

1st

LaSys

Workshop

24 - 26 October 2005

Tune Landboskole, Greve, Denmark

Processes, drivers and scales of global change

Danish land system research in a global perspective

Organizer

Danish Network for Land System Science (LaSys)

About LaSyS

”Danish Network for Land System Science” (LaSyS) is a multidisciplinary research network addressing the challenge of bringing together leading Danish research groups who work with human dimensions of global change, specifically issues related to the use of land. It receives funding for a set of workshops 2005-2007 from the Danish research councils (SJVF). The following Danish institutions are the responsible organizers (*Italics indicate contact person at various institutions; IGUC is coordinating institution*):

1. Institute of Geography, University of Copenhagen (professor Anette Reenberg)
2. Department of Agricultural sciences, KVL (professor John Porter, Lektor Jakob Magid)
3. Department of development and planning (professor Per Christensen, lektor Finn Arler)
4. Department of Earth Sciences, University of Aarhus, AU (professor Bent Odgård)
5. GEUS (seniorresearcher Richard Bradshaw)
6. Department of Agroecology, DJF (professor Jørgen E. Olesen)

More information about the network can be found at: <http://www.lasys.dk>

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Danish land system research in a global
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Danish Network for Land System Science
(LaSyS)

18. oktober 2005

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Del I
Program

LaSyS workshop Program

Monday the 24th

11.30 Arrival and check-in

12.00 *Lunch buffet*

The Broader Perspective

Chairperson 13 – 15: Anette Reenberg

13.15 Reenberg & Porter Introduction to the workshop

13.45 A. Mather Understanding land-use trends

14.30 *Coffee break*

Chairperson 15 – 18: John Porter

15.00 M. Rounsevell Modelling approaches for the assessment of land use change

15.45 F. Arler Mountain Thoughts and Human Thoughts - The Ethics of Large Scale Change

16.15 J. E. Olesen Climate change effects on agricultural production and nutrient losses

16.45 Poster presenters Introduction to posters

17.45 -

18.00 *Two course dinner*

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Poster session

- 20.00 P. Kenderessy & A. Veihe Regional soil erosion assessment in Slovakia using modelling and farmer's participation: a case study from Pariz creek catchment based on Erosion 3D
- I. T. Kristensen & P. K. Bøcher Danish Farm Register Information at Different Spatial Resolution Using the Danish Square Grid
- A. Veihe Regional planning and modelling of nitrate leaching in Denmark using DaisyGIS
- L. Vesterdal Afforestation management in north-western Europe - influence on carbon sequestration, groundwater recharge and nitrate leaching
- T. Birch-Thomsen *et al.* Temporal and spatial trends in soil organic carbon stocks following maize cultivation in semi-arid Tanzania, East Africa
- J. Jakobsen The Role of NTFPs in a Shifting Cultivation System in Transition - A Village Case Study from the Uplands of North Central Vietnam
- A. de Neergaard *et al.* Shifting cultivation as soil conservation: soil erosion in two smallholder farming systems in Sarawak, Malaysia
- I.G. Schiøtz and A. Veihe Processes, drivers and scales of global change - Danish land system research in a global perspective
- S. Bruun and J. Magid Estimating SOC turnover for assessment of land management changes in a global change perspective
- A. B. Nielsen Using Danish historical maps in pollen based quantitative land cover reconstruction: Model validation and parameter estimates

Coffee

LaSyS workshop Program

Tuesday the 25th

Danish research on land systems in developing countries

7.45 **Breakfast**

Chairperson 9 – 10: Jakob Magid

9.00 T. Birch- Thomsen & J. Agergaard Transitional rural landscapes: Land use, mobility and livelihoods in Post-Apartheid rural Kwa Zulu Natal

9.20 T. S. Hansen Land use and land cover dynamics in response to local-to-global socio-political forces: successive waves of change in Sarawak

9.40 S. Bolwig *et al.* Crops, Trees, and Birds: Biodiversity in Uganda's Farming Systems in Relation to the Intensification of Agricultural Land Use

10.00 **Coffee break**

Chairperson 10.30 – 12: John Porter

10.30 J. Magid & J. Færge Evaluating nutrient balances in Sub-Saharan African Agriculture - assessment of the NUTMON approach

10.50 T. T. Nielsen Long term trends in African vegetation productivity, land cover and desertification risk

11.10 R. L. Folving *et al.* Land tenure and farming system transformations in the North Central Vietnamese Uplands – Village studies from Nghe An Province

11.30 Introduction to group discussions

12.00 **Lunch buffet**

13.15 Group discussions: Round table discussion – Pin board exercise

Del II

Oral presentations

1 Mountain Thoughts and Human Thoughts - The Ethics of Large Scale Change

F. Arler

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In his famous essay on "Land ethics" the American ranger Aldo Leopold uses the metaphor of "thinking like a mountain" in order to underline the need to think in large scales when decision about land management are made. Human scale is different from mountain scale, however. The mountain perspective can only be one out of several. In this paper I shall a) bring attention to some examples of mountain scale changes, the knowledge of which already has or are likely to influence human priorities, b) try to identify the various interests human beings may have in taking on the mountain perspective, and c) identify some of the reasons why it is not sound always to try to think like a mountain

2 Climate change effects on agricultural production and nutrient losses

J. E. Olesen

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The agricultural production is affected both directly and indirectly by the global climate changes. The direct effect occurs through the effect of increased CO₂ and changes in climate on the development and growth of crops. The crop production is affected indirectly through effects of climate change on soil fertility, need for fertilisers, occurrence of weeds, pests and diseases, and the possibilities for carrying out field operations.

The increasing crop yields that results from increased CO₂ concentration and climate change will increase the optimal nitrogen fertiliser rates. This effect was estimated for continuous winter wheat cultivation using the DAISY model for two different greenhouse gas emissions scenarios. There was in general an increase in optimal nitrogen fertiliser rates. In both scenarios there was an increase in nitrate leaching for a climate from Western Denmark, whereas there was a tendency for a reduction for loamy soils for a climate in Eastern Denmark. The environmental effects of climate change in Denmark may therefore vary regionally. The effects can mainly be attributed to changes in temperature and CO₂ concentration, because the effect of lower rainfall during the growing season is compensated by an increase in water use efficiency at higher CO₂ concentration. The model calculations showed a clear tendency towards higher increases in nitrogen leaching under climate change for the sandy soils compared with the loamy soils. This is an effect of an increase in soil organic matter turnover rates at higher temperatures and an increase in the duration of bare soil during autumn.

There are major uncertainties associated with the assessment of effects of climate change on agricultural land use, production and environmental impact. Uncertainties are associated with the future agricultural and environmental policies and the agricultural structure, which probably have larger effects for agricultural land use and crop choice than climate change. The highest uncertainties are associated with the assessment of the effects of climate change on environmental impact of agricultural production, which for nitrate leaching is caused by opposing effects of temperature increase and higher CO₂. There is therefore in this area a need to improve the models to enable a more reliable assessment of climate change effects. This is also the case for processes affecting phosphorus losses from soils.

3 Transitional rural landscapes: Land use, mobility and livelihoods in Post-Apartheid rural Kwa Zulu Natal

T. Birch-Thomsen and J. Agergaard

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Agrarian transformation and land use changes are central issues in post-Apartheid development in South Africa. Regulations for settlement, mobility and employment have changed dramatically since the early 1990es; however, Apartheid legacies nonetheless shape the current transformation of agrarian livelihoods and rural landscapes. The main purpose of this paper is to discuss trends in and social impacts of transitional rural landscapes. The paper focuses on a case study of these changes in a former homeland south of Pietermaritzberg. Analyses of map materials and aerial photos reveal a number of changes in land use and zoning of the landscape which can be linked to national and local historical changes in socio-economic and racial policies in South Africa during the 20th century. These data are combined with an analysis of local narratives of historical changes in demography and livelihoods, the importance of local politico-legal structures, and the current challenges in making a living in and of the land. The paper argues that despite the fact that ...

4 Land use and land cover dynamics in response to local-to-global socio-political forces: successive waves of change in Sarawak

T. S. Hansen

By Tina Svan Hansen

This paper employs a local case study of land use and land cover changes in oil palm growing region in SE-Asia to identify important traits of development pathways and driving forces. It specifically emphasizes the need to maintain a multi-temporal, multi-scale and multi-disciplinary perspective combining theoretical lines of thought from landscape ecology, land change science, geography, as well as political science. First, it presents the development and contemporary conditions of two co-existing land use systems in Sarawak: shifting cultivation and large scale palm oil production. Documentation is drawn from satellite based mapping of land cover and interview based surveys. Then, it illustrates how the development can successfully be described by combining a composite set of conceptual analytical approaches. It concludes by discussing how insight into past and contemporary land use dynamics can constitute an important basis for designing sustainable land use planning strategies.

