees with DBH < 25 cm and an average of 2.745 seedling/ha in regeneration). Native forest was subjected to area reduction, which implied a habitat loss of *F. cupressoides* as a result of the fragmentation generated by a land use change. Urgent conservations actions are needed for the three populations that are viable. These must consist in restoration programs and integral management of the matrix. Actions that should consider the current configuration of the landscape and land use planning.

Key words: Chilean larch tree, habitat assessment, landscape change, spatial patterns, anthropogenic processes.

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POSTERS

Initial recovery of the vegetation after the eruption of the Chaitén Volcano (Chile) in a blast disturbed area

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In May 2008, an eruption began on Chaitén Volcano (42,83°S - 72,65°W). New surfaces were created by different volcanic impacts (piroclastic flows, tephra, lateral blasts, and lahars) occurring over 300 km^2 of natural vegetation. Four years after a massive tree fall and ash deposition, the early plant recovery was studied in a lateral blast disturbed area (3 km^2). Following a gradient of altitude, 50 plots (16 m^2) were systematically located. The coverage of all vascular plant species was recorded with the Braun-Blanquet scale during summer, 2012. Species richness and coverage have been calculated for each of the following major physiognomic groups: trees, scrubs, herbs, and ferns. The coverage of the moss, liverworts, lichens, coarse woody debris, and environmental site characteristics (slope, aspect, elevation, topographic position and ground coordinates) were also recorded for all of the plots. Preliminary results show that a total of 45 vascular plant species were found. The most frequent physiognomic group corresponds to herbs (31% of all vascular plants), then 22% are trees, and 18% are scrub species. More

frequent trees species are *Weinmannia trichosperma*, *Eucryphia cordifolia* and *Nothofagus nitida*. More frequent scrub species are *Baccharis* sp., *Fuchsia magellanica* and *Azara lanceolata*.

Key words: recovery, vegetation, volcanic eruption, blast, disturbance.

Measurements of alpha diversity and importance value indices in landscapes for woody species conservation in the Abdoulaye Protected Area (Togo, West Africa)

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This survey underlines the conservation status of woody species in the Abdoulaye Protected Area (APA) landscape in Togo, based on the health indicators of dense dry forest landscapes of this area. Forestry inventories data were collected using transect methods. Several indices were computed to analyse the alpha diversity such as Simpson's Reciprocal, Hill's, Alatalo's, Margalef, Dominance indices, and Family Importance Value (FIV). Based on alpha diversity descriptions and distance between Forest Checkpoints and plots, three vegetation groups, namely F5, F10, and F15, were found and characterized by high variation for all diversity indices computed. However, by converting the Shannon-Wiener Index into Hill's Index, also a non-parametric index, the meaningful differences between these groups were easily appreciated through the diversity number 37.7, 89.1, and 81.4, respectively, in F5, F10, and F15. With regard to FIV, Combretaceae and Sapotaceae were the dominant families in each group. In addition, the findings underlined the decreasing abundance of higher trees of Anogeissusleiocarpa from the centre of APA to the boundaries, related to human disturbances. Thus, conservation strategies to protect them against anthropogenic factors should be taken into account to increase the abundance of rare species. The study suggested full participation of local communities for the effective conservation plan of forest-threatened species in APA. Lastly, updating is highly desirable and must be considered by the government in the preparing for forest sustainable management in Togo.

Key words: dry forests, alpha diversity, landscape, conservation, togo.

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Role of traditional agroforestry practices in biodiversity conservation: The Pendjari Biosphere Reserve case study in West Africa

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The present study focused on the floristic diversity within traditional agroforestry parkland systems and showed the diversity of tree species as well as socio-economic factors which affect the practice of this farming system. It also points out the reasons which explain the spontaneity of these systems in contrary to introduced agroforestry systems. We used questionnaires and interviewed a total of 118 households to collect data. Respondents were

interviewed on their farms and during the interview; we inventoried the number of tree on the farm and determined the farm size. Twenty-one tree species belonging to 14 botanical families were recorded during the surveys and the average stand density of the woody component of farmlands was 7.97 ± 5.43 stems/ha. A number of both native and exotic tree species occurred in the parkland agroforestry systems with dominance of indigenous tree species. Species richness varied with the size of household where households with small land holding conserve more tree species in their field than households with large land holdings. 64% of households surveyed were making deliberate efforts to plant tree species on their farmlands. The most important reasons which determined household ambitions to conserve woody species on farmland were tree products contribution to food and medicine. Results also showed that respondents who noticed that trees were decreasing in the wild conserve more tree species on their farmlands. This research highlights the role of traditional agroforestry practices to support tree species richness and provides evidence of the farms' role as biodiversity reservoirs.

Key words: Conservation, indigenous species, parkland agroforestry, Socio-economic factors.

Predicting the potential distribution of *Ocotea porosa* (Nees & Mart.) Barroso, a threatened species in the State of Santa Catarina, Brazil

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In view of global environmental change, caused mainly by human activity, species distribution models have become an important tool for management and conservation of biodiversity, particularly for threatened species. In this study, our objective was to model the potential distribution of *Ocotea porosa* (Nees & Mart.) Barroso, a threatened species in the State of Santa Catarina, Brazil. The occurrence data were obtained from individuals with diameter at breast height (DBH) >10 cm in 440 permanent plots from the Forest Inventory Floristic Santa Catarina. A 21-environmental variable data set (WorldClim) was related to occurrence data (generalized linear models) to predict the potential distribution of species. The predictor variables were selected by the AICc and the predictive power of the models was evaluated using the method of cross-validation (k-fold), and utilizing ROC-AUC as a measure of precision. The annual average temperature, seasonal temperature, and seasonal precipitation were the most important predictor variables in the models, indicating a strong relationship between them and the distribution of *O. porosa*. The isothermality was also statistically meaningful. The predictive power of the models was considered good with the average AUC= 0.87 and 0.83 (train and test) and the mean proportion for predicted sites was high (0.85 and 0.79 correct). The results showed great performance of the models in the potential distribution of *O. porosa,* such that they could be an important tool to guide future strategies of conservation or subsequent studies, for example, the effects of global change on this species.

Key words: species distribution models, conservation of biodiversity, threatened species.

An overview of six years of forest fragmentation research in South America: gaps in research

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In order to achieve sustainable development, it is necessary to identify and understand the forces that challenge its success. These include natural or human-induced pressures which harm or accelerate deterioration of the earth's resources. Within that framework, the loss and degradation of native forests, and the associated loss of biodiversity, are recognized as main issues of global environmental alarm. In response to global concern over the rapid loss of the world's biodiversity, the FragforNet network was created as a platform to exchange ideas, knowledge, data, experiences, and results on the loss on biodiversity in the remaining native forests, with particular focus on South America. In order to identify the evolution on the subject of forest fragmentation, we performed a bibliographic search during the 5 years following the creation of Fragfornet network in 2006. In doing so, we focused first in forest fragmentation research in Latin America countries. In a second phase, we expanded the search using a set of key words specifically related to forest landscape ecology. To this end, the data set was extracted from Thomson Reuters's Web of Science® (WoS) and it was processed with a lexical analyser software program. The top subjects according to the journals' fields were identified. The trends of international collaborations were also studied. The work provides an overview of research of forest fragmentation in the region, showing also regional gaps to plan future work.

Key words: forest fragmentation, forest landscape ecology, research, South America, bibliometrics analysis.

Creation of native forests reserves for medical purposes by Mapuche communities in Southern Chile

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This project systematized and analyzed the implementation of native forest reserves in 2004-2005, in Mapuche farms located in the Region of La Araucania, Southern Chile. The conservation initiative originated within the community as they became aware of the shortage on medicinal plants in the area. The Mapuche rely on medicinal plants for their health care and most of these plants are only found within native forests. As a result, they decided to protect four privately owned native forest patches for this purpose. A group of investigators that included academics and community members was involved with this project. The methods used include semi-structured interviews, life histories, and conversations. The theoretical analysis contrasts the privatization thesis of natural resources of native forests in this case (Hardin) and the idea of common ownership of resources (Ostrom). Organizational aspects, rules and agreements established by the community were identified. The tension between private and common ownership is discussed. This study also analyzed the land cover of the area where the reserves were established, and used vegetation samples to evaluate the recovery of the forest after its protection by surrounding fences. Although the results are not conclusive, the importance of analyzing these fragments at the landscape scale is highlighted, especially for ecological restoration purposes.

Key words: conservation initiative, medicinal plants, ecological restoration, deforestation.

Acknowledgements: This investigation has been possible thanks to the support obtained with the project DI11-PE04. Universidad de la Frontera, Temuco, Chile and RIMISP-CHORLAVI 2011.

Changes in connectivity and vegetation cover in the Fechos Ecological Station surroundings, Minas Gerais State, Brazil

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Changes in connectivity can affect landscape ecological functions and compromise forest fragments sustainability on a long-term basis. This study aimed to verify the changes in the Fechos protected area surroundings regarding vegetation cover and natural vegetation connectivity. Geographic information systems, remote sensing techniques and Landsat TM images were used to generate the maps analyzed from the years 1992, 2001, and 2010. The results showed that in 18 years, there was an increase of over 100% of anthropogenic areas, comprised mainly of urban settlements and mining sites. The highest vegetation cover decrease occurred for grasslands that lost 27.2% of its previous area. The forest area was diminished by 2.5% but the reduction in connectivity among forest patches was around 40%. The findings indicated that forest law enforcement and conservation have been given higher priority than those for the grasslands. For grasslands, scarce knowledge and fewer protection laws might be jeopardizing that ecosystem. The smaller reduction of forest areas has been influencing the connectivity among patches, suggesting that a better planning for the region is needed, which considers the characteristics of the whole landscape.

Key words: change, connectivity, landscape, conservation, land cover.

Modelling the potential distribution of threatened plant species in Santa Catarina State, southern Brazil: a study case of *Ocotea odorifera* (Vell.) Rohwer (Lauraceae)

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Ocotea odorifera is a tree broadly distributed in southern Brazil. This species was an important source of wood and essential oil (safrole) and, as a consequence, was intensively exploited, especially in Santa Catarina where the species contains the highest concentration of safrole. Due to the illegal commercial exploitation, *O. odorifera* was included on the official list of Brazilian species threatened of extinction. Our objective was to model the potential distribution of *O. odorifera* in Santa Catarina, Brazil. Predictive models were fitted using GLM (generalized linear models) with occurrence data, obtained in 440 permanent plots of the Floristic and Forest Inventory of Santa Catarina, that were related to 21 environmental variables (WorldClim and DEM). The predictor variables were selected by the AICc and the predictive power of the models was evaluated using the method of cross-validation (10-fold) to calculate ROC-AUC and TSS for the training data set (90% of the original data) and test (10% remaining). The annual precipitation ($p < 0.0016$) and seasonal ($p < 0.019$) were the most important predictors for the distribution of the species. Despite its preference for well drained soils, *O. odorifera* is found mainly in the Itajaí river basin, where rainfall levels are high, and the sloped relief favors the species. The predictive power of the model was considered consistently for AUC (training=0.633±0.006; test=0.571±0.055) and TSS (training=0.812±0.011; test=0.801±0.019). The results obtained with the predictive models show its importance as a reliable tool in identifying and defining priority areas for conservation of *O. odorifera* in southern Brazil.

Key words: threatened species, conservation, generalized linear models, Brazilian Atlantic rain forest, southern Brazil.

Analysis of the impact of forest plantations on plant species diversity patterns at multiple scales

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Multi-scale analysis of species diversity patterns can provide important information for biodiversity conservation. An additive partition of diversity approach was used to analyzethe effects of forest plantations on plant diversity patterns in a mountain area near Beiing, China. A plot-slope-watershed multi-scale sampling system was used to analyze the impact of forest plantations on plant diversity. The results show that forest plantations significantly reduce plant species richness. The diversity patterns show significant differences between planted and natural forests at the multi-scale of analysis. The beta diversity value is lower in planted forests than in natural forests, which suggests that forest plantations could reduce environmental heterogeneity, which could, in turn, have a significant impact on the dispersal of species. This work argues that the additive partition of diversity is a useful analytical framework for analysis of the impacts of forest management on diversity patterns at multiple scales.

Key words: alpha diversity, beta diversity, gamma diversity, scale, additive partition of diversity.

Influence of grazing on vegetation in a Valdivian rural landscape

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The Valdivian region in Chile is characterized by a variety of physical features that were once covered by different evergreen forest types. Since the end of the 19th century, these forests have been exploited and converted to rangelands which are used for livestock grazing. These rangelands consist of a variety of diverse vegetation types. To date, these ecosystems have been poorly studied and mostly neglected in conservation planning activities. Therefore we aim to analyze the impact that current grazing levels have on the vegetation at different scales (species, community, and landscape) to help understand the underlying vegetation dynamics for forest restoration and integrated conservation activities. Vegetation was sampled in the field and grazing in each sampling plot recorded by different field indicators. Species and plant communities were analyzed using ordination techniques and regression models to determine the influence of grazing, abiotic, and spatial variables on plant species diversity and interactions between the predictor variables. Grazing effects varied among species and communities and influenced the native-exotic species relationship and functional trait composition. Areas with low livestock stocking had high levels of community diversity and heterogeneity. We found that grazing had a high impact on plant species composition. In areas where the grazing intensity was low, native tree species were regenerating in the herb layer, indicating a high potential for native forest regeneration. On the landscape level, the current grazing regime has produced a mosaic of plant communities which provide important ecosystem services for the local population and habitat diversity for native species.

Key words: vegetation patterns, grazing, plant functional traits, scale dependence.

Acknowledgements: German Academic Exchange Service (DAAD), Landesgraduiertenförderungsgesetz - Baden-Württemberg (LGFG).

Two landscapes, one trend? The effects of tree species change on the ground vegetation in southwestern Germany.

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Norway spruce (*Picea abies*), at one time the most economically important tree species in Germany and other parts of central Europe, has recently been declining in area covered. The decline is not only due to climate change risks but also because of close-to-nature forest management practices whereby pure, even aged coniferous stands are converted into structured broadleaved (*Fagus sylvatica*) or mixed wood stands on a large scale. Our objective is to quantify the impact of the tree species change on the functional composition of the ground vegetation and the implications for biodiversity. In both cases, we observed a qualitative change in ground species composition. These results have also been seen in previous studies, but our research and results are novel in that they provide the first direct comparison evaluating these changes regarding functional composition and diversity partitioning in limestone or silicate forest landscapes. For example, biodiversity and naturalness in forestry are often reduced to tree species composition and stand structure. However, if we broaden this limited definition, the situation becomes more complex. Our results revealed that managed stands with lower tree species diversity and less natural stand structure have greater ground vegetation diversity than do 'natural' stands. Thus, the questions as to what kind of diversity is most desirable and how 'natural' a cultural forest landscape should be, remain so far unanswered.

Key words: diversity, nature conservation, mixed woods, forest conversion, ground vegetation.