5 Crops, Trees, and Birds: Biodiversity in Uganda's Farming Systems in Relation to the Intensification of Agricultural Land Use

S. Bolwig *et al.*

By Simon Bolwig¹, David Mushabe², David Nkuutu³, Derek Pomeroy² and Herbert Tushabe⁴

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⁴ National Biodiversity Data Bank, Kampala.

Introduction

It is widely recognized that agricultural change is an important driver of biodiversity loss: the expansion of populations and commodity markets causes the conversion of natural vegetation into farmland and its intensifying use, which in turn renders the remaining natural habitats smaller, more fragmented, and less diverse. Recent evidence moreover shows that the effect of farming on wild nature is now greater in developing than in developed countries (Green et al, 2005). For example, an analysis of BirdLife International's World Bird Database (the most comprehensive of all taxa) indicated that farming is the major current and likely future threat to globally Threatened and Near-Threatened bird species, especially in developing countries where 1726 out of all 1923 birds in these threat categories are found (Ibid). Farming is at the same time the major source of income (and food obviously) for a growing number of poor rural households in developing countries, suggesting an acute and mounting conflict between species persistence and human well-being. Global patterns such as the above mask significant variations among different regions and species with respect to the determinants and rate of biodiversity loss, which are important for the design of policies that minimize the trade-offs between conservation and poverty reduction in particular environmental and socio-economic settings. With this in mind, and to add to the global pool of knowledge on farming - biodiversity linkages, the current study was carried out to improve the understanding of how agricultural intensification in a poor and densely populated developing region (Uganda) affects the abundance and species richness of woody vegetation and birds.

The local context

The study area is the western and central regions of Uganda, which straddle the equator in the humid tropics. Cooking bananas, sweet potatoes, cassava, coffee and maize in some places are the dominant crops in terms of area covered. Crops are frequently mixed in what is commonly referred to as the coffee-banana system. Trees are abundant on and around farms. Natural habitats are characterized by a high abundance and species richness of birds and trees, while the population of large mammals have been decimated over the last three decades. The following characteristics suggest a very high current and future pressure on biodiversity resources. Human population densities are high and increasing rapidly (around 3 % p.a.): in 2015 most localities will have more

than 100 persons per square kilometre and many above 400 persons, according to predictions reported in Bolwig et al (2005). Urban markets for food and wood products (timber, charcoal) are expanding and are easily accessible in most places (Ibid). Crop yields per area unit are low and generally stagnant (Nkonya et al, 2004). Non-farm income is less important for rural livelihoods than in many other African regions.

Data and methods

Because agricultural intensification is likely to affect different species of birds and trees in quite different ways, a classification was done for each taxa. Trees were classified into native and exotic species, while birds were grouped according to specialisation (particularly with respect to their dependence on trees/forest) and conservation status. Data were collected on land use, woody plants, and birds in 14 study sites in crop-based farming systems in the western and central regions of Uganda. The sites differ with respect to the intensity of land use (share of total farm land occupied by crops) and the scale of farming (smallholder farms versus commercial plantations). Most were selected among existing BirdLife bird long-term monitoring sites and a few were new sites. This design allowed for both cross-sectional and time-series analysis. A defining feature of the study is the use of data collection methods that have rarely been combined: survey of agricultural land use and land cover, survey of woody vegetation, and survey of birds. Two methods for surveying agricultural land cover/use were used: transect walks, configured from the route followed by the bird surveyor, to collect data in smallholder systems, and boundary mapping for large-scale systems. Agricultural land use was characterized principally through different measures of cultivation intensity and secondarily through crop diversity and cropping patterns. Biodiversity was assessed by the occurrence of different tree and bird species. Data on tree species were captured from 20m radius plots, placed 50m apart along the transect, while the occurrence of birds and their relative abundance were surveyed by Timed Species Counts (TSCs). We used predictive modelling and scatter plots (regression analysis of cross-sectional data was of limited use due to the small number of study sites) to examine the relationships between land use and biodiversity variables. One limitation of the study is the small number of study sites surveyed (that moreover are stratified into small-scale and large scale systems); a minor weakness is the somewhat basic characterization of larger-scale land use patterns around the sites. A larger, ongoing research project modelled on the current one is improving on these and other elements of the research design (BTO, 2005).

Results

The large-scale farming systems had very uniform land uses, while there was considerable variation in land use variables among smallholder sites. The cultivation intensity (area with crops / area with crops and fallow) was 1.00 in all four large-scale sites, and ranged between 0.26 and 0.98 in the eight smallholder sites. Land in smallholder sites in central Uganda is more intensively exploited than land in our western sites. This may be attributed to the differences in market access and population density between the two regions. Similar patterns were found for other indicators of high land use intensity - short fallow period, low proportion of natural vegetation, and dominance of mono cropping. All large-scale sites were mono cropped, as expected. Mixed cropping dominated most smallholder sites; the proportion of mono crop in total cultivated area ranged between 0.20 and 0.78 for these sites. Land use in the smallholder sites was

dominated by a few staple foods, notably bananas and root crops (cassava and sweet potatoes) that together made up between 25 % and 83 % of total cropland. Maize was important in two sites. Coffee, Uganda's largest export crop, on average only covered 10 % of cropland, while cotton was found in one site. This confirms the common observation that Ugandan smallholders are mainly subsistence oriented, although some of the food crops may also be sold. We recorded a total of 270 woody plant species in all the 14 sites, of which about 70 % were indigenous species. As expected, large-scale agriculture was associated with a considerable loss of woody plant species richness compared to smallholder farming, especially for native species. Results also indicated that woody biodiversity is not only affected by the scale of farming but also by farm ownership; large blocks operated in common by small farmers thus showed higher species richness than commercial plantations. For the smallholder sites, a negative relationship between cultivation intensity and woody species richness indicators was only found at the extreme ends of the cultivation intensity gradient. We found the same patterns for woody canopy cover as reported above for woody species richness. A total of 241 bird species were recorded in the 14 study sites, representing 24 % of the total for Uganda and 40 % of the birds living in that part of the country. All the bird species are indigenous. The Angola Swallow, Common Bulbul, African Thrush, Grey-backed Camaroptera, and Bronze Mannikin were found at every site, and the Tawny-flanked Prinia missed only one. Conversely, 69 species were recorded from only a single site. There was a very low presence (ten or 5 %) of Uganda's forest specialist species, and mostly in very small numbers. This confirms Naidoo's (2004) observations that these species are, as expected, on the whole unable to survive outside forests. Time-series analysis provided little evidence for a decline in birds, at least over the last 8-15 years, in the agro-ecosystems with highest biodiversity (less intensively cultivated smallholder farms). Yet when comparing across study sites, we found strong evidence that species are progressively lost (with only a few gains) as agriculture is intensified. Losses are greatest amongst the more specialized species, which are also those of greater conservation concern. Large-scale plantations had much lower levels of biodiversity than smallholder farms. (Time-series data were not available for large-scale systems.) The comparison of predicted (based on original natural vegetation) versus actually recorded bird species showed a significant negative effect of smallholder farming on birds, especially with regard to forest specialists species, and a much larger effect of large-scale agriculture. The effect was bigger for high-intensity smallholder farms compared to low-intensity farms, except in the case of generalist species. Large, charismatic species such as the Long-crested Eagle, hornbills and parrots, were scarce or absent from high-intensity cultivations. Whilst all trees are important for birds, we found strong evidence that native species support a larger numbers of birds than exotics. It is likely that native trees provide more food for birds, while exotics may be just as good for roosting, and possibly nesting. The current farmer preference for planting exotics, especially eucalyptus and pine, may therefore well lead to a decline in many important bird species. We were not able to examine the importance to birds of different spatial patterns of woody vegetation, but higher degrees of patchiness - i.e. clumping - are likely to be beneficial.

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6 Evaluating nutrient balances in Sub-Saharan African Agriculture - assessment of the NUTMON approach

J. Magid and J. Færgé

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Keywords: Nutrient balancing, NUTMON, sub Saharan Africa, transfer functions, N leaching.

Nutrient balances for the last two decades in Sub-Saharan Africa (SSA) reveal, almost unequivocally, alarming nutrient deficiencies. The nutrient balancing in SSA was initiated by Stoorvogel & Smaling (1990) and Smaling et al. (1993). Their widely cited nutrient monitoring (NUTMON) concept is conducted as input output analysis. Inputs are fertilizers, mineral and organic, wet and dry deposition, nitrogen fixation and sedimentation. Outputs are harvested crops and residues, leaching, denitrification and erosion. Nutrient flows, as fertilizers and harvested crops are in general measured or estimated by interviews, whereas flows that are difficult to quantify, such as leaching, denitrification and erosion, are modeled by means of transfer functions mainly elaborated by the NUTMON initiators. Generally, for the NUTMON studies the average losses worked out by means of transfer functions, seem high in comparison to similar rates in high input agriculture in temperate regions. Therefore, we decided to review some of the original transfer functions and their impact on the NUTMON calculations. The review revealed that the transfer functions have a strong tendency to overestimate losses. No attempts have been made to validate whether the modeled losses are consistent to empirical measurements for the actual locations for which the nutrient balances have been applied. Contemporary NUTMON studies rely on the original transfer functions, as well as the original assumptions employed in the parameterization. Therefore, NUTMON balances are bound to reveal alarming nutrient deficiencies, no matter what the SSA farmers do.

7 Long term trends in African vegetation productivity, land cover and desertification risk

T. T. Nielsen

By Thomas Theis Nielsen, Institute of Geography, University of Copenhagen, Østervoldgade 10, DK-1350 Copenhagen K. Denmark

In this study we examine 18 years of continental NOAA AVHRR data. Each year the vegetation productivity is estimated using the integrated vegetation index. Based on the 18 years of productivity estimates a linear regression is applied and for each 64 square kilometer pixel the inclination and intercept of the best-fit line is calculated. This is used to calculate the double time, i.e. the number of years needed to double the amount of vegetation productivity in a given pixel. Much in contrast to what could be expected large parts of the Sahel exhibits a very high increase in vegetation productivity and only rarely is decreases observed. These trends are analysed in relation to precipitation regimes and vegetation types and to the GLASOD map of risk of human induced land degradation. We find no correlation between the GLASOD map and the results of the trend analysis. The contrafiction between this lack of correlation is discussed in more detail and it is argued that there is no direct contradiction.

8 Land tenure and farming system transformations in the North Central Vietnamese Uplands - Village studies from Nghe An Province

R. Folving *et al.*

By Rikke Folving, Jens Jakobsen, Kjeld Rasmussen
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This paper examines a land allocation process currently taking place in the Uplands of Vietnam as part of the transition towards a market economy occurring in the socialist republic, since the late 1980ies. The Vietnamese uplands are inhabited by various ethnic groups, which traditionally have relied on shifting cultivation for their livelihoods. Customary land regulations have prevailed and existed contemporarily with the collective farming period, allowing for the traditional farming system to prevail. Since the land allocation was effectuated by law in 1993 long term usufruct rights to fixed fields are being transferred to individual households in the uplands, which is in conflict with the traditional practice of shifting fields. The argument of this article is that unless enough land is allocated for farmers to continue their shifting practice or alternatively a farming system transformation involving agricultural intensification is taking place, falling yields is a realistic risk in the near future. This paper is based on preliminary findings from a comparative case study in the upland districts of Nghe An Province in North Central Vietnam carried out in 2003 and 2005, consisting of five in-depth village studies of various ethnic minorities covering changes in their farming system and livelihood strategies, occurring during the implementation of the land allocation.

9 Multifunctionality and ecosystem services in european agriculture

J. R. Porter

By John R Porter

Multifunctional farming is a land use that can expand the provision of agro-ecosystem goods and services. The presentation will outline a possible future of a more multifunctional European agriculture, applying different strategies in order to improve its production of a wider array of ecosystem services.

Ecosystems provide us with air to breathe, ecosystems supply clean water, ecosystems recycle our waste. These and other unpaid-for ecosystem services underpin the ability for humans to live on this planet. Ecosystem services could be defined as the benefits that humans derive from the functioning of local and global ecosystems. Without these services, derived from ecological life support systems, market economies could not exist. There is a link between the notion of ecosystem services and multifunctionality in farming systems. A multifunctional farming system produces not only a variety of harvested components but also biogeochemical cycles within the farming system (such as the cycling of carbon, nitrogen and other elements), pollination services and enhancement of biodiversity. Within the framework of the UN Millennium Assessment, four subgroups of ecosystem services have been identified:

- o goods, primarily food, but also fibre and biomass for energy;
- o regulating services, such as the fluxes of carbon dioxide between the vegetation and the atmosphere which affect the regulation of the global climate system;
- o supporting services, for example the decomposition of organic matter which is crucial in soil formation;
- o cultural services, non-material services such as recreation, cultural and aesthetic values.

The paper will consider the ecosystem service situation in Europe in the current 25 EU countries where there are 378 million hectares of 'cultivated' land, i.e. agricultural land, urban areas, roads and other infrastructure. The presentation will consider the current ecosystem service value of such land and how it might change with different management.

10 Developments in agricultural land systems research and methodologies for the upscaling of farm level information

T. Dalgaard *et al.*

-Perspectives of seven research projects at the Danish Institute of Agricultural Sciences 1996-2006.

By Tommy Dalgaard, Chris Kjeldsen and Nick Hutchings. Danish Institute of Agricultural Sciences. Department of Agroecology. P.O. Box 50. DK-8830 Tjele, Denmark. www.agrsci.dk

During the 1990es, Danish Institute of Agricultural Sciences was involved in a number of national land systems research projects. Here, we aim to review four of these projects, from which results and methodologies are further developed in three recently initiated EU sixth framework research projects (www.mea-scope.org, www.sensor-ip.org, and www.neu.ceh.ac.uk). Two of the Danish projects, focused on the spatio-temporal developments in agricultural resource use (Dalgaard et al. 2001, 2002a; Dalgaard and Kyllingsbæk, 2003), while the two others had a broader focus on scenarios for landscape development, and the consequences for a sustainable development (Dalgaard et al., 2003). In these studies, state of the art techniques for the combination of digital land use registers with Geographical Information Systems was developed (Dalgaard et al. 2002b; Hutchings et al. 2004), and a common framework for the upscaling and synthesis of results from different research disciplines was derived (Dalgaard et al. 2003). The challenge is how to apply this framework outside Denmark, where less data is available, and other research agendas are in focus.

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11 Plant life form based habitat monitoring in a European landscape framework for early warning of changes in biodiversity

J. Brandt *et al.*

By Jesper Brandt, Martin Olsen and Margit Bloch-Petersen

During the last 25 years different programs for detailed landscape surveys based on stratified area covering sampling in landscape grids of $\frac{1}{4}$ to 4 km² have been carried out in a number of European countries with slightly different methodologies and perspectives, developing towards permanent landscape monitoring systems. In the intensively used Danish agricultural landscape it has been natural to concentrate on the dynamics of small biotopes. An area covering landscape monitoring program with emphasis on small biotopes (SBMP) has developed since 1981, and a continuation of this monitoring within the NOVANA program is planned for the future. During the last many years these different national landscape surveys have cooperated to develop a European platform for consistent habitat recording and monitoring. This has been realized through the EU BioHab concerted action in the preparation of a common European Field Monitoring Handbook as a user-friendly tool in support of implementing the Habitat Directive, including NATURA 2000, and linking scientific and policy-oriented European projects. The overall European monitoring role of the BioHab framework is to establish a landscape-based connection between the remote sensing-based monitoring of the environment and the site specific indicators of biodiversity. The landscape-based framework permits a methodology for an operational monitoring that can serve as an early warning system, relating changes in biodiversity to changes in habitat composition and quality.

The focus on essential features of the habitat that can be expressed quantitatively for identification and mapping of small but significant changes at a landscape level has resulted in the reintroduction of Raunkiers plant life-form concept from 1908 as an essential approach in the BioHab project, since plant life-forms to a high degree define the structure of the habitat and thereby the habitat's quality for the species assemblage.

Although plant life form has only partly been included in the Small Biotope Monitoring Program (through the registration of agricultural land use, general land cover and tree and shrub cover of small biotopes), it has not been difficult to adapt the SBMP-monitoring system to the BioHab framework, thus permitting the monitoring system to deliver an additional important European perspective with only very limited extra resources involved.