Regeneration and growth of service tree (*Sorbus domestica* [L.]) in former oak coppice forests in southwest Germany

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Sorbus domestica L. is one of the rarest tree species in Central Europe, being classified as endangered in Austria, Germany, and Switzerland. Many of the recorded individuals are growing in aged oak coppice forests. Although its timber is of high value, there is little quantitative information on its regeneration and growth dynamics. Since coppicing is no longer practiced, it is unclear whether the *S. domestica* population can persist in a continuous cover forest system or if coppicing is needed for species preservation. The objectives of this study are to analyse stand development and growth-related competition processes between *S. domestica* and other tree species in order to understand current and future forest succession processes and to anticipate landscape development within the extended aged oak coppice areas of western Germany. To reconstruct regeneration processes and growth, tree ring analysis was carried out on 42 *S. domestica* trees and their two nearest neighbours (mainly *Quercus petraea* (Matt.) Liebl.). In order to classify *S. domestica* shade and competition tolerance, we measured photosynthesis and light transmission characteristics. Dendrochronological data support the hypothesis that coppicing promotes the establishment of new *S. domestica* cohorts. Growth patterns and photosynthesis measurements suggest that *S. domestica* is an extremely light demanding species that is unable to survive long periods of intensive competition. We conclude that abandonment of coppicing in these forests does threaten the status of *S. domestica*. In order to preserve species occurrence, the resumption of coppicing should be taken into consideration wherever advisable.

Key words: *Sorbus domestica*, regeneration, coppice, preservation.

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Possibilities and challenges for biodiversity assessment in the national REDD+ strategy of Ecuador

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Ecuador has recently experienced declines in forest cover, mainly due to land-use changes. In this context, the Ministry of the Environment of Ecuador is currently working on the design of a national strategy for reducing emissions from deforestation and forest degradation in developing countries (REDD+). The goal of this study is to determine the possibilities and challenges for biodiversity assessment under the national REDD+ strategy of Ecuador. In this respect, the study has two main objectives: (1) define the biodiversity indicators that are relevant for REDD+, with the help of expert interviews, and (2) test the indicators in a case study in southern Ecuador. Expert interviews (n = 21), with the main actors involved in the national REDD+ strategy, were carried out in Ecuador in 2011. Additionally, information is being gathered through literature review and analysis of existing databases. First interview results highlight that the biodiversity indicators most often used by the experts are based on species inventories (e.g. number of species, presence/ absence data). Additionally, the experts identified the main constraints for biodiversity monitoring in Ecuador as problems related to the lack of information and methodologies, economic resources, human resources, and political support. Based on the results, a framework for biodiversity assessment will be developed for the case study that is expected to show how relatively simple biodiversity indicators can be used for biodiversity monitoring and land-use planning under REDD+. Finally, the study will give recommendations for biodiversity assessment and monitoring within the strategy REDD+ of Ecuador.

Key words: REDD+, biodiversity indicators, monitoring.

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A simplified inventory approach to estimate coarse woody debris and associated carbon in high-biomass forests

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Forests carrying large quantities of live and dead wood are important carbon (C) stores. Here, we investigate how the inventory of coarse woody debris (CWD) and associated C may be designed efficiently at the scale of logs, plots, and the landscape in Tasmanian tall *Eucalyptus obliqua* forests, which have very high levels of CWD (here 375-1085 m^3 ha^{-1}). From a set of 12 sites with different times since disturbance, a thorough census of dead wood >10 cm in

diameter was carried out at five sites using a fixed plot (50x50 m) approach. This showed that 90% of the volume can be captured by recording only CWD logs >40 cm in diameter. Based on this approach and known density and C content of 5 different decay classes, volume, mass, and C in CWD was determined for all 12 sites. To obtain an accurate estimate of CWD-C at the landscape scale, it was sufficient to allocate entire individual logs to single decay-classes, use one global value for C density instead of decay-class-specific values, and the most decayed logs, which are difficult to measure, could be ignored. However, there were no relationships between plot-level standing and downed CWD or standing tree biomass and CWD mass, which could be used to quantify CWD from these proxies.

Key words: coarse woody debris, monitoring, logs, decay-class, carbon.

Indigenous knowledge and biodiversity conservation and management: the case of the Ashanti region in Ghana

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An analysis of a series of biodiversity related areas in West Africa, including ecosystems for water and soil management, farming, fishing and hunting practices, and the collection of herbal medicines, shows that indigenous knowledge has the potential to contribute to the conservation of species, genes, and ecosystems. However, in the contemporary, fast-changing societies of sub Saharan Africa, indigenous knowledge is less and less applied and is at risk of disappearance. In spite of important paradigmatic differences between indigenous knowledge systems and modern science, traditional knowledge is at its best when it is matched with scientific approaches. Similar approaches are needed and possible for biodiversity conservation. They should focus on questions on effectiveness, efficiency, and monitoring of situations where indigenous knowledge is brought into biodiversity conservation and management. Next to a more human ecological approach to biodiversity loss, its management is looking forother new and effective approaches to reverse the current declining trends. In this context, attention is given to indigenous knowledge (IK). This is about the knowledge that women, men, families, and communities have developed themselves for centuries and allowed them to live in their environment for, often, long periods of time. In a context of contemporarily development, evidence shows that IK can help solve local problems, that it offers a resource to help grow more and better food, that it aids to maintain healthy lifestyles, and that it provides opportunities to share wealth and prevent conflicts (Mkapa, 2004). In this paper, the question is addressed whether and how IK can also contribute to biodiversity conservation and management.

Key words: Biodiversity, Indigenous knowledge, Paradigm, Policy.

Distribution of NTFP's through different vegetation types in degraded coastal evergreen forests of southern Chile

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As a result of anthropogenic alterations, the current vegetation and structure mosaic in the evergreen forests of the coastal mountain range of the Osorno Province, Chile (40° S 73° W), does not present an attractive timber capacity, but a great non-timber potential, so far not evaluated. This could begin the challenge of an integrated

forest management, involving both, timber and non timber perspectives. Therefore, is necessary to determine the distribution and abundance of the NTFP-species in the different vegetation types. Six NTFP-species were researched: the trees Lomatia ferruginea and Gevuina avellana, the climbing plant Luzuriaga polyphilla and the fern Lycopodium paniculatum which produce greenery. The liane Capsidium valdivianum that produces stems used for basket elaboration and the shrub Ugni molinae that produces edible wild berries. Based on the tree structure and floristic composition, three forest stands were classified in different vegetation types using a cluster analysis. The distribution of the NTFP-species was considered as their ecological preferences in each vegetation type and was estimated using the fidelity correlation coefficient. Eight vegetation types were found, which reflect different successional stages summarized in four categories: a) Open areas with incipient tree regeneration and no timber individuals, where U. molinae was found with a high level of preference; b) Altered open forests with low timber production, where L. paniculatum exhibited a high ecological preference; c) Secondary forests and d) Old altered forests, in which preferably grow L. ferruginea, G. avellana, L. polyphilla and C. valdivianum.

Key words: NTFP, degraded evergreen forest, fidelity, Chile, forest succession

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Forest conservation index and historical evolution in a coastal region: The São Sebastião Island – São Paulo Brazil

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The aim of this study is to identify the current conservation status of five forested watersheds which have been under different human pressures throughout history of São Sebastião Island to assess relations between pressures which have occurred in the past and the current environmental quality. Through maps of land use, landscape metrics, and the development of a Forest Conservation Index, it was possible to identify in watersheds the greater landscape fragmentation, implications on quantity and quality of available habitat, and effects of boundaries.

Key words: landscape change, landscape metrics, indexes.

Do beavers improve the habitat quality for Magellanic Woodpeckers?

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The effect of the disturbances caused by the American beaver (*Castor canadensis*), introduced to the Cape Horn Biosphere Reserve, on species of birds that are forest habitat specialists is poorly understood. Using telemetry

data, we determined which attributes of abandoned beaver meadows have a strong impact on habitat selection by the Magellanic woodpecker (*Campephilus magellanicus*). We detected a negative relationship between the woodpecker habitat use and the fraction of old-growth forest located near these meadows. These results suggest that favorable habitat conditions are generated around small meadows with old-growth forest, because they might increase availability of wood-boring larvae.

Key words: American beaver, *Campephilus*, habitat selection.

Topic: Spatial patterns and ecological processes

Symposium: Mapping natural phenomena: challenges and advances associated with spatial information
Organizers: Tarmo Remmel, York University, Canada. Ajith Perera, Ontario Forest Research Institute, Canada.

Mapping fuzzy boreal wildfire boundaries: strength, gradients, and cover types

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Northern boreal forests are regularly disturbed by cyclic wildfires of varying extent and intensity. Depending on local weather, microclimate, fuel conditions, and other physical conditions, the level of disturbance to the ecosystem will vary spatially, resulting in a heterogeneous mix of disturbed and undisturbed forest stands expressing internal complexity and incorporating nonburnable land cover components. This study focuses on characterizing the interfaces between the burned and unburned landscape at the fire event perimeter and the internal unburned, residual vegetation patch boundaries. Boundaries of such dynamic landscape elements can vary from being abrupt to gradual and mapping them should be able to capture this complexity when required. We develop means for measuring the level of gradation, produce maps depicting it, and summarize the gradation based on the land cover types present. The result is a mixed and rich representation of wildfire perimeter and internal boundary strength or fuzziness that we relate to specific elements of landscape composition. Our data is drawn from 11 large, naturally ignited and unsuppressed fires that occurred in northern Ontario for which we have Ikonos imagery and the subsequently classified land cover maps.

Key words: boundaries, gradient, wildfire, abruptness, forest land cover.

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Mapping 3-D forest heterogeneity using shape-based metrics from lidar waveforms

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Over the past three decades, great technological advances have been made to airborne lidar systems, which have allowed highly detailed three-dimensional (3D) measurements to be made over forested regions. But while the hardware has advanced, the methodology used to interpret the data has been slower to evolve. Common methods relate measurements of forest structure to frequency distributions of return heights and/or intensities, or bins of returns that are determined using regular height intervals. Although much of this research has demonstrated good correlations between these metrics and basic forest structure (e.g. canopy height and stand biomass), colinearity among the metrics and the regularity of the binning (percentiles or heights) make it difficult to identify patterns within the lidar data that can be linked to physical 3D forest structure. We applied a recursive method that uses two shape-based metrics, the centroid (C) and radius of gyration (RG), to identify major segments of the canopy that could be used to map the vertical landscape of a forest. Because these segments had variable thickness, they were better at identifying variations within a forested landscape than top-of-canopy and frequency-based approaches.

The approach was applied to full waveforms from LVIS data collected in 1998 and 2005 over the La Selva Biological Station and adjacent private holdings in Costa Rica.

Key words: LVIS, la selva, canopy heterogeneity.

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Mapping Patterns at Multiple Scales in the United States

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Maps of patterns at multiple scales may help to integrate assessments of the diverse array of socio-ecological benefits and risks that are associated with the spatial patterns of natural resources. A recent national assessment of forest, grass, and shrub land cover patterns in the United States mapped fundamental metrics of spatial pattern (composition, juxtaposition, and structure) at multiple scales using image convolution and morphological analysis. Most of the total area of forest, grassland, and shrubland occurs in landscapes dominated by seminatural land cover, yet fragmentation is so pervasive that only a small percent of that area is free of the ecological risks that are posed by proximity to human land uses. Overall, grassland is not only rarer but also more fragmented than either forest or shrubland. There is substantial regional variation in the degree of fragmentation and consequently in the type of ecological impacts that might be expected from fragmentation.

Key words: spatial pattern, multi-scale, assessment, interdisciplinary.

Mapping forest genera using discrete LiDAR and geometric tree metrics

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Maps of tree genera are useful in applications including forest inventory, urban planning, and the maintenance of utility transmission line infrastructure. We present a case study of using high density airborne LiDAR data for tree genera mapping along the right of way (ROW) of a utility transmission line corridor. Our goal was to identify single trees that showed or posed potential threats to transmission line infrastructure. Using the three dimensional mapping capability of LiDAR, we derived tree metrics that are related to the geometry of the trees (tree forms). For example, the dominant growth direction of trees is useful in identifying trees that are leaning towards transmission lines. We also derived other geometric indices that are useful in determining tree genera; these metrics included their height, crown shape, size, and branching structures. Our pilot study was situated north of Thessalon, Ontario, Canada along a major utility corridor ROW and surrounding woodlots. The geometric features used for genera classification could be categorized into five broad categories related to: 1) lines, 2) clusters, 3) volumes, 4) 3D buffers of points, and 5) overall tree shape that provide parameters as an input for the Random Forest classifier.

Acknowledgements: This research was funded by GeoDigital International Inc., Ontario Centres for Excellence, and a Discovery Grant from the Natural Sciences and Engineering Research Council of Canada.

Impact of forest boundary delineation on change detection in forested landscapes

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This study aims to develop an understanding of the spatial variation of mislocation of forest edges on medium and high resolution satellite images. Forest edges were delineated on satellite images taken in late winter under plain snow cover conditions. Winter presents specific conditions with high target to background contrast. The images were classified into forest or non-forest classes by thresholding pixel brightness values. The optimal edge threshold was defined by looking for a maximum radiance contrast of neighbouring pixels in a forest boundary area. Forest boundary segments were assigned an attribute of cardinal direction according to their relative position at the edge of a forest patch. Forest boundary locations on images taken in different atmospheric and solar illumination conditions were compared. The aim was to distinguish real changes at forest edges (forest patch expansion) from those changes in image classification stemming from different solar elevation and atmospheric haze conditions. The results of the study were used in mapping new forest patches and expansion of the existing forest patches within the context of agricultural lands. The mapping examples cover areas in Estonia, Latvia, and western parts of Russia, Eastern Europe. The time period covered was 1985 to 2011.

Key words: forest edges, forest change detection, medium resolution satellite images, high-resolution satellite images.

Short Manuscripts
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Frost ring distribution in *Araucarua araucana* trees from the xeric forests of Patagonia, Argentina

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Frost rings are defined as anatomically abnormal and ecophysiologically pathological structures. We studied the frost injuries in tree-rings of *Araucaria araucana* trees growing at the northern limit of its natural distribution. We recorded 121 frost injuries at two sites in the northern xeric distribution of *A. Araucana* forests. Frost rings at both sites were primarily restricted to the middle frost ring section of the rings. These results represent the first attempt to report and describe the occurrence of these events for this species and region. These proxy records represent important indicators of extreme temperature conditions.

Key words: tree-rings, injuries, earlywood, latewood, extreme events.