12 The effect of organic farming on rural landscapes - results from a Danish case study

G. Levin

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Implying changes in land use practices, the conversion from conventional to organic farming has a potential effect on the spatial arrangement of land cover and thus on structure and content of natural and semi-natural landscape elements. Within the political and public spheres there exists an expectation of organic farming practices improving nature content in agricultural landscapes. A positive effect of organic farming on content and diversity of wild flora and fauna on the land in rotation and in edge biotopes is relatively well documented. However, effects of organic farming on content and structure of natural and semi natural landscape elements are not well re-searched. In the light of extensive conversion to organic farming in Denmark, especially since the mid 1990'ies, this project investigates differences in the landscape between organic and conventional farms and looked into landscape dynamics following conversion to organic farming. The study was conducted for 3 case areas in Denmark covering a total of 44 organic and 72 conventional farms. On basis of aerial photos from 2002, land cover was registered and densities of different natural and semi-natural landscape elements were calculated at farm scale. In order to investigate landscape changes, land cover was also registered for 1999, 1995 and 1982. Farm specific data on production type and farm sizes were derived from agricultural registers and slope and soil data were obtained from biophysical base maps. Results show no significant difference in content or structure of natural and semi natural landscape elements between organic and conventional farms. Neither were any clear landscape changes following conversion to organic farming found. However, significant relationships were found between content of different natural and semi natural landscape element and slope and soil conditions on the investigated farms. Furthermore, farming styles, in terms of production types and farm sizes have shown significant relations to content of natural and semi natural landscape elements and to temporal dynamics within these. In general small-scale mixed farming seems to have the most positive effect on content of linear and patch biotopes. These results support earlier findings on the importance of farming styles for management of the rural landscape. Further-more, it feeds into a general discussion of the role of organic farming as an alternative to conventional farming.

13 Evolving institutions of landscape planning to accommodate the need for groundwater protection in Denmark

P. Christensen

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The use of groundwater resources has become one of the most discussed and regulated resources of the Danish countryside. Groundwater forms the basis for supply of drinking water and forms the basis for sustaining much of the Danish biodiversity. The importance of water is underlined in much of the institutional set-up that has been created during the last century. Based on an institutional theory background the development of institutions - in their broadest sense - is depicted ranging from everyday notions of the importance of clean drinking water to the legal requirements of groundwater protection as they recently have been framed to wrestle with the problems of regulating modern farming practices in the constantly growing sector of pig-production in Denmark.

14 The urban - rural gradient

O. H. Caspersen

A comparative study of the peri-urban development in Greater Copenhagen and St. Petersburg

by Ole Hjorth Caspersen Roskilde University dept. of Geography

Keywords: Peri-urban, ecological footprint, ecosystem service

The accessibility of urban green areas and how this is managed within city development are increasingly being acknowledged as an important factor on human welfare. This presentation addresses the implications of differences in the peri-urban ecological structure and functioning in a time perspective. It is based on empirical research of the peri-urban zone of Greater Copenhagen and St. Petersburg and is conducted by the use of GIS and remote sensing technologies. Furthermore it is based upon a close co-operation between planners and researchers in the two cities. Distinct differences in the development of peri-urban zone are recognised in the two cities that can be related to significant differences in planning structure. But both cities have developed a zone that supplies ecosystem services to the inhabitants. Nevertheless pressure for future development within this zone is great in both cities. The case from greater Copenhagen indicates that this development has had a great impact on the structure and use of the peri-urban ecosystem and when considered in a time perspective of 50 years the peri-urban ecosystem has changed significantly which has generated major ecological changes. However a still more developed legislation has helped to secure the ecological footprint around the urban structure. The case from St. Petersburg on the other hand illustrates the consequences of a less proactive planning structure and the difficulties in controlling and maintaining the ecological footprint of the greenbelt around St. Petersburg.

15 Land system changes in the context of urbanisation: examples from the peri-urban area of Greater Copenhagen

S. Præstholt *et al.*

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The paper investigates land change processes in the vicinity of metropolitan areas based on a case study in traditional agricultural areas in the Greater Copenhagen region. Peri-urban areas are characterized by rapid changes of land use due to urban sprawl. In both developed and developing countries, agricultural areas surrounding major cities have been converted into housing areas, infrastructure, industrial areas etc. and left some metropolitan regions with a very high percentage of artificial surfaces. Concomitantly, the processes of urbanisation have affected the land use and social structure of rural communities near urban agglomerations. For a variety of reasons, farm properties in peri-urban areas attract newcomers with little or no preference for agricultural production. They might search for a cheap housing alternative to those in urban areas, a nice living environment away from pollution and social problems in the city, more space for hobby activities or other qualities (van den Berg *et al.* 2000). The lifestyle of the new landowners might still be strongly attached to nearby urban areas in terms of social, cultural and occupational relations that are made possible by improved infrastructure and mobility. In addition, the structural development within the agricultural sector has forced many formerly full-time farmers to seek stronger relations to nearby urban areas e.g. commuting for off farm-work or engaging in agro-tourist activities (e.g. bed-and-breakfast). Whether the reason for the change in the land owners level of engagement in agricultural activities is a decline from full-time farming or a result of newcomers with marginal interest in agricultural production, the result is that a majority of European farms are now managed as part-time and hobby farms (Linares 2003). The traditional function of agricultural areas as supplier of agricultural products is in other words contested. Urban values and lifestyles encroach upon agricultural areas (Antrop 2000), and Amin *et al.* (Amin *et al.* 2002) argue that the "traditional divide between the city and the countryside has been perforate".

Based on quantitative data collected on agricultural properties in nine case study areas between 1984 and 2004 as well as qualitative information regarding land owners decision making and motives for land use changes, the paper seeks to identify key determinants of land use change. At the farm scale, primarily small hobby farms have raised the amount of extensive land uses such as extensively used grass lands and small lots of forest, leading to new biological and recreational opportunities at the local level. In addition, former agricultural areas have been turned into housing areas. On a regional scale, however, agricultural land use has continued largely unaffected by the processes of urbanisation. The land management system has been polarised, with a large number of small part-time and hobby farms contrasted with a few very large full-time farms, which are responsible for most of the agricultural production. Some hobby farms rent

out their lands to fulltime farms - leading to a mosaic of land ownership where most of the agricultural production is based on a mix of owned and leased land. In addition, the economic activities have been greatly diversified over the last three decades, resulting in a large number of other gainful activities taking place on the farms. Thus, land use decisions are being disconnected from local farm economy.

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16 Exploring local, regional and global drivers behind changes in function of landscapes and agriculture

H. Vejre

Henrik Vejre, Skov & Landskab, KVL - Danish Scientific Network for Multifunctional Landscapes and Agriculture

It is a well established fact that human activities on the land surface contribute to the complex phenomenon global change. The causes behind global change in terms of green house gasses induced climate change, encompass changes caused by deforestation, sealing of land surfaces, damming of rivers, flooding of agricultural land etc. Further the emissions of CO₂ from combustion processes, also suspected to spawn global heating, is driven by the energy consumption, of which a part is related to production activities on the land surface (agriculture, horticulture, etc).

The human activities on the land surface is commonly referred to as land use - in a broad context divided in main groups as urban, rural, agricultural, range, forest. Land use is often - but not always - a suitable indicator of the human activities taking place on a given tract of land. However, in many respects the concept of function better meet the need to characterize the extremely varied spectre of human activities and benefits obtained from land; present and potential land use and land services derived from a tract of land.

In contemporary landscape ecology, rural sociology, agro-ecology and agricultural economy the concept of function is commonly used to characterize land areas. To some degree land use and landscape function are synonyms, but many functions are not directly related to land use - and in accordance with the concept multiple use, the terms multifunctional landscapes and multifunctional farming denote some kind of integration of functions on the same farm, or in the same landscape.

The Danish Scientific Network for Multifunctional Agriculture and Landscape has done studies on the functionality of landscapes and farms. The studies have concentrated on conceptual development and models. The presentation summarizes the networks results and discussions.

Thorough analysis of functionality of agriculture and landscapes is a powerful tool to analyse drivers and processes behind change in functions, and subsequently land use change. Change in individuals and societal needs change the functionality of land areas, and this may in turn change land use and eventually land cover. Transdisciplinary studies are the key to the understanding of the links between wishes, land use and land cover.