Spatio-temporal effects of human drivers on fire danger in Mediterranean Chile

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The aim of this study was to analyze how human factors, specifically land use and cover change (LUCC), influence wildfire danger in a Mediterranean Region of central Chile. Main drivers of LUCC were associated with changes in socio-economic conditions, which had strong effects on the structure of the landscape and on the danger of wildfires. Ignition and flammability were evaluated as key components of fire danger. Ignition probability was modeled for 1999 and 2009 using an autologistic regression, based on fire records from Corporación Nacional Forestal (CONAF) and geographic, biophysical, and socioeconomic databases. Flammability was assessed by combining the National Vegetation Cadastre of 1999 and its update of 2009, and the fuel model developed by Julio (1995). Spatiotemporal analysis of flammability was performed and related with primary LUCC processes, namely, plantation expansion, forest regrowth, and agricultural abandonment. We combined the ignition probability and flammability analysis to produce wildfire danger maps. Results show that fire danger is a dynamic indicator that depends largely on human factors. By 1999, the area under high fire danger comprised 31,399 ha, whereas by 2009 this area had increased by 54,705 ha. For both periods, wildfire danger had a similar spatial distribution, concentrating near main roads, cities, and larger towns (26.3% of the high fire danger area). Also high fire danger areas concentrated over zones covered by exotic forest plantations (33.2%). These results provide a basis for a more effective design of fire control strategies.

Key words: Fire danger, probabilities of ignition, flammability, landscape.

Mapping tree genera using discrete LiDAR and geometric tree metrics

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Maps of tree genera are useful in applications including forest inventory, urban planning, and the maintenance of utility transmission line infrastructure. We present a case study of using high density airborne LiDAR data for tree genera mapping along the right of way (ROW) of a utility transmission line corridor. Our goal was to identify single trees that showed or posed potential threats to transmission line infrastructure. Using the three dimensional mapping capability of LiDAR, we derived tree metrics that are related to the geometry of the trees (tree forms). For example, the dominant growth direction of trees is useful in identifying trees that are leaning towards transmission lines. We also derived other geometric indices that are useful in determining tree genera; these metrics included their height, crown shape, size, and branching structures. Our pilot study was situated north of Thessalon, Ontario, Canada along a major utility corridor ROW and surrounding woodlots. The geometric features used for genera classification could be categorized into five broad categories related to: 1) lines, 2) clusters, 3) volumes, 4) 3D buffers of points, and 5) overall tree shape that provide parameters as an input for the Random Forest classifier.

Key words: Airborne LiDAR, tree genera mapping, tree geometry, Random Forest Classification

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Spatial-functional pattern of ecotonal riparian landscapes on Meridional Plateau, Southern Brazil

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This study analyzes the Pitangui and Jotuba riparian zones in the Meridional Plateau, trying to create a landscape model in forest/field riparian ecotones. The areas were delineated from 2001 orthophotos (1:10,000), including all native vegetation in flooding limits of the lotic channels. The landscape units (UP) were represented by the Alluvial Ombrophilous Mixed Forest metacommunity (FOMA) including as phytocoenosis both the riparian woody forest (FR) and hydrophilous vegetation (VH). Landscape metrics and statistical treatment were used to characterize landscapes and patches. To evaluate the FR patches we presumed a 30 m edge. The Pitangui River (1,072 ha) has double the riparian area of Jotuba River (539 ha), although proportionally both were UPs equivalent (40% of FR and 60% of VH). Both rivers have a large number of small rounded patches and relatively few large areas that trend to more complex and irregular shapes as the area increases. Also smaller patches are more spatially heterogeneous than the larger ones, and more aggregated along the river channel. 60% of FR area on both rivers is under an edge effect: Pitangui has 91 core areas linked by 69 corridors and the Jotuba River has 53 core areas with 47 corridors. In the riparian zones, VH areas occupy the flood plains showing higher variability in size and spatial distribution. This summarizes the natural fragmentation remarks for the riparian vegetation of regional rivers at South Brazil.

Key words: landscape ecology, Campos Gerais, landscape metrics, natural fragmentation.

Selecting ecotonal landscape units on Meridional Plateau, Southern Brazil

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The Escarpa Devoniana Environmental Protection Area, located in the Meridional Plateau of South Brazil, supports a high diversity mosaic of native Araucaria forests and grasslands patches. In order to conduct studies of its dynamics, the *Biodiversity of grassland-forest ecotones in South Brazil Project* team has been developing a methodological approach for sorting ecotonal areas for sampling. This essay validates this methodology to the major grasslands occurrence area in the Brazilian Atlantic Forest Biome, the Campos Gerais region. The entire area was divided into a 1 x 1 km grid that was overlayed with vegetation typology files. The criteria for quadrat selection were: (a) 25% or more of forest remnants; (b) 25% or more of grasslands remnants; (c) at least 20% of contact between them. The non-supervised classification potential ecotonal areas were validated through visual checking in a high-resolution qualitative way, always by the same operator. The quadrats could be achieved by the researchers in a *.kmz file, which allowed someone selecting them in the Google Earth platform.

Key words: landscape ecology, Campos Gerais, sampling methods.

GIS-based classification and mapping of forest site condition and vegetation

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A method of automated classification and mapping based on a spatial analysis of a digital elevation model (Shuttle Radar Topography Mission (SRTM) 90m), Landsat 5-TM imagery, and ground data was applied to classify and map forest site conditions and vegetation on a test site. The vector maps obtained reflected the test site potential environmental conditions, forest types, and regenerating vegetation age stages.

Key words: Central Siberia, site conditions and forest type mapping, Geographical Information System (GIS), digital elevation model (DEM), remote sensing data

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Recognizing vegetation chronosequence in Landsat imagery

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This paper presents a description of an algorithm of automated identification of forest regeneration stages using a spatial analysis of Landsat-5 TM imagery and field data. Based on this algorithm, several raster maps were built to show the vegetation regeneration stages in a range of habitat types found in southern Yenisey Siberia.

Key words: remote sensing data, GIS, forest regeneration dynamics map.

Boundaries and Mosaics: an approach to evaluate changes and to profit landscape planning –São Sebastião Island- SP/Brazil

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This study assumed that the spatial identification of mosaics obtained by the analysis of interactions between frontiers over time would be a great strategy to obtain planning units, since the boundaries reveal the changes, heterogeneity and fluxes in a landscape. For this purpose, we selected 16 watersheds in São Sebastião Island (São Paulo, BR), mapped the land use and cover (1962 and 2009) and built matrices of patches by boundaries. The analysis of these matrices using multivariate ordination and clustering allowed us to identify mosaics. The mosaics showed very well the temporal diversity of interactions across frontiers and the landscape conservation status, but had limitations to indicate management practices.

Key words: Environmental planning, forest conservation, landscape ecology

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The influence of land-use on edge effect in an Atlantic forest fragment in north-east Brazil

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Although the edge effect is a phenomenon much studied in tropical forests, the effects of edge creation in open ombrophilous forests of the Atlantic Forest of northeastern Brazil are little discussed. Plant communities with large canopy openness, including periods with partial loss of leaves may respond differently to the impacts of edge formation because species may be more light-tolerant. The matrix can have a direct influence on the edge effect. Most studies available examine the consequences of the interface between forest and agricultural areas or pasturelands. However, the effects of the creation of a water body have been little studied, despite being frequent in the last century. In this study, we analyze the edge effect in two faces of a fragment, the first edge in contact with sugarcane crop, and the second with a lake formed by a dam. To neutralize the effect of selective logging and avoid counting species established before the edge formation, we analyzed the composition and density of the juvenile layer (≤1m). The results pointed out that the construction of a dam (water body) has caused an edge effect in the forest fragment, which seems to be not relevant in the area adjacent to sugarcane cultivation.

Key words: Rain Forest, fragmentation, edge effect, Atlantic forest, Brazil.

Linking the process of fragmentation and forest structure: a multiple factor in Central Argentinean Chaco

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Subtropical Argentinean Chaco forests were dramatically fragmented due to agriculture during the last 6 decades, mainly the semi-deciduous Bosque de Tres Quebrachos. The aim of this work was to analyze the fragmentation process, considering spatial (individual fragments and landscape) and temporal (history of the process) scales, studying the responses on the forest structure (density and basal area of the arboreal species). All individuals of arboreal species (adult trees, saplings, and seedlings) were registered and measured in 112 plots (400 m^2), distributed in 28 forest fragments (0.9 to 160 ha), and located at four different landscapes (4,500 ha) in an environmentally homogeneous zone (70,000 ha). The four landscapes have different total forest cover (low / high) and deforestation history (low / high). Using linear mixed models, we evaluated the effects of fragment size, landscape forest cover, and landscape deforestation history on the density and basal area of total arboreal species, considering different age class and different strata separately. Results indicate that total density increases with fragment size, a pattern weighted by the lower age classes of trees. Landscape forest cover did not show a significant relation with overall tree density, but did have a positive relation in superior strata and negative in middle strata. Basal area responses were similar, but weaker. The history of landscape deforestation affected forest structure, mainly in higher age classes. Our results reveal the importance to consider simultaneously historic and spatial scales to (i) better understand the fragmentation process, and (ii) improve prescriptions in fragmented landscapes management.

Key words: fragmentation, fragment size, forest cover, deforestation history, Chaco.

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Analysing landscape connectivity change of the Cuitzeo lake basin, México (1975-2008) as a framework for identifying potential conservation areas

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The Cuitzeo lake basin is an important ecological area with a strong human pressure on forest cover, which is a key element for long-term biodiversity support. Therefore, we studied landscape connectivity change as a framework for identification of potential conservation areas, in the years of 1975, 1996, 2000, 2003, and 2008. We modeled the two focal species' potential distribution with contrasting dispersal ability and determined the habitat availability and suitability. Then, we identified the optimal habitat patches and produced the landscape cumulative resistance maps. We estimated the least cost paths (graph-based approach) and current flow maps (circuit theory approach). For the landscape connectivity evaluation, we applied an integral index of connectivity (IIC) in each study period,

and we determined the individual habitat patch contribution (dIIC) in the overall landscape connectivity. The IIC index reported very low values associated with reduced focal species habitat availability. However, the individual habitat patch contribution study showed the conservation importance of very large areas of optimal habitat patch. The application of a graph-based approach and current flow mapping were very useful and complementary in terms of the potential corridor for mobility estimation and the identification of high probability dispersion areas. Therefore, the landscape connectivity analysis provides a useful tool for identification of potential conservation areas and landscape planning.

Key words: landscape connectivity, habitat suitability, landscape resistance, potential corridors, Graph Theory and Circuit Theory.

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Landscape dynamics and drivers assessment in NW Amazonia

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Only a few studies in Latin America have looked at both the drivers of deforestation and also the temporal and spatial dynamics by which those drivers act, which is critical for assessing the conservation of biodiversity. In this study, we analyse land cover change in north-western Amazonia and study the interactions between the use of fire, illicit crops and pastures, and their impacts on deforestation in the region. Our results indicate that despite even with the presence of two national protected areas, deforestation occurred at a low annual rate (0.06%). Conversion to pasture was the main factor responsible for forest loss, and this dynamic process occurs independent of the landscape matrix in which the forests were located. Burning is a common tool for forest clearing and conversion to pasture, thus, forests were highly disturbed and frequently transformed from primary to secondary forests in areas where fire is extensively used. Forest regeneration from pastures and secondary vegetation was observed in forest-dominated mosaics. If the observed pasture conversion trend and its relationship with forest fire continues, better targeting and focus of future land-planning activities and policies are needed in the area.

Key words: NW Amazonia, deforestation , pastures, illicit crops, fire.

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Forest canopy changes after logging in a rainforest of Ghana

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Dynamics of the canopy cover in rainforest of Ghana were evaluated to analyze the impact of forest management. The Kakum Conservation Area, a 360km^2 contiguous rainforest, was logged from 1936 to 1989, when the management

objective was changed from timber production to biodiversity conservation. Satellite images (Landsat TM and ETM+) of 1986 and 2000 were used to represent the vegetation structure changes during the logging period and conservation period, respectively. These scenes were processed using IDRISI Kilimanjaro software. It was found that in 1986 when the timber operation was in progress, out of the total canopy coverage of 295.8km^2 the open canopy area was 80.6%, closed canopy was 18.4% and the farms at the peripheries of the area were 1.0%. In 2002, out of 302.9 km^2, the open canopy area had been reduced to 58.4% while the closed canopy area had increased to 37.4%. The coverage of farm was also found to have increased to 4.1%. It was concluded that the reduction of open canopy and increase in closed canopy area could be attributed to the change from timber logging to biodiversity conservation area. It is recommended that other forest reserves which are undergoing convalescence must be managed from the conservation approach.

Key words: forest dynamics, canopy coverage, satellite image.

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Selective logging and landscape structure patterns in three Conservation Areas in Costa Rica

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In Costa Rica, selective logging takes place at the forest unit level with little to no consideration for the landscape level, even though this aspect of forest management may be very important due to the degree of forest fragmentation. Here, we analyze landscape structure and its relationship with selective logging in three Conservation Areas (CAs) with distinct ecosystems but similar historical patterns of selective logging. Our main objective is to identify the variability in the spatial patterns of selective logging within and between CAs and to determine potential conservation implications at the landscape level. We used an official forest cover assessment for the country (2005) in combination with a geospatial database encompassing historical records of selective logging. To analyze the relationship between selective logging and landscape structure, we calculated statistics for each CA in Fragstats 4.0. Then, we calculated the spatial patterns of selective logging (point data) and intersected these results with the landscape statistics for each CA. Our results illustrate a fragmentation gradient with the largest forest patch per total forest area encompassing 40% to 93% for each CA. Shape metrics however, indicate minimal variation between CAs. The spatial patterns for selective logging indicate significant clustering (Ripleys K) for two of the conservation areas at all scales, while the third tends towards a random pattern at scales greater than 400m, indicating a trend consistent with the landscape structure. Our results emphasize the important of establishing a landscape-level spatial framework for selective logging in the country.

Key words: landscape structure, selective logging, spatial patterns, conservation, tropical forest.

Acknowledgements: We would like to express our gratitude for the financial support of the Global Environment Climate Change Centre (GEC3) and the Dept. of Geography at McGill University and the support from SIREFOR.

Effects of forest fragmentation on the floristic biodiversity of a seasonal tropical moist forest in northwest Venezuela

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Anthropogenic fragmentation of landscapes is a globally occurring phenomenon that causes numerous side effects on functions and processes of ecosystems, as well as an enormous loss of biodiversity. It leads to reduction and isolation of habitats, increased edge effects and is responsible for an alteration at the different levels of biodiversity. In this study, the fragmentation of a seasonal tropical moist forest in the region South of Lake Maracaibo (Venezuela) and its impact on the original floristic biodiversity was examined. Landsat-7 (ETM+) satellite image data (2010) were applied for detecting spatial patterns of forest cover and conducting an analysis of landscape structure using landscape ecology metrics. To evaluate the changes of biodiversity, vegetation data were collected and analysed from fragmented and non-fragmented forests. It has been shown that the moist forest is characterised by an advanced degree of fragmentation manifested by a large number of dissected and isolated forest areas. As small-scale fragments, they provide larger areas of marginal zones than core zones. In consequence, it causes accelerated edge effects that impact the core areas, too. This was demonstrated by an increased diversity, a displacement of native by invasive species, and a change in species composition inside the core areas. The determined species richness and forest stand structure pointed out the disturbance of forest areas and its current state of transition (succession). Hence, forest fragmentation not just reduces forest cover and associated habitats, but implies changes inside the floristic structure and composition of the remaining forest areas as well.