The driving forces behind land use change may be divided in local, regional and global drivers. Local drivers encompass decisions made within the production unit or property. Decisions comprise typically the land cover, crops to be grown, irrigation, drainage, fertilization, establishment of shelterbelts and other biotopes. Regional drivers encompass typically legislation and policies, subvention schemes etc. that regulate the primary actors' decision. Besides, regional market conditions, transfer of technology and capital determine land use and changes in land use. The regional level encompasses everything from the local landscape over the administrative region, the nation state to supranational bodies as the EU. The global drivers encompass trade agreements, typically in these years the liberalization of trade, but also non-negotiated drivers as the general urbanization, the counter-urbanization of post industrialized countries, and other global cultural phenomenon, as tourism etc. It is crucial

to emphasize that global drivers are also influencing regional and local drivers and vice versa - and that it often is impossible to distinguish strictly between levels. In this context, the scale issue behind drivers is very important. Aggregated local decisions may have regional and even global impact, and regional and global drivers may influence the local actors directly. The links between local decisions and global impact, and the role of the regional regulation of the primary actors are crucial to understand if global change is to be addressed actively. In this context, the concept of function in relation to landscape and agriculture is a key concept. The operationalization of the concepts of function and multifunctionality, and not least the links between sustainability and multifunctionality is the pathway to a more sound management of land areas.

17 Globalisation and the local agricultural landscape. Studying landscape changes in an international policy context

J. Primdahl and L. Kristensen

Jørgen Primdahl and Lone Kristensen, Skov & Landskab, KVL

Two international policy agendas are increasingly affecting agriculture and agricultural land-use, namely the so-called 'globalisation agenda' with liberation of the world food market as one of the important points and the 'sustainability agenda' with the integration of environmental costs into economic policies as one of the key issues. The EU Common Agricultural Policy, currently being reformed, is heavily influenced by both agendas with profound and partly unpredictable impacts on the future of European agricultural landscapes. However, public policy interventions are not the only drivers, changes of the market, technology and the urban-rural relationship are also affecting the agricultural landscapes in ways which in turn may result in new policy responses.

Although there is a rich literature based on interdisciplinary agricultural landscape research only little is available - in Denmark and internationally - on the policy dimension of agricultural landscapes. Consequently, the area is poorly developed, conceptually, as well as methodologically. This research gap may be explained by the complexity of the ways local areas adapt to and/or are affected by regional and global driving forces including policy interventions. A deeper understanding of the change process is nonetheless a prerequisite for adequate policy design within the two agendas and at all levels - as it is for regional and local actions in general.

Based on recent and ongoing research projects, the presentation will give an outline of relevant research, including reference to relevant parts of the 'globalisation literature' and - supported by concrete examples - provide basic concepts and models for the study of agricultural landscape change and policy interventions. The presentation will include discussions of structural (macro) as well as actor (micro) models of driving force-landscape-policy relationships and reflect on central concepts related to territory and space. Finally we suggest - for discussion - a number of research questions related to global changes and local space.

18 Millenium-scale land cover changes in Denmark

B. Odgaard

By Bent Odgaard

Estimation of long-term land cover changes may help understanding mechanisms of land cover changes and links to land-use, erosion rates, socio-economic development and climate change. So far, the time range of such estimation has been limited by the availability of remotely sensed data, land cover/land-use statistics and historical maps. In the project AGRAR 2000 a multidisciplinary approach has been developed for the estimation of past land cover changes in Denmark through the last 2000 years. For the longer time scales the approach uses a combination of archival sources, place names, archaeological data as well as sedimentary pollen for estimates of past land cover. Although limited in temporal resolution estimates of past land cover from archaeological data allows inferences to be made about the spatial organisation of land cover units. In contrast, estimates based on sedimentary pollen allow higher temporal resolution but little spatial resolution.

In the period before AD 1800 three major landscape units can be identified dominated by either heathland, by agricultural land or with a fair representation of woodland. These units follow separate trajectories through the last 2000 years. The woodland unit generally occupied areas with a high topographical variation. An expansion of woodland cover can be identified in the period AD 400-600 and a decline of woodland is seen either in the Viking Age or in the medieval time. The heathland unit experiences general decline in woodland cover and a parallel expansion of heathland until the 17th or 18th century. At the same time heathland landscapes tend to transgress into areas formerly occupied by the agricultural unit. The agricultural unit can be divided into central areas and more marginal ones. In the central areas little woodland dynamics is observed but there is a change from pastoral landscapes towards landscapes with more crop cultivation. In the marginal areas quite strong dynamics involving expansion and contraction of woodland is observed. Generally, border zones between landscape units show the strongest long-term dynamics in land-cover. After AD 1800 the landscape units seem to become more complex. Numerical classification of parish-scale land cover data document the transformation of heathland landscapes into landscapes dominated by crop cultivation or afforestation. The land cover changes during the last two centuries are dramatic but comparable rates in land cover changes may be suggested for some prehistoric and historic intervals.

19 Classification of the Danish landscapes based on land use data - a historic analysis

P. Frederiksen

Pia Frederiksen, Bernd Münier and Jørgen R. Rømer

Various classifications of the Danish cultural landscape have been carried out based on geomorphology, soil properties and expert interpretations of data on agricultural potential and productivity, among others. The present study attempts a digital classification of the cultural landscape at three periods during the last 200 years, based on land use estimations at parish level. Land use has been estimated for 6 land use classes in 1800, 1881 and 1998. The data has been derived from sources of very different origin, such as old maps and agricultural and land use statistics, giving rise to various degrees of uncertainty related to the different land use classes and time periods. For each year an automated classification was carried out based on transformed land use data and digital statistical analysis. The resulting land use maps from the three periods confirms well-known developments in the Danish landscapes, but gives an overall view of the national development in the period.

20 Spatial indicators for landscape development in Denmark - GIS-based analysis of long term changes and persistence

B. Münier *et al.*

by B. Münier^a, P. Frederiksen and G. Levin

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Continuity and history of land cover and landscape patterns is an important but often neglected dimension when assessing biodiversity at a landscape scale. The development of agricultural landscapes in the wider countryside of Denmark throughout the last 2000 years has been investigated within the multidisciplinary Danish research project 'Agrar 2000'. The sub-project 'Natural amenities in agricultural landscapes - changes and mechanisms' focuses on semi-natural areas, forests and agriculture at three study areas of about 100 km², selected around Danish lakes. Sets of topographic maps covering the 4 periods from mid 1800 until present have been digitised and overlaid to form a spatio-temporal map-database, allowing analysis of each individual tract of land and its development over time.

The research presented focus on analysis of landscape persistence and relative changes as well as systematic landscape transitions. In a second step, the grain size of every land cover class inside each study area has been assessed using a multiple resolution moving window analysis. This reveals whether changes between two periods occur as swap of neighbouring land cover classes (e.g. cropland and grassland within one farm) or changes over larger distances, (e.g. forestation of heathlands in one part of a study area and cultivation in another part).

It can be concluded that analysis of historic and present landscape configuration and development can provide valuable information for nature conservation tasks and spatial planning. Results show clear regional and local differences in development trends related to the three study areas and their landscape types. A set of indicators is proposed, describing land cover changes, persistency and their spatial magnitude.

21 A fresh look at shifting cultivation: fallow length a weak indicator of productivity

Ole Mertz *et al.*

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Empirical evidence of the relationship between fallow length and crop yields in shifting cultivation is limited, despite such evidence being fundamental to understanding the ecology of this farming system and to shaping - often negative - opinions about its sustainability. We analyze longitudinal fallow and yield data from Malaysia and Indonesia, finding fallow length to be a weak predictor of yields, though interactions with fertilizer inputs may increase its importance. Other factors such as drought, flooding, and pests are more important determinants of yields. We conclude that earlier calls for bringing a "Green Revolution" to shifting cultivators are still relevant though in need of modification.

22 Patterns of continuity, change and adaptability in Sudano-Sahelian land use

D. A. Wardell and A. Reenberg

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Keywords: Africa; Burkina Faso; colonial forest history; Tiogo Forest Reserve; tropical dry forests; land use and land cover changes

This paper aims to contribute to the understanding of the interactions between humans and the biophysical environment in the management of tropical dry forests. It does so by exploring the patterns of land use changes in and around a forest reserve in a region of Burkina Faso distinguished by successive waves of out-migration and in-migration. It subsequently conceptualises the processes of change, and the forces driving change in an historical perspective.

A brief overview of the environmental history of forest reserves in Burkina Faso is presented. A conceptual model of Sudano-Sahelian landscapes encompassing tropical dry forests, agricultural lands and settlements is outlined. The model aims to capture the perspective of a hierarchical ordering of several temporal and spatial scales which are needed to understand the dynamics of land use systems. A detailed study of the land use changes monitored by use of aerial photography (1956, 1982 and 2000) is presented. The land use dynamic is discussed in the light of the analytical framework, and recent changes in forest policy that aim to foster greater local management of forest resources.

The governance of state forests continues to be based on negotiated and politically sensitive arrangements tolerating access by neighbouring villages. It is concluded that forest histories have important implications in understanding forest ecology and contemporary social and political relationships with forested land, in identifying coping strategies and adaptation to environmental stress, and in providing a frame of reference to assess contemporary patterns and processes.

Del III

Poster presentations

23 Regional soil erosion assessment in Slovakia using modelling and farmer's participation: a case study from Pariz creek catchment based on Erosion 3D

P. Kenderessy and A. Veihe

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There has been an increasing interest by decision makers to obtain regional assessments of soil erosion risk, whereas many existing models require substantial amounts of high quality input data with high spatial resolution and they are often only validated at the plot level. Operational models for regional assessments should be based on simple data requirements, must consider spatial and temporal variability in hydrological and soil erosion processes, and must be applicable to a variety of regions with a minimum of calibration. This study aims to assess the applicability of the Erosion3D model for erosion risk assessments at the landscape scale in Slovakia using a combination of quantitative and qualitative methods for assessing spatial prediction patterns. The model was set up for the Paráz creek catchment (239.93 km²) in south-western Slovakia. The area has been intensively cultivated primarily with cereals, sunflowers and corn and is characterised by poor cultivation practices and use of fertilizers leading to land degradation. As a first step, the initial raster-based modelling of soil loss and deposition has provided acceptable and realistic values. The predicted spatial patterns of erosion are now being identified using farmer participation to ensure that the 'correct' hot spot areas are being identified. In the end, scenarios will be set up to assess the effect of farming practices and/or conservation measures on soil erosion rates in the area.

24 Danish Farm Register Information at Different Spatial Resolution Using the Danish Square Grid

I. T. Kristensen and P. K. Bøcher

Inge T. Kristensen and Peder K. Bøcher, Danish Institute of Agricultural Sciences.

Agriculture in general represents one of the most significant impact factors in the modern Danish landscape, and it comprises an example of human-biophysical interaction par excellence. Our knowledge of important aspects of these interactions has increased and often, complex models have been constructed to simulate these interactions. Frequently however, when it comes to the modelling and parameterisation at local levels over large extents, there is a lack of relevant data at the necessary spatial resolution. In Denmark the National Survey and Cadastre, Statistics Denmark and others have produced a standard for which georeferenced data that are not usually available in "local" resolutions, if for example the data are assignable to single persons, may now be aggregated into standard square grids of different resolutions. The standard is denoted the Danish Square Grid. The General Farm Registers in Denmark holds data of many important kinds of relations between farms, farm properties, farmers, fields, crops, livestock etc. These data may be georeferenced in different ways; some may be georeferenced to the address of the farm property, some may be georeferenced to single field blocks, some may be georeferenced to all the field blocks managed by one farm etc. These differences in the spatial attributes of the data hinder or at least makes it difficult to use them in modelling. The Danish Institute of Agricultural Sciences have worked on making data from the General Farm Registers operational at different spatial resolutions using a method based on the Danish Square Grid. In this presentation we show details about the method and via some illustrative examples we put the method into a pragmatic perspective in the context of land system science.

25 Regional planning and modelling of nitrate leaching in Denmark using DaisyGIS

A. Veihe *et al.*

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Spatial deterministic simulation models such as DaisyGIS are increasingly being used for decision-making in European planning and there is a growing interest in using DaisyGIS as an administrative tool at the regional level in Denmark. The current study evaluates the use of DaisyGIS for nitrate leaching assessments based on nitrate leaching experiments carried out at the Marbjerg experimental site at Roskilde University. Limitations and implications of using existing data sources for assessing nitrate leaching at the plot scale are analysed by means of geostatistical analysis of soil and hydraulic variables and sensitivity analysis. The possibilities of regionalization using remote sensing are assessed and the use of remote sensing for deriving spatial information about the Leaf Area Index is evaluated. Finally, the use of DaisyGIS in counties and the implications for regional planning is discussed.

26 Afforestation management in north-western Europe - influence on carbon sequestration, groundwater recharge and nitrate leaching

L. Vesterdal *et al.*

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Clean drinking water and carbon sequestration in biomass and soils are among the possible environmental benefits from afforestation of arable land. The AFFOREST project (EU 5th framework programme) finished in April 2004 and a book is currently drafted for publication at Springer early spring 2006. The project has provided new information for scientists looking at ecological aspects of new forests and for planners aiming at optimizing the environmental performance of afforestation. The objective of the project was to quantify carbon sequestration, groundwater recharge and nitrate leaching following afforestation and to develop guidelines and tools for optimization of these environmental services by localization and management strategies.

The deliverables include a literature review (2001), field experiments in Denmark, Sweden and the Netherlands, and a guideline booklet on best management practices to optimize the environmental impact of afforestation (2004). Although written for afforestation practitioners, the guideline booklet is valuable for scientists as well, because it integrates results from work in field chronosequences in different countries with literature sources and expert knowledge. The project has also produced two tools. The METAFORE model is a mechanistic forest model, which predicts carbon sequestration, nitrate leaching and groundwater recharge for a range of climate/soil/afforestation practice combinations. The AFFOREST sDSS is a fully operational spatial decision support system programmed in a GIS environment. It is able to answer complex questions on where, how, how long and how much land to afforest to reach a certain environmental performance. All these products are available free of charge from the AFFOREST website (www.sl.kvl.dk/afforest).

27 Temporal and spatial trends in soil organic carbon stocks following maize cultivation in semi-arid Tanzania, East Africa

T. Birch-Thomsen *et al.*

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(preliminary version)

Conversion of native ecosystems to agro-ecosystems influences the amount, quality and turnover of soil organic carbon (SOC). As most agro-ecosystems are not in a steady state in terms of the content of SOC, the time scale and feedback mechanisms of changes in SOC are highly relevant for predicting future soil fertility and potential soil carbon losses or sequestration. The present paper focus on changes in land use linked to measured changes in the distribution of total stocks of SOC in the semi-arid parts of Tanzania. Based on documented land use changes since 1950s using remote sensing data, 12 sampling sites along two transects were selected to represent semi-natural/natural savannah and maize fields cultivated for up to five decades. Cultivated soils revealed significantly reduced concentrations of carbon and nitrogen in the top 0-10 cm and a total of 2-4 kg C m⁻² integrated over the top 50 cm. Comparisons between sites showed that a combination of age of field, fallow and farming intensity explain a 42 % reduction in SOC stock over the last 50 years of cultivation. This equals a C-loss of more than 400 kg C ha⁻¹ per year. This reduction was not found at sites which have been cultivated for more than 40 years and located near present or former villages. It remains uncertain to which extent such individual fields have received substantial manure. Ways of estimating the rate of soil element loss following cultivation is furthermore discussed in relation to produce region-specific tool for predicting future decline in crop- and soil type-specific soil elements following land clearing.

28 The Role of NTFPs in a Shifting Cultivation System in Transiston - A Village Case Study from the Uplands of North Central Vietnam

J. Jakobsen

By Jens Jakobsen

Non-timber forest products (NTFPs) often act as buffers in the livelihood strategy of shifting cultivation farmers in mainland Southeast Asia. In the upland village of Que in north central Vietnam, several different drivers are currently changing land use and land cover. The implementation of the Forest Land Allocation policy is one of the major driving forces, where shifting cultivation farmers have been allocated certain areas of land for shifting cultivation in order to prevent any further deforestation and land degradation. However, the reduction in agricultural land set aside for shifting cultivation has led to a severe decrease in hill rice production. As a response to the increased pressure on the shifting cultivation component, farmers have recently initiated cultivating paddy rice in the narrow valley bottoms. The land use system is in a transition phase - from a conventional shifting cultivation system into a composite swiddening system. The area under shifting cultivation is reduced, and the system is intensified via paddy rice cultivation, increased livestock rearing and commercial exploitation of NTFPs. For the time being, 40 of 69 households in Que village have established paddy rice fields, but especially lack of land and water makes any further expansion difficult. Thus, the current transformation of the system has resulted in a drastic reduction in overall rice production. However, the collection and selling of NTFPs such as bamboo shoots, broomgrass and pherynum leaves seem to prevent severe shortage of food. Farmers purchase food products from the money generated from the selling of NTFPs. Increased access to markets and traders has made it more profitable to collect and sell these products. Collection of NTFPs is no longer only subsistence-oriented, but also a commercial activity for most households. These products, together with selling of livestock, act as an economic safety net and appear to make most households able to deal with shocks and crisis.