Key words: fragmentation, biodiversity, forest, vegetation, flora.

Land cover dynamics and factors influencing vegetation loss and regeneration in Central Chile

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Since the middle of the sixteenth Century, Central Chile has experienced profound landscape transformations. Remnant perennial vegetation cover like forest and shrubland remain threatened due to land use intensification and limited natural regeneration. To quantify land cover changes and obtain an understanding of specific pressures on vegetation cover, satellite images from 1975, 1985, 1999 and 2008 were classified and linked to a multi-temporal analysis of influencing socio-economic and biophysical factors. Classified maps were analyzed in GIS, obtaining the spatial distribution and rates of land cover changes. The major trend was a continuous reduction in forest and shrubland cover and a strong increase of human-induced land-cover types. In contrast to deforestation patterns in other parts of Latin America, vegetation loss took place as a stepwise and progressive modification from forest to shrubland cover, and as a highly dynamic conversion between shrubland and human-induced types of land cover. Socio-economic and biophysical factors influencing vegetation change were analyzed using classification trees and logistic regressions in separate models for forest and shrubland loss as well as forest and shrubland regeneration within four time intervals. Slope and distance to primary roads were identified as the most significant factors effecting vegetation change over time. Often, forest and shrubland loss and their regeneration pathways displayed

opposite patterns in relation to the different explanatory variables. Therefore, the differentiated results provide important insights on continuing vegetation pressures and factors enhancing vegetation regeneration, which are a critical basis for conservation and restoration planning in Central Chile.

Key words: Land cover change, Deforestation, Proximate drivers, Forest regeneration, vegetation dynamics.
Acknowledgements: This work was financed by the REFORLAN Project, INCO Contract 473 CT2006-032132 (European Commission).

Optimizing land cover classification accuracy for change detection, a combined pixel-based and object-based approach in a mountainous area in Mexico

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Inventories of past and present land cover changes form the basis of future conservation and landscape management strategies. Modern classification techniques can be applied to more efficiently extract information from traditional remote-sensing sources. Landsat ETM+ images of a mountainous area in Mexico form the input for a combined object-based and pixel-based land cover classification. The land cover categories with the highest individual classification accuracies determined, based on these two methods, are extracted and merged into combined land cover classifications. In total, seven common land cover categories were recognized and merged into single combined best-classification layers. A comparison of the overall classification accuracies for 1999 and 2006 of the pixel-based (0.74 and 0.81), object-based (0.77 and 0.71) and combined (0.88 and 0.87) classifications shows that the combination method produces the best results. These combined classifications then form the input for a change detection analysis between the two dates by applying post-classification, object-based change analysis using image differencing. It is concluded that the combined classification method together with the object-based change detection analysis leads to an improved classification accuracy and land cover change detection. This approach has the potential to be applied to land cover change analyses in similar mountainous areas using medium-resolution imagery.

Key words: object-based, pixel-based, landsat, segmentation, post-classification, change detection.

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Boundaries and Mosaics: an approach to evaluate changes and to profit landscape planning – São Sebastião Island- SP/Brazil

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This study assumed that the spatial identification of mosaics obtained by the analysis of interactions between frontiers over time would be a great strategy to obtain planning units, since the boundaries reveal the changes, heterogeneity and fluxes in a landscape. For this purpose, we selected 16 watersheds in São

Sebastião Island (São Paulo, BR), mapped the land use and cover (1962 and 2009) and built matrices of patches by boundaries. The analysis of these matrices using multivariate ordination and clustering allowed us to identify mosaics. The mosaics showed very well the temporal diversity of interactions across frontiers and the landscape conservation status, but had limitations to indicate management practices.

Key words: Environmental planning, forest conservation, landscape ecology

Landform basics for spatial ecological patterns and processes

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The complementary elevation-depression forms of land surfaces are shown as a figure (e.g. rolling hills with slope ridges, erosion channels). The elevations as remains of upper plains (areas of divergent slope curves [orthogonal trajectories of contour lines]) are complementary to the dendroform depressions as erosion channel networks (sensulato); (areas of convergent slope curves). The landform diversity (complementary elevations / depressions) represents all geographical factors (geology, soils, hydrology, local and micro climate, natural vegetation, dry / wet sites including potentially flooded areas). The more extensive the roughness of terrain carving, the more diverse is landscape ecology, and the more diverse is also the scenery. The most decisive characteristics of landform are (i) altitude difference of an area, e.g. a watershed, and (ii) relief roughness (frequency of complementary elevation-depression forms). Here is a common principle of the spatial landscape ecological order of strata: moving down the slope curves increases species number and / or biomass (biodiversity and / or vegetation functions of more biomass) steadily from areas of divergent slope curves (elevations) to complementary areas of convergent slope curves (depressions). Down the slope curves increases exponentially, e.g. the wooden species height growth is stronger in depressions than on elevations. Exceptions might be near the bottom tree lines. Other exceptions are e.g., rock fall chutes on steep rocky slopes. Conclusions arise for forestry choice of tree species and in general for choice of woody species in landscape planning.

Key words: landform diversity, landscape ecology, forestry ecology, landscape planning.

Tree regeneration responses to microsite characteristics after the eruption of Chaitén Volcano in a toppled forest

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Large-scale disturbances, as the eruption of the Chaitén Volcano, play a major role in the dynamics of South American forests. They can initiate regeneration patterns, forming even-aged stands dominated by shade-intolerant tree species. Microsites can provide the precise conditions and resources required for the germination and regeneration processes. The objectives of this study were to characterize the types of microsites present in the study area, to evaluate their frequency, and to analyze which microsites are favorable or suitable for the tree regeneration in a toppled forest disturbed after the eruption of the Chaitén Volcano (42°59´S, 72°38´W). The microsites and the tree regeneration plants were sampled in 250 quadrats (1 m^2) systematically placed in summer, 2012. Environmental site characteristics were also recorded (slope, aspect, elevation, topographic position, and ground coordinates). Preliminary results show that vegetative reproduction is a common regeneration strategy of the tree species. The most frequent microsites found were ash, lapilli, coarse woody debris (on them, in their border, and below them), under shrubs (shrub sites), under ferns (fern sites), tip-up mounds of uprooted trees, lichens, cushions of mosses, and cushions of liverworts. The border of woody debris, cushions of mosses, and fern sites are frequent microsites used by *Weinmannia trichosperma*, *Embothrium coccineum* and *Nothofagus nitida*, all of them shade-intolerant tree species, to germinate and begin the regeneration process.

Key words: microsite, Chaitén volcano, eruption, disturbance, tree species regeneration.

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Spatial patterns of genetic variation in the Iberian honey bee hybrid zone: a comparison between mitochondrial and nuclear DNA

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The Iberian honey bee (*Apis mellifera iberiensis*) has been intensely surveyed for genetic variation with different markers ranging from morphology, allozymes, mitochondrial DNA (mt DNA), to microsatellites. Some of these markers have revealed non-concordant complex patterns of genetic variation, which led scientists to evoke competing hypotheses for the origin of Iberian honey bees. While complex patterns and underlying historical processes are typical of hybrid zones, the use of more powerful molecular and analytical tools and the fine-scale sampling promised to help dissecting the complexities of the Iberian hybrid zone. In this study, we conducted a genome-wide sampling by genotyping over 384 SNPs (single nucleotide polymorphisms) and sequenced an intergenic fragment of the mt DNA in 711 georeferenced honey bee samples collected across three North-South transects in the Iberian Peninsula. Both mt DNA and SNP datasets were analyzed using spatial tools to represent the structure generated by both types of molecular markers. We found concordant spatial patterns between markers which led to rejection of the standing hypothesis of recent human introductions and selection as the processes shaping Iberian honey bees patterns. This study shows that the fine-scale genomic and spatial analyses can reveal patterns which would otherwise had been undetected.

Key words: Iberian honey bee, *Apis mellifera iberiensis*, mitochondrial DNA, spatial analysis, landscape genetics.

Deriving indicators to assess historical effects of selective logging in oak pine forests of Western Mexico

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Unsustainable forest management is one of the major causes of forest degradation that is intended to be counteracted by the implementation of the REDD+ mechanisms (Reduced emissions from deforestation and forest degradation, carbon enhancement and conservation of carbon stocks). In this study, we investigated the relationship between spectral image components and forest degradation, with the objective to evaluate possible indicators derived from remote sensing that ultimately can serve to indirectly measure forest degradation. Spectral image components are derived after modifying multispectral or hyperspectral image data, to extract the percentage of the main materials found in each image pixel. In our case, after the processing of SPOT 5 data (2004, 2010) soil and green vegetation were identified as such components. The field data that was related with the image components were obtained through forest inventory performed in areas of oak-pine forest that have undergone intensive logging processes in the last 30 years, and areas without human intervention for more than 30 years, that serve as reference areas. A participatory mapping approach was used to locate such areas. Canopy cover, above ground biomass (AGB), forest height, basal area, and species richness obtained from field data were related with the percentage of soil and green vegetation components. The percentage of soil explained 61% of

the AGB observed, suggesting that this type of analysis has potential to monitor changes in AGB for areas under human intervention.

Key words: selective logging, REDD+, forest degradation, image spectral components, remote sensing.

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Can unproductive sites function as refuges for *Austrocedrus chilensis* against fire?

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Fire is a disturbance that modulates forest dynamics around the world. Sites with low biomass and humidity could have less probability of being burned or could be affected by less severe fires. Furthermore, thicker trees could be more fire resistant, thus reinforcing the pattern. *Austrocedrus chilensis* forests of northwestern Patagonia are expanding since the early 20th century due to fire suppression. We hypothesized that this expansion has been triggered from specific sites in the landscape that, because of their biophysical characteristics, are less affected by fire, allowing the survivorship of obligate seeder trees. To test this hypothesis, we surveyed 9 rocky outcrops in SW Rio Negro, Argentina and found that *Austrocedrus* trees with fire scars were older and larger in diameter than the rest of the trees. Some of the larger individuals had up to three fire scars, indicating the survival from several past fires. In eight of the nine study sites, we found female trees with fire scars. However, soil depth and slope, two of the physical variables we studied, could not explain the survivorship of these individuals to fire. While our results suggest that these groups of surviving trees could have acted as seed sources of present post-fire *Austrocedrus* forests, we still could not identify the physical site attributes which explain a higher persistence of trees in the landscape.

Key words: fire refuge, *Austrocedrus chilensis*, fire scars, seed sources, persistence.

Habitat selection of the magellanic woodpecker (*Campephilus magellanicus*) in the Omora Park (55°S), Navarino Island, Cape Horn Biosphere Reserve, Chile

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There is a broad consensus that woodpeckers establish their territories in mature and pristine forests. Therefore, it is expected that in landscapes modified by humans or with heterogeneous vegetation, woodpeckers would have

marked preferences for non-disturbed areas at different spatial scales. In this study, we assessed habitat selection by the Magellanic woodpecker (*Campephilus magellanicus*) in the world's southernmost forests, dominated by evergreen (*N. betuloides*) and deciduous Nothofagus (*N. pumilio* and *N. antarctica*). We examined two spatial scales, within and between home ranges, in a mosaic of forested habitat with varying degrees of disturbance in the Omora Park (55oS) and its surroundings on Navarino Island, Chile. Using telemetry, we estimated that the woodpeckers' home ranges varied between 55 and 160 ha (n = 6), with a mean of 102.9 ± 9.3 ha. By applying Resource Utilization Functions, we determined that within their home ranges, woodpeckers preferred old-growth and partially disturbed forests, as well as sites nearby. Woodpeckers also preferred forests adjacent to beaver ponds and flooded areas. We found a positive relationship between the home range size and the proportion of disturbed areas (i.e., beaver ponds and open scrublands), as well as peat bogs included in each of their home ranges. These results suggest that the conservation of the Magellanic woodpecker in sub-Antarctic forests should consider the selectivity of this species at different spatial scales.

Key words: *Campephilus*, disturbance, habitat preferences, scales, Sub-Antarctic forests.

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Land-use and land-cover change dinamics in a mediterranean landsacape in central Chile: a case study of the Catapilco, Valparaiso Region

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The Chilean Mediterranean landscape has undergone drastic changes due to the historical process of human occupation. Catapilco was a big Hacienda assigned by the Spanish as an encomienda during colonial times (Latitude -32.5, longitude -71.3). With the agriculture land reform in 1969, the Hacienda was split among 92 farmers, who organized a cooperative model that ran until 1991. In 1993, the cooperative changed into an independent system. Many farmers have sold their properties to urban developers or they turned the land into several independent agriculture units (e.g., annual and perennial crops, bee keeping, or livestock). The objective of this work was to evaluate the effects of land ownership in the dynamics of land-use and land-cover change from 1991 until 2011. The area was selected taking into account the characteristics of the Mediterranean landscape (spinal, sclerophyllous scrub dominated by evergreen species). Landsat images were used from the years 1991, 2001, and 2011. We performed supervised classification assessments through a confusion matrix and Kappa index, using ENVI. The land partition was established as the main driver of change. The main vegetation trends in the dynamics of the landscape were the conversion of spinal forest to agriculture crops, scrub to grassland, and dryland to urban developments. Since 2001, the loss of scrub was offset due to the decrease of animal farms, which, when abandoned, end up resulting in a passive restoration of the scrub. The results of this work indicate that farmers need to implement a strategic plan to decrease fractionation and improve land use capability.

Key words: landscape dynamics, land use and land cover change, Chilean Mediterranean.

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Forest productivity assessment using relationships between environmental factors and dominant height derived from airborne LiDAR data: a case study in the French Alps

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High-resolution estimates of forest productivity, coupled with environmental variables, could improve sustainable management of forest resources in mountain landscapes. In this work, we investigated the best models relating dominant height in mature uneven-aged stands and factors based on a set of ancillary geographic data. Dominant height is retrieved from LiDAR data acquired in a part of the Vercors Mountains range (French Alps). Ancillary data include topographical data (elevation, slope, TWI, radiation), climatic data (precipitation, temperatures), and other variables related to soil properties (soil water content, geological mapping). First, a Principal Component Analysis (PCA) was performed to select criteria most related to dominant height. Then, a multiple regression analysis is used to select competitive models. Preliminary results indicate, regarding dominant height, 1) that geomorphologic features are often determinant, (2) a weak positive effect of temperature, and 3) a weak negative effect of elevation.

Key words: forest productivity, environmental gradients, forest mountain, LiDAR.

Reconstructing landscape changes in the Itata river basin, through historical and pollen records

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The watershed of Lake Laguna Avenda is situated 65 km northeast of Concepción, and belongs to the Itata river basin. This area has a Mediterranean climate and the native vegetation is an association characterized by *Aextoxicon punctatum* (Olivillo), *Eucryphya cordifolia* (Ulmo), and *Nothofagus obliqua* (Roble). However, due to intensive human activity, this vegetation has been drastically reduced and replaced by exotic species. The objective of this research was to identify the period when the replacement of the native forest by introduced plants took place and determine which environmental factors are mostly associated to the current vegetation of this area. We used pollen records from sediment cores of Laguna Avenda and information from historical notes to reconstruct the history of the area. Our results indicate that the landscape transformation began with the arrival of conquerors and Spanish settlers during the sixteenth and seventeenth centuries, which brought several exotic taxa for agricultural use. Among them, the Poaceae were the most important, increasing their abundance especially at the end of the seventeenth century, due to the wheat fever. During this period, most of the native forest in the Itata River Basin was clearcut for agricultural crops, provoking changes in the rural economy and ecological landscape, which lasted until nowadays. In the nineteenth century, different species of ornamental plants and fruit trees were introduced, such as *Prunus* spp. Due to intensive farming, the soil was depleted and eroded and for this reason, the Chilean Government introduced new exotic trees such as *Pinus* spp. and *Eucalyptus* spp., which started to appear in the pollen profile at the middle of the nineteenth century. These species are currently the most abundant in the pollen profile and still dominate the landscape of Laguna Avenda.

Key words: environmental effects, human activities, native vegetation, exotic taxa.

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Spatial and temporal patterns of an invasive tree at the landscape scale: *Acacia dealbata* Link in South-Central Chile

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Acacia dealbata Link (silver wattle), native to Australia, has been reported as a major problem in South Africa and some European countries due to their naturally aggressive spread. *Acacia dealbata* is also an invasive species in south-central Chile, associated with roads and other human disturbances and riparian habitats. *Acacia dealbata* is one of the few species that have a distinct spectral signature and unique phenology which allows for better accuracy in detection and monitoring using remote sensing techniques. We are studying the species at the landscape scale to detect invasion processes, assess current patterns of invasion and detect changes over time. We have used aerial photos (1:20,000) from 2003, 2007, and 2009. We randomly selected 2 by 2 km quadrats to detect spatial patterns. We built a vector grid consisting of 10*10 m pixels, using visual photointerpretation, and the presence of *A. dealbata* was recorded when more than 5% of the pixels were occupied by the species. To increase our understanding of the invasion of *A. dealbata*, we analyzed the relationship between the mapped infestations with a number of data layers (e.g., roads, rivers, land use). Our results indicate *A. dealbata* has a high correlation with rivers and roads, and land use is not limiting for its establishment. The advance of the invasion is highly correlated with the primary stands, which function as propagule sources. Human activity has both positive and negative effects on the progress of the species due to the aid for the dispersal of the species and the reduction due to firewood harvesting.

Key words: *Acacia dealbata* invasions, spatial and temporal, landscape scale, invasions processes, remote sensing techniques.

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Spatial patterns of three tropical plant species in a 50 ha plot in Panama

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The spatial distribution of a tree species is a key aspect as to how a species is dispersed, to its reproductive biology, and to its habitat preferences. Assessing possible changes in spatial distribution patterns of species according to different temporal and spatial scales is one of the most important fields of research in landscape ecology. The main goal of this study is to analyze spatial distributions of adult individuals (DBH > 10 cm) of two tree species (*Tabebuia*

guayacan and *Dipteryx oleifera*) and one palm species (*Astrocaryum standleyanum*) in an old-growth forest. Data come from a 50 ha forest permanent plot in Central Panama. Analyses were performed using aL(r) function which is based on the common Ripley's K function. Both *A. standleyanum* and *T. guayacan* had random patterns at short distances and aggregate distributions at medium and large distances. On the contrary, the spatial pattern of *D. oleifera* was random at all distances. Changes in spatial pattern of a species may be related to shifts in processes and factors affecting its spatial distribution. On the other hand, these results indicate that *A. standleyanum* and *T. guayacan* had mainly aggregate patterns, probably due to positive habitat association with certain topographic conditions in the plot. These findings also show that *D. oleifera* had a random spatial distribution, which suggests that random demographic events in early stages would be important in its spatial structure. These results would be useful to design conservation and management strategies for these important tropical species.

Key words: spatial, patterns, tropical, plant species.

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Atmospheric deposition effects on nitrogen fixation in tropical montane forests canopies

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Although the canopy can play an important role in forest nutrient cycles, canopy-based processes are often overlooked in studies on atmospheric deposition. Our primary objective for this project was to measure N_2 fixation in arboreal and forest floor (FF) soils of tropical montane forests, and compare soil responses to nutrient inputs. N-fixation was measured using the acetylene reduction assay, in intact cores of arboreal and FF soil at three elevations (1000, 2000 and 3000 masl) of a tropical montane moist forest in southern Ecuador. The FF of the study site had been fertilized biannually with moderate amounts of N and phosphorus (P) for 4 years (treatments included control [C], N, P and N+P). Rates of N-fixation in arboreal soils were of a similar magnitude and demonstrated the same response to increased N availability as those in the FF soils. On average, soils in the C and P plots exhibited significantly higher rates (75% at 1000m, 87% at 2000m and 15% [ns] at 3000m) than those in the N and N+P plots. However, unlike the FF soil, there was no significant accumulation of inorganic N in the arboreal soil of the N-fertilized plots; NO_3 was minimal at all sites, and NH_4 only differed significantly between elevations. Results show that N_2 fixation is an active process in arboreal soils, but suggest that it is sensitive to even slight increases in N availability. Therefore, long-term atmospheric N deposition has the potential to significantly decrease N-fixing activity in forest canopies.

Key words: N fixation, arboreal soil, montane forest.

Frost ring distribution in *Araucarua araucana* trees from the xeric forests of Patagonia, Argentina

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Frost rings are defined as anatomically abnormal and ecophysiologically pathological structures. We studied the frost injuries in tree-rings of *Araucaria araucana* trees growing at the northern limit of its natural distribution. We

recorded 121 frost injuries at two sites in the northern xeric distribution of *A. Araucana* forests. Frost rings at both sites were primarily restricted to the middle frost ring section of the rings. These results represent the first attempt to report and describe the occurrence of these events for this species and region. These proxy records represent important indicators of extreme temperature conditions.

Key words: tree-rings, injuries, earlywood, latewood, extreme events.

Spatio-temporal effects of human drivers on fire danger in Mediterranean Chile

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The aim of this study was to analyze how human factors, specifically land use and cover change (LUCC), influence wildfire danger in a Mediterranean Region of central Chile. Main drivers of LUCC were associated with changes in socio-economic conditions, which had strong effects on the structure of the landscape and on the danger of wildfires. Ignition and flammability were evaluated as key components of fire danger. Ignition probability was modeled for 1999 and 2009 using an autologistic regression, based on fire records from Corporación Nacional Forestal (CONAF) and geographic, biophysical, and socioeconomic databases. Flammability was assessed by combining the National Vegetation Cadastre of 1999 and its update of 2009, and the fuel model developed by Julio (1995). Spatiotemporal analysis of flammability was performed and related with primary LUCC processes, namely, plantation expansion, forest regrowth, and agricultural abandonment. We combined the ignition probability and flammability analysis to produce wildfire danger maps. Results show that fire danger is a dynamic indicator that depends largely on human factors. By 1999, the area under high fire danger comprised 31,399 ha, whereas by 2009 this area had increased by 54,705 ha. For both periods, wildfire danger had a similar spatial distribution, concentrating near main roads, cities, and larger towns (26.3% of the high fire danger area). Also high fire danger areas concentrated over zones covered by exotic forest plantations (33.2%). These results provide a basis for a more effective design of fire control strategies.

Key words: Fire danger, probabilities of ignition, flammability, landscape.

The influence of land-use on edge effect in an Atlantic forest fragment in north-east Brazil

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Although the edge effect is a phenomenon much studied in tropical forests, the effects of edge creation in open ombrophilous forests of the Atlantic Forest of northeastern Brazil are little discussed. Plant communities with large canopy openness, including periods with partial loss of leaves may respond differently to the impacts of

edge formation because species may be more light-tolerant. The matrix can have a direct influence on the edge effect. Most studies available examine the consequences of the interface between forest and agricultural areas or pasturelands. However, the effects of the creation of a water body have been little studied, despite being frequent in the last century. In this study, we analyze the edge effect in two faces of a fragment, the first edge in contact with sugarcane crop, and the second with a lake formed by a dam. To neutralize the effect of selective logging and avoid counting species established before the edge formation, we analyzed the composition and density of the juvenile layer (≤1m). The results pointed out that the construction of a dam (water body) has caused an edge effect in the forest fragment, which seems to be not relevant in the area adjacent to sugarcane cultivation.

Key words: Rain Forest, fragmentation, edge effect, Atlantic forest, Brazil.

Recognizing vegetation chronosequence in Landsat imagery

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This paper presents a description of an algorithm of automated identification of forest regeneration stages using a spatial analysis of Landsat-5 TM imagery and field data. Based on this algorithm, several raster maps were built to show the vegetation regeneration stages in a range of habitat types found in southern Yenisey Siberia.

Key words: remote sensing data, GIS, forest regeneration dynamics map.

Topic: Agents, socioeconomic connections and policy-making processes

Short Manuscripts
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LANDSCAPE CHANGES IN SERRA DO JAPI: LEGAL PROTECTION OR SCIENTIFIC EXPECTATION?

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The creation of new legally protected areas brings many conflicts that distance the real landscape from the expected according to environmental law or conservation researchers. In this study, we mapped and compared the changes in Serra do Japi (São Paulo, Brazil) throughout 40 years with scenarios of legal protection and scientific expectation on forest conservation, to evaluate the distance between them. This may allow us to infer the direction of historical changes and assist in the debate among decision makers. The results showed that most legal requirements on forest protection in the current landscape have been met. The 1960s was the period when the forest cover was closest to the desirable conservation stage. Although the Serra do Japi has maintained large areas of forests during the entire study period, human interference increased with the expansion of reforestation and urban areas, and access roads were identified as a primary potential driving forces of change. In addition, habitat loss was observed in the landscape, which can represent the first phase of a sequence of modifications detrimental to the environmental conservation of this protected area, including decision changes to land use. In conclusion, the changes evolved toward conservation expectations, but not toward the forests' configuration of scientific expectation.

Key words: landscape ecology, environmental laws, scenario, LUCC, Atlantic Forest.

Non-wood forest products for livelihoods

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Forests provide a diversity of non-wood forest products (NWFPs) as a resource base for regional and rural development. The role of NWFPs differs in time and space. The aim of the study was to analyze the role of NWFPs in livelihoods, especially forest-dependent communities, in Ukraine and Sweden. 114 interviews with local stakeholders in two countries were done for this study. The results showed that (1) NWFPs have potential for economic rural development, (2) traditional practices of NWFPs' utilization were retained and revived in Ukraine, (3) and were no longer economically but rather socially important for local people in Sweden. NWFPs have great potential for sustainable rural development, as resources for economic development.

Key words: sustainable forest management, sustainable rural development, sustainable livelihoods, Ukraine, Sweden.

Recognizing the nature of traditional identity through the study of changes in the landscape (Juréia- Itatins, São Paulo, Brazil)

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This study analyzed spatial variability with regard to natural resources of interest to traditional communities within an important protected area in the São Paulo State - the Juréia-Itatins Ecological Station. The historical occupation of the area was interpreted with a focus on the traditional practices related to the use of land, exploitation of the natural resources and topographic features. A historical line was drawn showing a clear relation between the expansion of the occupation and the development of new practices, giving rise to different outcomes in different ways of living with nature. We suggest that the decisions made about Juréia Forest conservation recognize the historical and territorial variations of traditional practices.

Key words: cultural identity, traditional community, changing landscape.

Forest transition in Chile? Assessing the impact of forest sector intensification on native ecosystems

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As one of two South American countries to have reversed persistent losses in forest cover, Chile holds important lessons to guide the creation of effective mechanisms for slowing global deforestation. Rising incomes, labor diversification, and government policies are all influencing the expansion of tree cover. However, much of this expansion has come in the form of monoculture plantations. As a result of this rapid growth of plantation forests, Chile can inform our understanding of the land-use impacts of forest-sector intensification. Plantations provide nearly 95 percent of the country's timber production on 15 percent of its forested lands. Such intensive production has the potential to reduce pressures on native forests. However, plantation expansion has also been an important direct driver of native forest clearing. As a result of these competing interactions, the ecological impacts of Chile forest transition are unclear. Careful consideration of the Chile experience may give forest transition theory greater nuance in describing the range of possible ecological consequences of forest expansion. In this paper, I use a combination of remote sensing and econometric modeling to assess increases in Chilean forest cover over the past 25 years both through rapid expansion of plantation forests as well as gradual regrowth of native secondary forests. By looking at the links between these two trends, I describe the causes of the Chilean forest transition as well as the ecological implications of these national-scale changes. In addition, I consider the complex role of global trade in impacting Chilean land use.

Key words: land use change, forest transition, globalization.

Acknowledgements: This research was made possible through collaboration with the Laboratory of Landscape Ecology at the Universidad de Concepcion. Robert Heilmayr was funded by NSF-GRFP number DGE- 1147470

A new forest model for Chile

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The Chilean forest economy is based upon plantations of *Pinus radiata* and *Eucalyptus* sp. that supply an industry of exported commodities that ranks second in the country. This is the result of a process that started during the middle of the twentieth century when the State created industries and established plantations especially in public lands, and was modified by Pinochet´s dictatorship that during the 70´s, started subsidizing plantations, relaxed restrictions to exportations, and privatized state-owned companies. These public policies, accompanied by a deregulation of the public role to enforce laws and regulations, allowed for the creation of 2,5 million hectares that, on the way, replaced native forests, forced rural-urban migration, and generated negative environmental impacts, especially due to the large-scale clearcuts used to harvest these plantations. This model has transformed the landscape of south-central Chile, has deteriorated the quality of life of rural people, and has benefited the largest forest companies that have grown under this model at the expense of numerous middle- and small-sized companies that used to exist until the 90´s. This is, overall, a model that needs to be transformed for the benefit of the environment, the people, and Chile´s economy. The AIFBN proposes a new forest model based upon three major foundations: a landscape management approach, strengthening of the state institutions, and improvement

of forest practices both in plantations and native forests. These changes would improve forest ecosystem services, the quality of life of local communities, and, in general, the potential social benefits from forest landscapes.

Key words: public policies, forest model, socioeconomic impacts, landscape transformation, environmental impacts.

Acknowledgements: Agrupación de Ingenieros Forestales por el Bosque Nativo.

Payments for environmental services and their impact on forest transition in Costa Rica

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Previous attempts to estimate the causal impacts of the Costa Rican system of payments for ecosystem services (PES) have been based on the combination of remote sensing data with secondary data primarily on bio-physical characteristics such as road density and soil quality. Previous literature has also focused on the role of PES in reducing deforestation, or loss of existing forest cover. However, it is clearly also relevant to ask what impact PES has on the forest transition in Costa Rica, and given that this dynamic has been closely tied with socio-economic development, it is critical to incorporate socio-economic characteristics into the analysis. This paper contributes to understanding the causal impact of PES by analyzing the effect of the Costa Rican system of PES on several dimensions of forest cover, using census data at the tract level combined with remote sensing data on land use and biophysical land characteristics for the entire country. To isolate the causal impact of PES, matching estimators were applied to identify appropriate controls for census tracts that had land placed under PES contracts. We found that the program has no statistically significant effect on existing forest (i.e. no effect on forest loss), but it does have a statistically significant and positive effect on the establishment of new forest (i.e. positive effect on forest gain and net deforestation). This suggests that in Costa Rica, PES is making a significant contribution to the forest transition.