29 Shifting cultivation as soil conservation: Soil erosion in smallholder farming systems in Sarawak, Malaysia and north Thailand.

A. de Neergaard *et al.*

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Shifting cultivation systems have often been considered "unsustainable" even at low intensity, due to the lack of nutrient replenishment of the soils, the reduced carbon inputs due to burning of vegetation, and the risk of soil erosion when clearing the land. The hill rice shifting cultivation systems in South East Asia are typical examples of such, and are particular prone to erosion due to steep slopes and intensive rainfall during the planting season. This study aimed at quantifying soil erosion and land degradation on various land uses in Borneo, Malaysia and Nan province, North Thailand. Land use types included undisturbed forest, shifting cultivation hill rice and more permanent plantations of pepper (Malaysia) and various fruit trees and permanent crops (Thailand). Soils were sampled to 90 cm depth and analysed for various physical and chemical parameters, including ¹³⁷Cs - a radioisotope homogeneously distributed on the topsoil during the radioactive fallout after the atmospheric nuclear testing in the 1950's and early 1960's. Soils were sampled from upslope, midslope and downslope areas on each field. The results showed very little evidence of land degradation as a consequence of shifting cultivation activities. Topsoil quality in undisturbed forest and hill rice was not significantly different, soil from pepper plantations were significantly lower in organic C concentration. However, over the entire profile (0-90 cm), there was no effect of land use on C content per m² surface, indicating that cultivation does not lead to major C losses. When comparing topslope and downslope samples from hill rice, certain cations as Ca, Mg and K were significantly lower at the top and midslope, indicating losses and accumulation at the foot of the slope. However, when comparing soil C, clay and P, there was no significant difference, indicating that there was no intensive soil erosion on the slopes. ¹³⁷Cs concentration in topsoil was highest in the undisturbed forest and lowest in the pepper plantations, intermediate in the hill rice. As for organic carbon, when corrected for soil density the difference between land uses were not significant. However, ¹³⁷Cs did appear in subsoil layers of downslope pepper fields, indicating a deposition of topsoil from upslope areas following erosion. In conclusion, shifting cultivation of hill rice did not result in significant soil erosion and fertility loss, even after numerous clearing cycles, whereas more intensive plantations did give indications of more substantial losses of topsoil from the slopes.

30 Processes, drivers and scales of global change - Danish land system research in a global perspective

I.G. Schiøtz and A. Veihe

By Schiøtz, I.G. and Veihe, A.

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Diffuse phosphorus loading from agricultural areas has been pointed out as one of the main threats to the ecological condition of the Danish aquatic environment. It is well known that agricultural practices combined with existing weather conditions play an important role when it comes to major soil erosion events in Denmark. This work presents a rainfall simulator study and results from plot studies in the Haraldsted catchment (12,5 km²) in eastern Denmark carried out during the winter 2001/2002. The aim was to obtain data to describe within catchment variability of soil erosion rates and their relation to various agricultural practices. The results are to be used at a later stage for spatial validation of soil erosion modelling predictions and for building up scenarios which potentially may be used for decision making regarding future land use and management. For the rainfall simulator study, a pressured, oscillating even spray nozzle rainfall simulator was used with a Hardi 37E nozzle in order to obtain low rainfall intensities characteristic of Danish conditions. Resulting soil loss rates and corresponding phosphorus contents are presented. The most sensitive areas in the catchment in terms of soil and phosphorus production are identified and the prospects of using rainfall simulator experiments for catchment based assessments and spatial model validation in the Danish environment is evaluated.

31 Estimating SOC turnover for assessment of land management changes in a global change perspective

S. Bruun and J. Magid

By Sander Bruun and Jakob Magid

Soil organic carbon (SOC) is an integral of the global C cycle representing two to three times as much carbon as contained in the atmosphere. As this carbon stock is influenced by land management, estimates of soil organic carbon (SOC) turnover are important in assessments of the effects of land management changes in a global change perspective. We examined the use of "bomb ^{14}C models" to estimate turnover times of SOC fractions. Our model uses an atmospheric ^{14}C record for the period from 22050 BC to 2003 AD and is based on a number of assumptions. First, it is assumed that there is no fractionation and that SOC fractions decay by first order kinetics. Second, it is assumed that the soil has reached equilibrium between decomposition and inputs, the inputs are constant, and the ^{14}C contents of the inputs are known. We used Monte Carlo simulations to estimate the uncertainties of the estimated turnover times, accounting not only for measurement errors but also for uncertainties introduced from assumptions of constant input and uncertainties in the ^{14}C content of the CO_2 assimilated by plants. The uncertainty of the estimates are quite small if the variation of ^{14}C content around the value in the record can be assumed to be random. However, as the SOC sample has received inputs from vegetation at the same site all the time, the ^{14}C content is likely to be offset from the record in a systematic way. When the inter-annual variation deviates from the ^{14}C record in a systematic way, the uncertainty of turnover estimates becomes large when SOC fractions of fast turnover are analyzed. The relative uncertainty of the turnover estimates turned out to be smaller than 30% when the turnover time of the analyzed SOC fractions were longer than 30 years and smaller than 15% when the turnover time was longer than 100 years.

32 Using Danish historical maps in pollen based quantitative land cover reconstruction: Model validation and parameter estimates

A. B. Nielsen

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A better understanding of the quantitative relationships between subfossil pollen assemblages from lakes and the composition and structure of the vegetation in the surrounding landscape will allow a more detailed interpretation of late Holocene pollen diagrams, and thus hopefully lead to a better understanding of the history of the cultural landscape. Some studies have used modern pollen vegetation calibration data sets, but in Denmark extensive plantation, drainage, fertilisation and use of pesticides have greatly altered the vegetation during the last century, so instead a method using historical analogues was used. Historical maps are available from around AD 1800 that show areas of different land cover such as arable fields, forest, meadow and heath. The aim was to improve the quantitative interpretation of fossil pollen diagrams from small lakes by testing methods of pollen-landscape calibration, and by estimating important model parameters including the size of the pollen source area. A dataset of pollen assemblages from ca. AD 1800 from the sediment of 30 small (3-30 ha.) Danish lakes, and landcover data from digitised historical maps surrounding the lakes has been collected and analysed using the Extended R-Value model (Parsons and Prentice, 1981; Prentice and Parsons, 1983) and the Prentice-Sugita model of pollen dispersal (Prentice, 1985; Sugita, 1993), which are implemented in the POLLSCAPE simulation model (Sugita, 1994, Sugita et al., 1997; 1999). As a validation of the POLLSCAPE model, pollen assemblages simulated from the AD 1800 vegetation are compared to observed AD 1800 pollen assemblages. The size of the Relevant Source Area of Pollen (RSAP) (Sugita, 1994) for the lakes is estimated to around 1700 m radius. A difference between the RSAP in eastern and western Denmark is observed, which can be explained by differences in the patch size of the vegetation in the two regions. Using the Extended R-value (ERV) model, pollen productivity and background pollen loading is estimated from the AD 1800 vegetation and pollen data. These are compared to modern estimates from Scandinavia (Hjelle, 1998; Sugita et al., 1999; Broström et al., 2004). The parameter estimates are used in the inverse form of the ERV model (Prentice and Parsons, 1983), to estimate vegetation composition around the nine study sites of the project AGRAR 2000 (Odgaard, 1999 and in prep.), and the reconstructions are compared to historical maps.

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Del IV

Discussion papers

Guideline for LaSyS-workshop group sessions

In the workshop program, three time periods have been reserved for group sessions. The intention, organization and expected outcomes are:

Aims

1. To create a conceptual overview of Danish research activities addressing human dimensions of global change, specifically issues related to the use of land.
2. To discuss and provide suggestions of ways in which Danish research environments can best combine expertise in order to contribute to the international development of an interdisciplinary analysis of land use change processes.

Organization of group sessions

Three group discussion sessions will be held and are organized as follows:

Session 1 - Tuesday 13.15-14.15

1. Introduction to the Global Land Project's (GLP) conceptual framework (John R Porter) - see http://www.igbp.kva.se/uploads/report_53.pdf, page 8.
2. Round table discussion - each participant argues for and writes down on cards on a pin board 1 or 2 issues that need to be incorporated into an ideal conceptual land science framework. Issues may support the GLP framework or be suggestions for its improvement. The inputs will be grouped and serve as bases for the following group sessions.