Key words: Impact evaluation, Costa Rica, Payments for Ecosystem Services.

Integrated landscape level planning in Nepal: lessons learned from western Teria landscape complex project (WTLCP)

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Strong partnerships among conservation partners, sectoral agencies, and local governments are essential for landscape conservation. Recognizing this, WTLCP, in collaboration with conservation partners, developed and implemented an integrated landscape planning process (ILP) in order to develop a synergy of partnerships between organizations working in the landscape, through consultative and participatory processes consistent with existing planning processes of Nepal. Likewise, ILP is piloted in selected conservation landscapes to strengthen

stakeholders. ILP adopted a desired condition planning approach. Priority for management of given landscapes was identified following consultative processes. Afterwards, programs of different actors and stakeholders were reviewed and analyzed to assess whether it hindered or facilitated the management priorities. A priority action matrix (PAM) of landscape was prepared with a view to develop shared vision among different stakeholders. Stakeholders then planned their program independently following their own planning processes consistent with PAM. Multi-stakeholders forum, formed at the district level, reviewed programs of different agencies which further harmonized, prioritized, and integrated programs by linking conservation and development goals together. The forum then recommended to the local government for approval along with requesting funding support. Introducing new planning processes for managing landscapes is quite challenging. However, realization of shared goals along with small improvements on existing planning processes is one of the most effective ways to achieve multiple objectives of landscape conservation. This has further supported making informed decisions within the context of predicted thresholds, together with resource leverages. However, the multi-stakeholder forum and the local government should be strengthened for taking the lead to ensure effective coordination.

Key words: integrated landscape planning, conservation landscape, multi-stakeholders forum, coordination, Nepal.

Acknowledgements: We would like to thank MFSC, UNDP, GEF along with conservation partners for providing support for implementing landscape conservation project in western Terai of Nepal.

Stakeholders' perception of forest landscape management: an analysis of Tukad Ayung watershed in Indonesia

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The implementation of landscape management of watersheds, in practice, very often has to face conflicts of interest with the land use which is more sectorally oriented. Therefore, it is necessary to make good coordination and common perception of various stakeholders to achieve better management of forest landscapes in a watershed that integrates ecological, social, and institutional factors in its implementation. This study aims to analyze the perception of the stakeholders regarding the management of forest landscapes, and the factors that influence their perception. The study was carried out at Tukad Ayung Watershed in Bali Province. The data were collected by survey method and in-depth interviews, while the samples were determined purposively. The first objective was analyzed by the Analytical Hierarchy process (AHP) method to determine the priority of stakeholders' perception, while the second objective was analyzed by descriptive qualitative methods. The results showed that according to stakeholders' perception in Tukad Ayung, from the 4 factors in landscape management, ecology, economy, social, and institution, economic aspects have the highest priority (38%). Land use value was considered to be the most important indicator (32%) from the economic aspects. Meanwhile, the microclimate had a percentage of 38% of the ecological aspects, community participation 48% of the social aspects, and the institution 34% of the institutional aspects. Their perception is affected by area condition, their institutional background, and economic motivation.

Key words: management, perception, stakeholders, landscape, watershed.

Acknowledgements: Virni Budi Arifanti, Retno Maryani, Mimi Salminah, Epi Syahadat.

Recognizing the nature of traditional identity through the study of changes in the landscape (Juréia- Itatins, São Paulo, Brazil)

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This study analyzed spatial variability with regard to natural resources of interest to traditional communities within an important protected area in the São Paulo State - the Juréia-Itatins Ecological Station. The historical occupation of the area was interpreted with a focus on the traditional practices related to the use of land, exploitation of the natural resources and topographic features. A historical line was drawn showing a clear relation between the expansion of the occupation and the development of new practices, giving rise to different outcomes in different ways of living with nature. We suggest that the decisions made about Juréia Forest conservation recognize the historical and territorial variations of traditional practices.

Key words: cultural identity, traditional community, changing landscape.

Trade-offs between conservation and development in Seram Island, Central Moluccas, Indonesia

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In many tropical developing countries, tradeoffs between conservation and development still depend strongly on land uses and land allocation issues. Seram Island in the Moluccas is no exception. Recent conflicts for land uses among stakeholders have started to impact negatively on livelihoods and forest resources. Through a thorough baseline study using household questionnaires, focus group discussions, and key informant interviews, a number of critical issues have been identified, such as ownership and boundaries, access to land and forest resources, the development of industrial plantations (oil palm, cocoa), or oil exploration. Our analysis clustered villages into five landscapes identified as pilot areas, based on different socio-biophysical situations, but also distinct population growth, access to markets, and distinct needs for economic development. Agriculture, as the primary source of income, is still the norm, but forests have still high potential in coastal and urban areas. Forests are even essential for livelihoods as subsistence in the mountain villages. On the coast, fisheries represent a dominant source of cash in comparison to all of the forms of agriculture. In other areas, waged employment is linked to greater market access and proximity to the district capital. This study provides a thorough baseline understanding of the relationship between the communities in Seram, other stakeholders and the natural resources use and non-use, coupled with needs for economic development. Results and information can now be used in the development of collaborative land-use planning tools and processes, potentially leading to the development of Payment for Ecosystem Service options.

Key words: collaborative, land-use planning, natural resources, forest-dependent people, subsistence.

Acknowledgements: We thank the European Commission, CIRAD, and CIFOR to support this research.

Incorporating landscape ecology principles into Natural Resource Condition Assessments of U.S. National Parks

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The U.S. National Park Service has initiated a program of Natural Resource Condition Assessments to summarize current knowledge of ecological status and trends at selected U.S. National Parks. The aim of these assessments is to integrate multidisciplinary data representing the current science into a form useful for both decision making by park managers and for educating the public on natural resources issues facing the parks. In the past we conducted an assessment of two parks in the northeastern U.S., the Delaware Water Gap National Recreation Area and the Upper Delaware Scenic and Recreational River, and we are currently conducting an assessment of the Fredericksburg and Spotsylvania National Battlefield parks in Virginia. In both projects, we are applying landscape ecology principles of fragmentation thresholds, connectivity corridors, patch context and edge influences, and natural versus human influenced landscape elements as central to understanding the status of park ecosystems. Since many U.S. National Parks are threatened by near-park land conversion and development, understanding the changing nature of the landscape context is central to supporting proper management and decision making. We illustrate our application of landscape analysis in support of Natural Resource Condition Assessments and discuss challenges and opportunities for future research.

Ecological and economic strategies for forest conservation and landscape permeability increase in the Chapecó and Timbó ecological corridors, Santa Catarina, Brazil

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The Chapecó and Timbó Ecological Corridors (EC) protect approximately 250 thousand hectares of the endangered Araucaria Forest in Santa Catarina, southern Brazil. With less than 4% of its original distribution, forest remnants have a high level of fragmentation. The creation of both EC is an attempt to increase the landscape permeability in these highly productive areas. This study aims at presenting the main results of both EC planning and the challenges and opportunities to their implementation. The planning process (2007-2009) aimed at developing mechanisms for landscape management, integrating environmental conservation and economic development. The methodology was based on: (i) rapid ecological evaluation and landscape analysis (ArcGIS, Fragstats); (ii) socioeconomic assessment; (iii) stakeholders participation; and (iv) the strategic planning itself. The main result is a zoning proposal based on a scoring system, which considered conservation priorities, biodiversity threats, land use, and economic tendencies in the micro basin level. The management strategies were developed according to the EC zoning and include the establishment of a market for payment for ecosystem services at the state and national level, and the structuring of an Ecological Economic System for the main agricultural activities within the landscapes. From 2012 until 2016, the World Bank and the State Government will provide funds for the implementation of both EC. The challenges include the high opportunity cost of the land, the threats of the environmental legislation change and the consequent reduction of forest requirements in the private lands, and the continuity of the actions after the 6 years of international funding.

Key words: ecological corridors, araucaria forest, payment for ecosystem services, landscape management.

Acknowledgements: This work was developed in the Santa Catarina Microbasin 2 Project and was financial supported by World Bank and the State Government.

POSTERS

Paying for international environmental public goods

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The supply of international environmental public goods must meet certain conditions to be socially efficient, and several reasons explain why they are currently undersupplied. The diagnosis of a failure of the public goods associated with particular ecosystem services is critical to the development of the appropriate international response. There are two categories of international environmental public goods that are most likely to be undersupplied. One has an additive supply technology and the other has a weakest link supply technology. The degree to which the collective response should be targeted depends on the importance of supply from any one country. In principle, the solution for the undersupply lies in payments designed to compensate local providers for the additional costs they incur in meeting global demand. Targeted support may take the form of direct investment in supply (the Global Environment Facility model) or of payments for the benefits of supply (the Payments for Ecosystem Services model).

Key words: public goods, ecosystem services, payments for ecosystem services.

Seven steps of knowledge production and learning for sustainable development and sustainability: landscapes as laboratories

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Global, national, and business policies about natural resource use imply that economic, environmental and socio-cultural dimensions should be satisfied. Two important challenges are to develop (1) accounting systems for different sustainability dimensions so that actors and stakeholders are provided with transparent information about states and trends concerning economic, environmental, and socio-cultural objectives, and (2) approaches to adaptive management of larger areas and governance at multiple scales. A large number of concepts for implementation of sustainability policies in actual landscapes have been developed and local initiatives are appearing worldwide. To learn from existing experiences which implement policies about sustainable landscapes, we developed a network of case study areas in terms of multiple geographical territories, catchments, or management units in forest landscapes in geographical Europe's West and East. These form landscape laboratories for transdisciplinary knowledge production and learning. This implies the combination of natural and human sciences, as well as close collaboration with actors and stakeholders representing multiple sectors and levels. Our suite of landscapes represents gradients in two main dimensions. The first is the variation in the history of forest and woodland landscapes from areas in the periphery of economic development to areas with a long history of management closer to markets. The second is the governance systems, ranging from institutions and planning with links to non-industrial private ownership and commons to company and state ownership. We describe a systematic approach for integrative research in seven steps to support sustainable development towards sustainability.

Key words: comparative politics, landscape, governance, sustainability, integrative research.

Functional green infrastructures biodiversity and ecosystem services: a transdisciplinary research challenge

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The term 'green infrastructure' captures the need to satisfy policies about biodiversity conservation and delivery of ecosystem services by functional ecosystems at multiple spatial scales. Using Sweden's forests and woodlands as a case study, we review (1) the policy creation process from the late 1980s, (2) the implementation outputs regarding formally protected and voluntary set-aside areas with a focus on the period 1991-2010, and (3) protected area development in terms of the amount of formally and voluntarily set-aside forest stands. To demonstrate the need for assessment of the functionality of green infrastructures, we (4) give examples of how the functionality of different forest habitat networks can be assessed, and (5) present an approach to understand the operational planning processes across forest owner categories and among responsible government agencies. We then stress the need to (6) estimate the cumulative effects on biodiversity of formally protected and voluntary set-aside areas, and retention forestry in the managed forest matrix surrounding protected areas. While Swedish policy pronouncements do capture evidence-based knowledge about biodiversity and conservation planning well, the current amount of formally protected and voluntary set-aside forests are presently too low and has too poor connectivity in relation to the current forest and environmental policy ambitions. Moreover, collaboration with the aim to increase size, quality and connectivity of forest habitats among forest and conservation planners needs to be improved. We conclude that this requires integrative approaches to planning and transdisciplinary knowledge production.

Key words: biodiversity, policy, implementation, protected areas, conservation planning.

The importance of SFC health and security criteria in forest management in Brazil

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This study aims to reflect on FSC (Forest Stewardship Council) standards used to apply Forest Plantation Certification, and its connection with the rights of workers. A central condition of the FSC is the idea of improvement of workers´ lives and their communities in terms of economic and social welfare. In addition, a very important measure refers to the commitment from the owners on reforestation of the areas in order to improve security and health conditionsfor the workers and their families. From these criteria, this study analyzes how the Brazilian Policies are being implemented with regards to Health and Workers Health in the areas used for forest management.

Key words: Forest management, Health Policies, Forest Certification.

Valuing the recreational services of Nonguén National Reserve, Chile

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The south central Chile concentrates an outstanding biodiversity being one of the world's 34 hotspots. Along the last century, this landscape has been affected by human disturbances, resulting in a spatially heterogeneous mosaic of vegetation. In this context, the Nonguén National Reserve represents one of the last remnants of native forest that occur in the urban area of Bio bio Region. Unfortunately Nonguén has been affected by uncontrolled and illegal forest exploitation activities, putting at risk its potential as an area of recreation and leisure for the inhabitants of Great Concepción. The main objective of this work, therefore, was to estimate the economic value of the recreational services provided by the Nonguén National Reserve to the inhabitants of the urban area of Bio bio region. For this, we applied a Contingent Valuation questionnaire that allowed for the calculation of willingness to pay measures. We adopt and experimental design with two elicitation questions, one related to the monetary contribution, the other to the work hours that individuals are willing to offer as a voluntary contribution to the realization of a restoration project of the Reserve. Then we estimated the corresponding willingness to pay (WTP) money and willingness to pay labor time using a bivariate probit model. At the sample mean of the explanatory variables, the conditional expected value of yearly household WTP was US$ 217, and the annual aggregate use benefits of restoring recreational services in Nonguén was calculated in US$ 33 millions. Overall, these results indicate a substantial use benefit of Nonguén's recreational services, the importance of the Reserve for the community and stress the need for developing strategies for its conservation and restoration.

Key words: restoration, ecosystem services, contingent valuation.

Landscape changes in serra do japi: legal protection or scientific expectation?

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The creation of new legally protected areas brings many conflicts that distance the real landscape from the expected according to environmental law or conservation researchers. In this study, we mapped and compared the changes in Serra do Japi (São Paulo, Brazil) throughout 40 years with scenarios of legal protection and scientific expectation on forest conservation, to evaluate the distance between them. This may allow us to infer the direction of historical changes and assist in the debate among decision makers. The results showed that most legal requirements on forest protection in the current landscape have been met. The 1960s was the period when the forest cover was closest to the desirable conservation stage. Although the Serra do Japi has maintained large areas of forests during the entire study period, human interference increased with the expansion of reforestation and urban areas, and access roads were identified as a primary potential driving forces of change. In addition, habitat loss was observed in the landscape, which can represent the first phase of a sequence of modifications detrimental to the environmental conservation of this protected area, including decision changes to land use. In conclusion, the changes evolved toward conservation expectations, but not toward the forests' configuration of scientific expectation.

Key words: landscape ecology, environmental laws, scenario, LUCC, Atlantic Forest.

Non-wood forest products for livelihoods

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Forests provide a diversity of non-wood forest products (NWFPs) as a resource base for regional and rural development. The role of NWFPs differs in time and space. The aim of the study was to analyze the role of NWFPs in livelihoods, especially forest-dependent communities, in Ukraine and Sweden. 114 interviews with local stakeholders in two countries were done for this study. The results showed that (1) NWFPs have potential for economic rural development, (2) traditional practices of NWFPs' utilization were retained and revived in Ukraine, (3) and were no longer economically but rather socially important for local people in Sweden. NWFPs have great potential for sustainable rural development, as resources for economic development.

Key words: sustainable forest management, sustainable rural development, sustainable livelihoods, Ukraine, Sweden.

Topic: Urban landscapes and land use planning

Symposium: Ecosystem Services in Urban and Periurban Forests (UPFs)
Organizers: Giovanni Sanesi, University of Bari, Italy.

Planning for new green infrastructure to support ecosystem services and human well-being in urban regions

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The last decades have seen an important shift in planning and development of landscapes and ecosystems in Europe. First of all, in line with international developments, the productivity of ecosystems has come in focus through the concept of ecosystem services. Second, grounded in e,g., landscape ecology, nature conservation in Europe has changed from site protection to the enhancement of linkages between ecosystems, and are stressed through the concept of ecological reserves towards the establishment of green infrastructure networks linked to wider urban, peri-urban, rural and environmental processes. Green infrastructure networks at different scales, and across urban, peri-urban and rural landscapes, both support ecological processes and contribute to human health and well-being by providing added ecosystem services through networking. Moreover, especially in an urban context, green infrastructure places green spaces at the same level as other essential urban infrastructure. This paper discusses the concept of ecosystem services and its increasing implementation in Europe. A new framework for the development, management, and analysis of green infrastructure networks is presented. Application of this framework at different spatial and temporal scales is illustrated through a series of case studies. Finally, directions are provided for future research, and for developing and delivering green infrastructure in the emerging context of ecosystem services and human well-being.

Key words: green infrastructure, ecosystem services, human well-being, landscape planning.

SYMPOSIUM

Assessment of the quality of riparian forest remnants in the metropolitan area of Buenos Aires

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40% of Argentina's population (approximately 16 million people) lives in the urban area established by the City of Buenos Aires and the metropolitan area. Due to a lack of planning combined with a careless use of the environment, there is a severe impact on water courses and the riparian forest remnants linked to the urban matrix. Among them, the Matanza-Riachuelo and Reconquista basins, and the waterfront of the La Plata River are the most affected. We evaluated the use of land along 70 km of coastline. We analyzed the use of land within a radius of 500 m in 103 points and designed a riparian quality index at an immediate shore (<50 m) in 54 stations, considering proportion of forested area and low vegetation, urbanization and impervious surfaces, vegetation structure, and potential impacts. On the other hand, we surveyed bird communities in 103 point counts of fixed radius of 50 m for 5 min. Results indicate a decrease in bird species with decreasing proportion of trees and herbaceous cover. Rare species (seen in less than 10% of sites) responded positively to the increase of forest and lawn with critical values (7 and 20% of the evaluated areas, respectively) below which rare birds disappear. They were also positively associated

with the riparian quality index. It is important to consider urban settlements as a combination of natural and urban areas, respecting suggested proportions of green areas to preserve natural biodiversity.

Key words: riparian forest, land use, bids, urbanization.

The scaling of forest in and around Danish and Swedish cities in relation to landscape context and urbanisation traits

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As long as urbanisation has progressed, forest has been the major biotope that is fragmented. However, while forest coverage differs enormously among cities, little is known about the interrelationships of this variation and the consequences for the multiple ecosystem services forest provide to urban societies. We used GIS analysis of high resolution land-use data to measure forest coverage and spatial configurations (number and size of patches) in and around all Danish and Swedish cities > 10,000 inhabitants (n=176), and general linear modelling to explore the relationship with (1) the gradient from inside the city, through the urban fringe to the peri-urban zone (respectively 2 and 5 km from city border), (2) regional landscape context, and (3) population increase during 1960-2010. We show that while coverage in and around a city is primarily related to regional landscape, the spatial distribution and size configuration of forest patches shows similar traits between cities with varying forest coverage, landscape context, and population trends. Thus, while forest coverage differed significantly between cities settled in regions of large-scale agriculture, regions of mosaic forest and small-scale farming, and forest-dominated regions, forest coverage peaked in the urban fringe zone irrespective of landscape context and population increase. Similarly, mean forest patch size peaked at the urban fringe rather than with increasing distance to the city. These general spatial patterns offer a common reference for the integration of forest in strategies of sustainable urban development across cities with varying forest coverage and landscape setting.

Key words: urban-rural gradient, urban forestry, forest patch size, urbanisation, spatial configuration of forest.

Functional behavior of Green Infrastructure concept for the strategic ecological planning of South European urban areas

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Over the last decades, in North Europe and America, Green Infrastructure was foreseen as a working concept to integrate urban forestry and ecology in landscape and urban planning. In South Europe, the planning styles are still far away from assuming landscape ecology and urban forestry issues as guidelines towards a holistic vision of strategic urban planning. The Green Infrastructure planning agenda, wherever applied, brought together planners, ecologists, and architects and proposed a holistic and functional understanding of the ecology of urban environments. Decision makers, planners, and practitioners are working to meet the challenges of growth, development, and dramatic climate changes using adaptive green approaches to urban landscape management. This includes a

range of processes (e.g. water cycle, brownfield regeneration, energy, etc.) and benefits (environmental education, nature and health, etc.) in urban areas. The aim of this paper is to retrace the state of the art of the use of Green infrastructure concepts and its potential role in urban planning. The analysis of South European cities highlights the need for adaptive procedures able to translate, in current actions, the landscape ecology and urban forestry issues and therefore offering solutions to urban strategic planning issues at a number of scales. Case studies of different scale from Italy and other countries of Mediterranean Europe are presented in order to determine the strategic functional aspects and the key indicators that can be adopted both to improve the methods of ecological urban planning and to serve as communicative and policy tools for the agendas of decision makers.

Key words: urban ecological planning, urban forestry, adaptive planning, Green strategies, Healthy cities.

Air pollution removal by urban forests in the metropolitan area of Concepcion, Chile

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The metropolitan area of Concepcion has experienced significant urban growth, which displaced forests and agricultural land and created new sources of air pollution, including fugitive dust from the streets, manufacturing plants, and residential wood heaters. Currently, Concepcion has air quality problems, which directly affects people's health. The purpose of this study is to assess the benefit of vegetation in the Metropolitan areas of Concepcion, since vegetation has a positive effect on air quality, as the foliage of plants clean the air by absorbing gaseous pollutants and deposits particulate matter throughout the surface of the leaves. The Urban Forest Effects Model was used to estimate air pollution removal by urban and suburban forests for a projected area of 295.3 km^2. Data were collected from randomly selected plots. The monetary value of externalities from air pollution removal by vegetation was estimated using US median externality values. A total pollution removal rate of 1221 tons $year^{-1}$ was estimated for the 295.3 km^2 of vegetation of the metropolitan area of Concepcion, with the highest removal rate found for particulate matter (3.47 g m^{-2} yr^{-1}). The monetary value for externality was estimate to be about $5.5 million.

Key words: air of pollution removal, urban forest, forest economic benefit evaluation, UFORE.

Acknowledgements: We thank the students who devoted much of their time to field work and running the UFORE model. This study was funded by the INNOVA BioBio Grant for undergraduate Final Project.

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Stream corridors as indicators of watershed land use: A case study in Istanbul

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Riparian ecosystems as components of stream corridors provide a range of regulating ecosystem services including water production. Water quality, a component of water production is a major concern in urbanized watersheds. Water quality monitoring has been a very common method of investigating watershed impairment particularly in case of human impacts but it is now clear that hydrologic and ecological parameters may support and improve monitoring studies substantially. In three major watersheds of the Istanbul city (Alibeyköy, Sazlıdere, and Kağıthane) we initiated a large scale study with the objective of evaluating integration, health, and functionality levels of riparian ecosystems. We combined a thorough field survey study with a GIS assessment to reach this objective. A total of 66 sub-watersheds have been selected in the main study watersheds and survey points have been determined at their outlets. All perennial streams in the study have been surveyed for 5 main categories; ecological water quality, water quality for use, riparian integrity, riparian functionality, and riparian habitat potential. We found that a substantial amount of the streams in or close to urban areas had lost their functionality. Furthermore, around 10 percent of all streams in the peri-urban areas had been channelled. Water quality has also been deteriorated in many streams. For example average NO_3^{-1} concentration at the urban streams was 76.63 mg L^{-1} while it was 2.67 mg L^{-1} at the forested part of the same watershed.

Key words: Urban planning, land use, sprawl, watersheds, stream corridors.

Land-use changes and their impacts in megacities exemplified at Karachi: an integrated modelling approach investigating socio-environmental flows

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This study investigates the hypothesis: how do urban land-use changes affect the ecosystem services and functions specifically at the interfaces of urban, peri-urban and rural areas of megacities? Using the example of Karachi, Pakistan, the aim of the study is to better understand how land-use/land-cover (LULC) changed over time and what could be the patterns of land conversion/consumption and ecosystem services demand in the future. Karachi is a very interesting case study for such questions as it currently represents one of the fastest growing megacities worldwide. Our approach to explore this complexity involves (i) conducting an in-depth investigation to help define and characterize drivers of land-use changes in Karachi, (ii) assessing existing spatial models that link social and ecosystem processes, and (iii) developing and empirically testing these models. First, we analysed the LULC changes based on conceptual models which integrate socio-economic patterns and ecosystems. Secondly, a system dynamics modelling approach was developed to portray the semantic translation of LULC in selected urban neighbourhoods in Karachi at urban/peri-urban interfaces and along an urban-rural gradient. Third, we applied this framework for evaluating the ecological effects of land-use change in design (urban ecological) scenarios, substantiated with the results of the described research. The results will help identify the demands (on land and on ecosystem services) in a highly dynamic urban region that impact both bio-physical and social systems along the urban-rural gradient, forming zones of influence and having fuzzy boundaries that can multiply the impact on landscape and ecosystem stability.

Key words: urban ecology, ecosystem services, landscape modelling, remote sensing, future scenario modelling.

Landscape considerations in spatial planning of protected areas in Poland: A case study of Wolin National Park

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Spatial planning of areas under legal protection is an issue with a high degree of complexity. These are areas where high priority is given to the protection of the natural environment, cultural heritage, and landscape, but at the same time, it is necessary to take into account the economic development of the site and the needs and expectations of local communities. In this paper, referring to Polish law, the scope of analysis needed for drawing up outlines for spatial management of natural areas with different protection regimes will be presented, with particular attentionpaid to issues of conservation, management, and landscape planning in Polish national parks. The existing provisions of law, only in very general terms, define the scope of analyses performed for landscape planning studies, and also leave a lot of flexibility in the choice of research methods on how to assess the landscape. The assumptions and results of the valuation methodology of Wolin National Park landscape will be discussed. The park area was divided into landscape units, determined from analysis of the land-use structure and relief. Within each landscape unit, view points and view lines were inventoried, for which detailed studies were conducted. Scenic analysis allowed the establishment of guidelines for surface, linear, and point protection of the landscape. The results were the basis for determining protective actions of the Park, and establish guidelines for local spatial management plans of municipalities covering the area of the Park and its buffer zone.

Key words: landscape value, landscape protection, national park, spatial planning.

Stream corridors as indicators of watershed land use: A case study in Istanbul

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Riparian ecosystems as components of stream corridors provide a range of regulating ecosystem services including water production. Water quality, a component of water production is a major concern in urbanized watersheds. Water quality monitoring has been a very common method of investigating watershed impairment particularly in case of human impacts but it is now clear that hydrologic and ecological parameters may support and improve monitoring studies substantially. In three major watersheds of the Istanbul city (Alibeyköy, Sazlıdere, and Kağıthane) we initiated a large scale study with the objective of evaluating integration, health, and functionality levels of riparian ecosystems. We combined a thorough field survey study with a GIS assessment to reach this objective. A total of 66 sub-watersheds have been selected in the main study watersheds and survey points have been determined at their outlets. All perennial streams in the study have been surveyed for 5 main categories; ecological water quality, water quality for use, riparian integrity, riparian functionality, and riparian habitat potential. We found that a substantial amount of the streams in or close to urban areas had lost their functionality. Furthermore, around 10 percent of all streams in the peri-urban areas had been channelled. Water quality has also been deteriorated in many streams. For example average NO_3^{-1} concentration at the urban streams was 76.63 mg L^{-1} while it was 2.67 mg L^{-1} at the forested part of the same watershed.

Key words: Urban planning, land use, sprawl, watersheds, stream corridors.

Is my city different to yours? The urban form and its anthropogenic drivers

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The dynamics of urban areas make them a complex system where infrastructure, socioeconomics, and social characteristics interact, generating different morphologies. This research aimed to understand the urban landscape structure, how they vary among cities, and what the drivers of these forms were. We used simple GIS and remote sensing techniques to compare the morphologies of 100 cities distributed along different climates, economies, cultural, and historical backgrounds. We characterized the urban morphology based on commonly used landscape metrics of vegetation, impermeable surfaces, and water surfaces obtained from a combination of normalized vegetation and built-up indices (NDVI and NDBI). A selection of the most relevant landscape metrics of urban areas is provided, i.e vegetation average patch size, connectivity. To recognize similar cities, we performed a cluster analysis combined with a discriminant analysis. The drivers of the urban form were assessed using a hierarchical mixed model where socioeconomics, demographics, cultural, and location variables were input as predictors. Results indicated that the use of Landsat imagery and the normalized built-up index are appropriate to classify the three components of the urban landscape. Seven landscape metrics were able to characterize the urban form. Through the configuration and composition of the urban landscape, we were able to recognize 8 urban forms. We showed that cities from different geographical context could have similar morphologies. The drivers included in this research were able to explain a limited amount of variation on the urban form, confirming the complex dynamics involved in urban form trajectories.

Key words: urban form, landscape metrics, connectivity, global analysis, landsat.

The scaling of forest in and around Danish and Swedish cities in relation to landscape context and urbanisation traits

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As long as urbanisation has progressed, forest has been the major biotope that is fragmented. However, while forest coverage differs enormously among cities, little is known about the interrelationships of this variation and the consequences for the multiple ecosystem services that forests provide to urban societies. We used GIS analysis of high resolution land-use data to measure forest coverage and spatial configurations (number and size of patches) in and around all Danish and Swedish cities > 10,000 inhabitants (n=176), and general linear modelling to explore the relationship with (1) the gradient from inside the city, through the urban fringe to the peri-urban zone (respectively 2and 5 km from the city border), (2) regional landscape context, and (3) population increase during 1960-2010. We show that while coverage in and around a city is primarily related to the regional landscape, the spatial distribution and size configuration of forest patches shows similar traits between cities with varying forest coverage, landscape context, and population trends. Thus, while forest coverage differed significantly between cities settled in regions of large-scale agriculture, regions of mosaic forest and small-scale farming, and forest-dominated regions, forest coverage peaked in the urban fringe zone irrespective of landscape context and population increase. Similarly, mean forest patch size peaked at the urban fringe rather than with increasing distance to the city. These general spatial patterns offer a common reference for the integration of forest in strategies of sustainable urban development across cities with varying forest coverage and landscape setting.