Session 2 - Tuesday evening

1. Participants will be divided into three groups working in parallel with all groups addressing all the issues identified from session 1:
2. The question to be considered is how do the LaSyS-workshop presentations fit into the GLP conceptual framework or similar conceptual frameworks aimed at social and ecological dimensions of land use change. What is missing in current Danish research efforts in this area? Output of discussion to be presented on 1-2 overhead/powerpoint sheets.
3. What suggestions does the group have to improve the GLP conceptual framework? Output of discussion to be presented 1-2 overhead/powerpoint sheets.

Session 3 - Wednesday 13.15-14.30

1. Plenary session: reports from the group work Tuesday - discussion and conclusion of the two issues presented.
2. Recommendation for focus, scope and timing of the 2007 workshop.

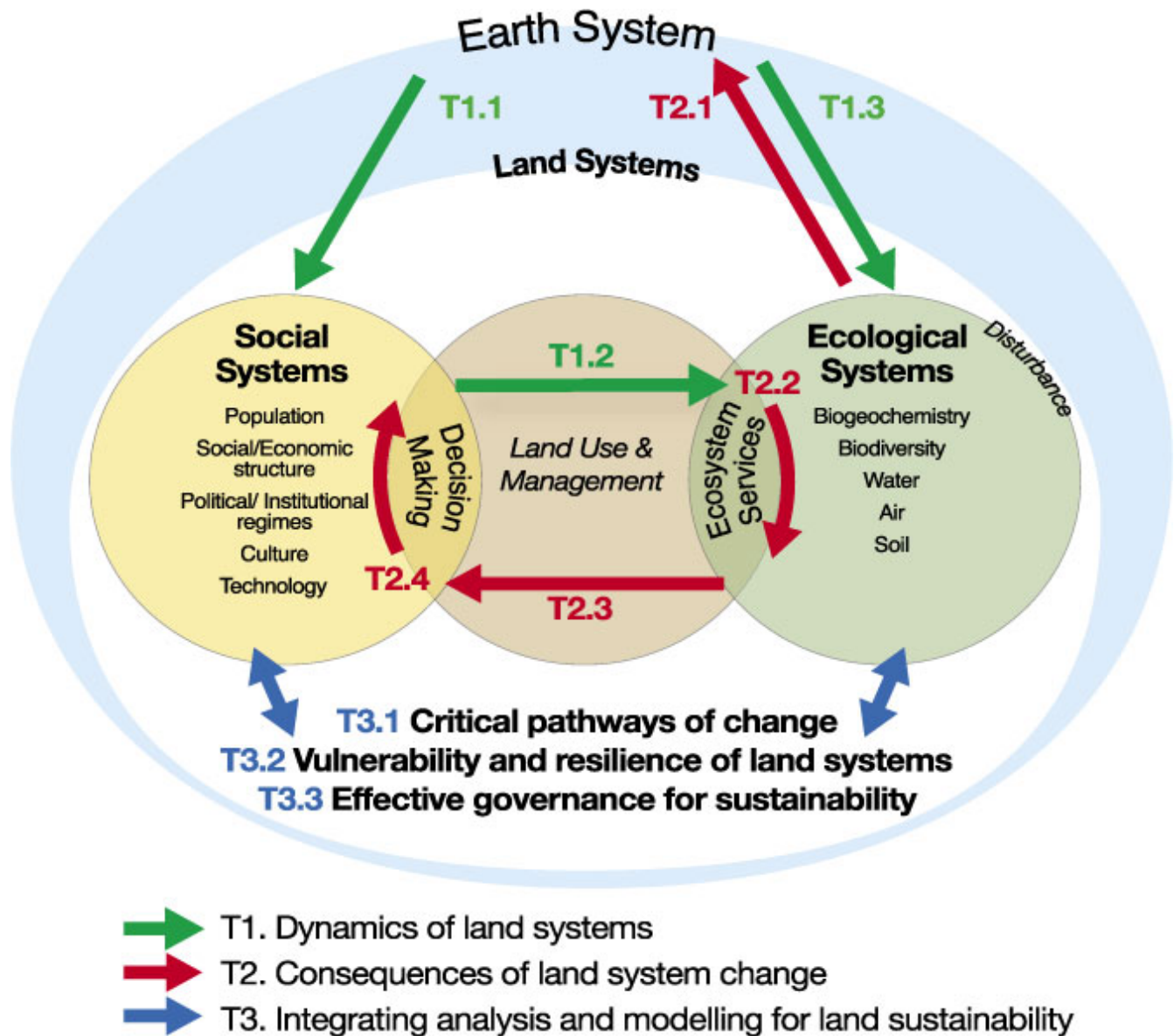


Figure 1: Global Land Project conceptual framework.
 Source: <http://www.glp.colostate.edu/scienceplan.pdf> page 9.

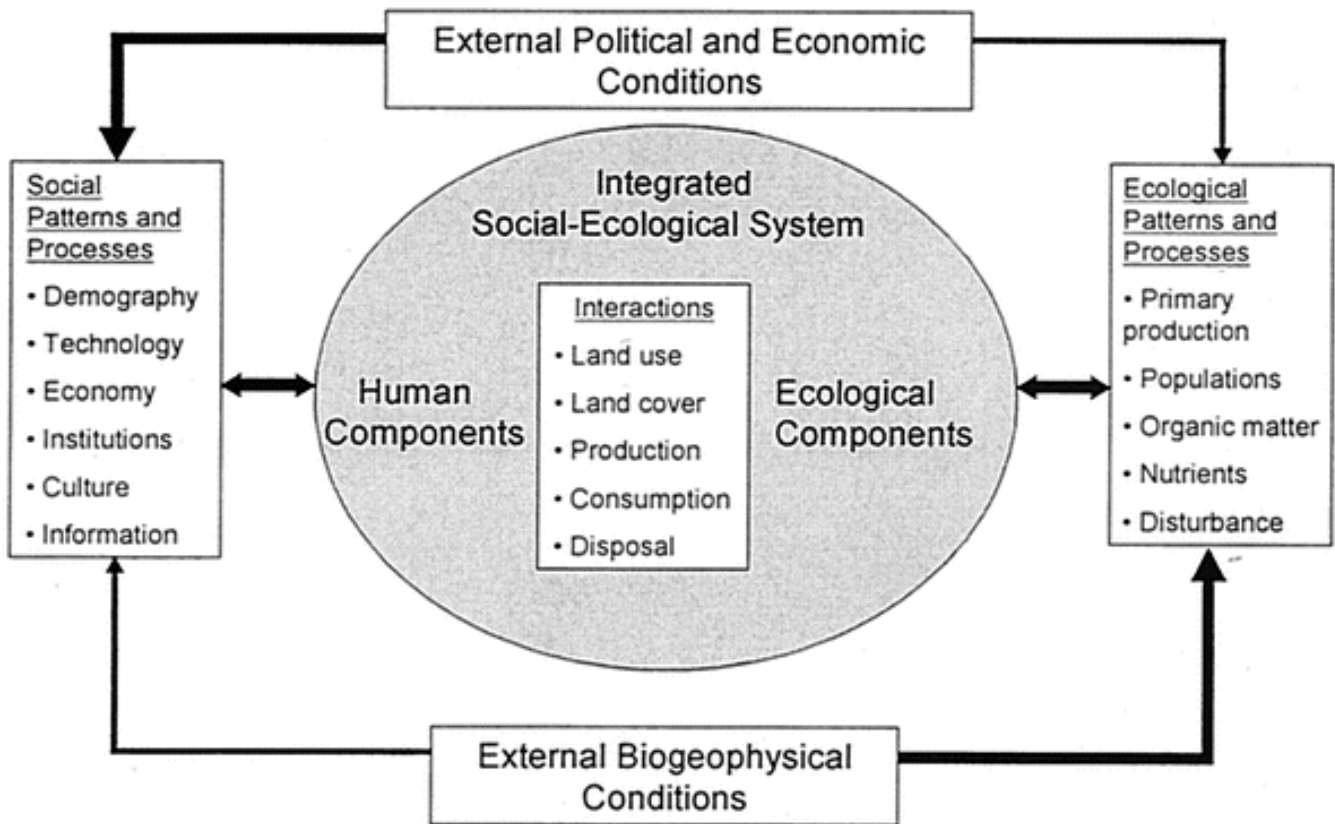


Figure 2: Source: Redman et al 2004. Ecosystems 7:161-171 Integrating social science into the Long Term Ecological Research (LTER) Network: Social Dimensions of ecological Change and ecological dimensions of social change.

Del V

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