Key words: urban-rural gradient, urban forestry, forest patch size, urbanisation, spatial configuration of forest.

Functional behavior of Green Infrastructure concept for the strategic ecological planning of South European urban areas

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Over the last decades, in North Europe and America, Green Infrastructure was foreseen as a working concept to integrate urban forestry and ecology in landscape and urban planning. In South Europe, the planning styles are still far away from assuming landscape ecology and urban forestry issues as guidelines towards a holistic vision of strategic urban planning. The Green Infrastructure planning agenda, wherever applied, brought together planners, ecologists, and architects and proposed a holistic and functional understanding of the ecology of urban environments. Decision makers, planners, and practitioners are working to meet the challenges of growth, development, and dramatic climate changes using adaptive green approaches to urban landscape management. This includes a range of processes (e.g. water cycle, brownfield regeneration, energy, etc.) and benefits (environmental education, nature and health, etc.) in urban areas. The aim of this paper is to retrace the state of the art of the use of Green infrastructure concepts and its potential role in urban planning. The analysis of South European cities highlights the need for adaptive procedures able to translate, in current actions, the landscape ecology and urban forestry issues and therefore offering solutions to urban strategic planning issues at a number of scales. Case studies of different

scale from Italy and other countries of Mediterranean Europe are presented in order to determine the strategic functional aspects and the key indicators that can be adopted both to improve the methods of ecological urban planning and to serve as communicative and policy tools for the agendas of decision makers.

Key words: urban ecological planning, urban forestry, adaptive planning, Green strategies, Healthy cities.

Endemic Xochimilco: an analysis of park and city management in Mexico City

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Referred to as the Venice of America during the Spanish colony, the Ejidos de Xochimilco y San Gregorio Atlapulco (EXSGA) is a protected area (PA) located south of Mexico City. The EXSGA site consists of seasonal, groundwater-fed springs which sustain a cultural landscape, in the form of chinampas (agricultural use of wetlands). Although Mexico City was once a five cultivated lake-system, Xochimilco is the only remaining example of this pre-colonial heritage. Shortly after the EXSGA was designated as PA, the 1997 Urban Development Program noted urban sprawl around and within the designation. Today, the groundwater-fed springs of Xochimilco are the main supply of water to four boroughs of Mexico City. To keep this wetland from running dry in 2-3 days, a pipe constantly replenishes the lake with treated water. Being wholly dependent on tourism and a seemingly irregular historical traditional agriculture, a multitude of actors are working to influence the development and implementation of policies that collectively determine the long-term viability of EXSGA and in greater degree, the future of the city. Some of these actors work cooperatively towards shared objectives; others seem to work at cross purposes. This research approaches this gap through a strategic organization analysis and assesses the relationships between the specific policies and management actions. Results present a complex landscape of institutional aims and contradictions of park and city policy, how synergies are maintained, and what kind of tradeoffs are inherent in this balance which thus, point towards the opportunities of park & urban policy integration.

Key words: urban, protected area, local authorities, landscape, biodiversity.

Four decades of land cover changes in a peri-urban area of NW Argentina

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Peri-urban systems allow us to understand the interaction between humans andenvironment, because they include components of both systems. The natural-urban area of Sierra de San Javier (SSJ)- Great San Miguel de Tucumán (GSMT), in NW Argentina, includes different types of natural and human-dominated land cover units, interacting in a complex way in response to changes in economy and demographic dynamics. Our objective was to analyze patterns of land-cover change in the last four decades, related to urbanization and forest dynamics, as a consequence of current socio-economics and demographic trends. Land-cover change analyses allowed us to identify systematic transitions and characterize the spatial patterns of change in relation to environmental and socio-economic variables. Expanding urban areas in the piedmont was the most evident change of land cover in the period 1972-2010, occupying agricultural areas which were relocated in areas suitable for modern mechanized agriculture, resulting in deforestation of dry forest in drier and flat lands. Subtropical montane forest area increased in humid mountainous areas and steep slopes. Numerous swaps between categories were observed, representing changes in location of one category and implying a modification of composition and structure of original ecosystems while the total area does not change (e.g. secondary forests replacing mature forests). The SSJ-GSMT system exemplifies a process of economic development, promoting expansion of cities and agricultural intensification to increase food yields, concentrating activities in more productive lands, and allowing forest recovery in marginal agricultural areas, which in turns favor watershed protection and biodiversity conservation in mountain areas.

Key words: peri-urban systems, land-cover changes, urbanization, forest dynamics, NW Argentina.

Naturalness index of landscapes: A planning tool for the Metropolitanarea of Concepción

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This work describes a methodology and application of the Naturalness Index (NI) in the Metropolitan Area of Concepción (MAC) in the context of Urban Planning. The Naturalness Index was conceived as a proxy for the degree of human disturbance in habitats. The method is based on the evaluating land cover maps (GIS Layers) from 2000, 2009, 2010 (30m satellite images) and 2020 (30m map of Urban Planning). The categories of land cover maps were scored in ten naturalness classes from 0 (very low) to 10 (very high) degree of disturbance produced by human intervention. Thus, native forests and wetlands were considered as the most natural classes. In contrast, forest plantations were assigned to the low naturalness class, because they are anthropogenic and constitute one of the principal causes of landscape alteration that threatens the conservation of flora. When the results were reclassified into regressive and progressive changes, they showed that between 2000-2010, the loss of naturalness was around 22%, between 2009-2010, it was 12%, and during 2010-2020, the planned scenario will result in a loss of approximately of 7.2 %. These results have particularly negative effects on native forest and wetland areas. In contrast, the positive effects were increased on the brushwood areas. We propose this methodology can be a valuable contribution as a tool for land planning of urban areas.

Key words: Naturalness Index, Planning tool, Landscape, Urban Areas, Metropolitan Area of Concepción.

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Landscape fragility analysis from a gender perspective: Campus design, University of Concepción

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Landscapes are spaces perceived by human beings that live there; in other words, there is no landscape if there is no observer. These spaces are seen differently according to the viewer and the way they are perceived by them (multisensory). In addition, they are influenced by personal characteristics of the observer, such as gender, culture, educational level, personal experiences, socioeconomic status, etc., therefore perception is not something neuter, but it is laden with value judgments. Nonetheless, perception of landscapes is an important element as an object of study of cultural geography and other social sciences. The analysis of quality and landscape fragility of the campus property of the University of Concepcion is intended to be a contribution to the preservation and restoration of heritage landscapes that are so characteristic of the University.

Key words: landscapes, University of Concepción, landscape fragility, perception, gender.

Cultural landscape(s), cultural history(ies): towards an interdisciplinary construction from social sciences

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Landscapes are spaces that are integrally perceived by human beings from different perspectives such as economy, politics, social science, cultures, history, etc. They are more than a mere link among social, economic, or environmental processes; above all, landscapes have a historical construction. Therefore, they have a social and cultural history that can be analyzed and evaluated. Both disciplines are included since they share many similarities, especially their lack of research activities from social and academic entities, because basically they are considered as non-profitable areas to the current economic system.

Key words: cultural landscapes, cultural histories, interdisciplinarity, historical construction, landscape analysis.

Incorporating spatial autocorrelation into CLUE-s model to simulate the distribution of urban landscape pattern: a case study in Changzhutan city group

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Spatial autocorrelation characteristics are ubiquitous in most geospatial data. The CLUE-s model is a widely used dynamic land-use change model. However, little has been done to examine the impact of incorporating spatial autocorrelation into CLUE-s. In this study, ordinary logistic regression and autologistic regression were constructed for quantifying the relationships between landscape and the drivers. In addition, based on the results obtained by the two techniques, the CLUE-s model was used to simulate landscape pattern in Changzhutan city group. Relative operating characteristic curves (ROCs), Nagelkerke's K, and Moran's I coefficient were used to compare the goodness

of logistic regression and autologistic regression. Kappa index and Fuzzy Kappa index (Kfuzzy) were used for accuracy evaluation of simulation results. The validation results illustrate that, in this case, autologistic regression provides a better fit between landscape and the divers, and also the simulation results show considerable improvement. While with the growth of the forecast period, the simulation ability of CLUE-s model incorporated with spatial autocorrelation reduced faster, indicating that the improved model is more suitable for a short time span's simulation (a decade or so). In summary, incorporating spatial autocorrelation into the CLUE-s model may provide more precise landscape distribution probability maps, better model performance, and more reasonable mechanisms of landscape changes.

Key words: spatial autocorrelation, urban landscape patterns, CLUE-s model, spatial simulation.

Acknowledgements: I would like to extend sincere gratitude to my tutor, Dr. Jiang Weiguo, for his instructive advice and useful suggestions on my thesis.

Environment, urbanization, and human gender: reflections on the modification of the landscape in the city and its impacts

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This paper brings considerations on urbanization, gender, and environment, and its central thesis encompasses the contradictions present in the make-up of the city as theoretical and analytical categories. In this sense, it considers urbanization, environment, poverty, landscape alterations, and their impacts to the human gender. As an empirical research, it is based on a qualitative analysis of social processes and their relationships with the environment and social conflicts present in the urban setting. The geographical area of research is the region of Campos Gerais, interior of Paraná, centering in the city of Ponta Grossa. In recent decades, the urban design in Brazil has dramatically altered the landscape. In 2000, according to the Brazilian Institute for Geography and Statistical Studies (IBGE), approximately 82% of the population was living in cities and in Ponta Grossa, this index is 97%. From this number, 8,778 families live illegally near the valley bottoms and contribute to the loss or alteration of biodiversity by removal of the riparian vegetation which results in pollution of local water and streams, erosion of slopes, landslides, among other consequences for the social development and for the natural habitat and environment conservation. In order to deal with this precarious situation, as an attempt to reverse the process of extreme poverty generated during urbanization, a treatment is necessary which has normative and evaluative principles, and can thus enable urban planning that can be implemented to avoid further deterioration of the area.

Key words: environment, urbanization, landscape, city.

Acknowledgements: State University of Ponta Grossa

Distributional pattern of allergenic plants in built-up areas of Beijing, China

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Plants with airborne pollen could cause the seasonal allergic symptoms which have been intensified by increased air pollution and temperatures in urban areas. Urbanization has intensely affected the distributional pattern of plant diversity by reducing native plant species, and increasing exotic plant species which may affect the distribution

pattern of allergenic plants. To clarify the distributional pattern of allergenic plants in urban areas and detect the effect of urbanization on these plants, we surveyed and analyzed the plants with airborne pollen in different land use types in Beijing, China. Results showed that richness of allergenic plants was significantly different between land-use types, especially the exotic plants with airborne pollen. The total plant diversity was positively correlated with allergenic plant diversity which suggests a high risk of allergic symptoms in high diversity areas such as parks. The flowering phase also shows a different pattern in different land-use types. We suggest that allergenic plants should be avoided in urban planning, especially the exotic species, and people with pollinosis should stay away from places with more allergenic plants.

Key words: Allergenic plants, plant diversity, urbanization, plant community.

Effects of sacred forests on local biodiversity of urban and suburban areas

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Most forests and green spaces in urban areas are fragmented and reduced by uniform spatial development. As a result, natural spaces that serve as a breeding ground for diverse wildlife are greatly reduced in urban areas. In this study, the effects of location and design of sacred places such as shrines in urban or suburban areas on the biodiversity of forests and green spaces in these areas were examined by two approaches. In the first approach, the distribution morphology of small open/green spaces in an urban area was examined. In the second approach, the locations of shrines, temples, parks were analyzed by GIS. It was found that shrines and parks tend to be dispersed and temples tend to be concentrated in certain areas. 68% of shrines have been built on slopes. To investigate the geographical features and their relationship with ecological resources, a continuous green space was generated by forming a buffer between the spaces of forests that include shrines and the surrounding green spaces. This analysis showed that the main building located on the downward slope shows either a high green preservation function or a low one. It was conjectured that this difference derives from the relationship between the entrance path and the steep inclination.

Key words: urban forest, sacred forest, green space.

Spatial analysis of remaining forest in the urban context as subsidy for the establishment of protected areas

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This study aimed to diagnose the distribution of fragments of natural vegetation in the city of Sorocaba /SP/ Brasil, and identify priority areas for conservation through the use of landscape metrics to support the creation of protected areas (PA). The remnants of natural vegetation were mapped (1:2.000) through a vectorization screen using aerial photographs with scale 1:20.000 from 2006. Theses metrics were generated from the map of priority areas for conservation: Area (hectares) POX (connectivity between fragments) and SHAPE (relationship between perimeter and area). The metrics were valued and assigned a weight. The results showed a high degree of habitat fragmentation, with only 16.7% of municipal land with forest cover, and 62% of fragments smaller than 1 ha, with

the largest fragment of approximately 300ha. The areas with the highest priority for conservation are located in the southeast region, where most of rural areas still exist. Another high priority area appeared on the watershed Pirajibú. Except for the public area called Parque Municipal Mário Covas, the other fragments with very high priority areas are on private properties. The present situation of the scarcity of forest remnants in the city generates a demand for immediate action for conservation and ecological restoration. Whereas the expansion of the city is an ongoing process, plans for urban and industrial expansion should be integrated into the plans of conservation and restoration of natural areas, as provided in Municipal Environmental Policy.

Key words: protected areas, urban landscape, priority areas for conservation, urban planning.

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Green Landscapes – Designing Sustainable Landscapes in an African Context

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The Department of Forest and Wood Science was recently awarded a South African National Research Foundation Grant under the banner of Global Change, Society and Sustainability theme for a three-year programme on Green Landscapes – Designing Sustainable Landscapes in an African Context. The aim of this research programme is to develop applicable Decision Support Systems (DSS's) with which to identify management pathways and subsequently develop spatially optimised land-uses in the broader African landscape. The practice of combining spatial ecosystem models with DSS's is currently being applied at the frontiers of scientific research worldwide. However there are currently no applicable or similar systems available for specific sub-Saharan African conditions. Ultimately the scientific challenge is not multi-criteria decision making itself but rather the models' necessary to produce the input for decision making. These models, which rely heavily on the spatial arrangement of land-use forms, must establish the ecological, production oriented and socio-economic variables used to fuel the decision making process. Thus the development of specific DSS's, based on Multiple Path Theory and system-based models are seen as the main output of the programme. They will in turn aggregate information in such a way that it can be used by all stakeholders involved in land-use and land-use management. This programme will serve as a platform from where a large number of postgraduate students from various disciplines such as forestry, soil science, conservation and social sciences can work together towards the development of a DSS.

Key words: spatial ecosystem models, decision making, forest.

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