09:05 Rebecca Snell (FE)

Landscape Patterns in Mountain Pasture-Woodlands under Changing Climate and Management

Pasture-woodlands are unique semi-natural landscapes that result from the combined influences of climate, management, and intrinsic vegetation dynamics. Highly heterogeneous landscape patterns emerge from fine-grained intensive management and grazing by cattle, which lead to different successional stages between grassland and forest. These cultural landscapes are not only valued for the production of dairy products, but also as habitats which support high species diversity, and have high aesthetic value. However, pasture-woodlands are expected to change in the future due to increasing land abandonment and climate change. Our ability to predict how these landscapes will change is limited due to the disparate scales in time and space that govern the dynamics of these systems.
To improve our understanding of the processes and interactions that shape these systems, we modified a dynamic forest landscape model to simulate a pasture-woodland landscape in the Jura region (Switzerland). This involved the inclusion of an herbaceous layer, grazing from cattle, and additional management routines. The new model version allows us to address the following questions: (1) What are the effects of current and possible future land management practices on the long-term development of the landscape patterns that are so characteristics of pasture-woodlands? (2) How are these trajectories influenced by future climate change? (3) How is the provisioning of various ecosystem services affected by changing these driving conditions?

09:20 Charlotte Pavageau (EM)

Influence of landscape structure on the spatial distribution of the giant honeybee Apis dorsata: Which scale matters most?

Relationships between landscape structure and biodiversity distribution often involve different scales. In the case of central place foragers such as the giant honeybee *Apis dorsata*, patterns of land-use and forest cover are key to understand the distribution of colonies of this pollinator as they are mediating the availability of foraging resources at medium scale and suitable local habitats at smaller scale. One of the challenges of comparing two spatial patterns is to perform analysis simultaneously at different scales. The objective of this study is to analyze the fine-scale influence of landscape pattern on the spatial distribution of colonies of *Apis dorsata* in a coffee growing region in South India. We are using a Correlation Map Profile (or CMP, developed by Gaucherel et al.) method combining a moving window approach with cross-correlation indices, to investigate the relationship between two spatial variables (here, the density of colonies and the mean forest cover) across scale and space. Maps of forest cover and density of colonies were significantly correlated on average but this relationships include both local positive and negative correlations located at different places. In particular negative correlations appears in areas of high density of colonies when performing a cross-correlation at scales larger than 1.3km (size of the reference moving window). This indicates that, at larger scale, the density of colonies is not varying according to gradient of forest cover in the part of the landscape with the highest presence of *Apis dorsata*. On the contrary, this reveals that the forest cover is rather higher in the outskirt areas of high density of colonies than in the proper areas of nesting. Those results point out how nesting sites and areas within the foraging distance are influenced by specific pattern of forest cover.

09:35 Niklaus Zimmermann (WSL)

Linking the modelling of species distribution with evolution

The species distribution modelling (SDM) method has been developed significantly over the last 20 years, and has become a standard method in climate change impact assessment, biodiversity and

conservation management, and in assessing niche characteristics of species. Several review papers have summarized the state of the art over this period, and we now have a good handle of the capacity and limitations of this approach. While smaller or larger technical and conceptual developments are ongoing, the method has asymptoted compared to the activities 5-10 years ago.
One element that has never been tackled well over this period of development was the question, how stable niches are and whether the entities we consider as species actually do behave according to expectations: as classifiable units with well-defined niches that can be best characterized from a statistical sampling of the whole area of a species' range. Micro-evolutionary and genetic research suggests that local populations may well deviate from the species total average, which may have significant consequences on our ability to characterize the niche of the species as a whole and to project its suitable habitats into the future. I will summarize some of the latest results on this end and demonstrate how difficult a simple thing such as characterizing the niche of a species can be.

11:00 Peter Lehmann (STEP)

Rainfall induced shallow landslides - triggering mechanisms and runout distances

Rainfall induced shallow landslides in mountainous regions are released abruptly without precursory signs and are transformed into rapid and destructive debris flow. Risk assessment and related damage mitigation by appropriate protection measures requires information on position, volume and composition of the released mass to estimate the complex flow dynamics of the debris over the landscape. To provide this essential input we developed a landslide triggering model that reproduces the abruptness and criticality of mass release as a progressive failure of interconnected soil columns. Using surface elevation model and information on soil type and vegetation (defining hydro-mechanical properties of the system), the soil depth map and loading and failure patterns were then computed at hillslope and catchment scale. For different catchments and rainfall events we computed the landslide triggering and estimated then the path of the debris flow based on simple physical and empirical models. The coupling between modeled landslide triggering and debris flow runout offers a more complete spatial picture of shallow landslide and subsequent debris flow hazards. The additional information provided by the triggering model concerning location, shape, soil type and water content of the released mass may also be incorporated into more advanced models of runout to improve predictability and impact of such abruptly-released mass.

11:15 Hansjörg Seybold (PES)

Climate's signature in the geometry of stream networks

The Earth's surface is shaped by the interplay between tectonic movements and the dynamics of its atmosphere, which itself is the result of running water and life.
While most of Earth's surface is dissected by river networks, little is known about the processes controlling their growth. By analyzing almost one million digitally mapped rivers in the continental United States, we find that the branching angles of stream junctions strongly correlates with the recharge of the ground water given by the ratio between evapotranspiration and precipitation. Theory predicts that bifurcated streams incised by re-emerging groundwater flow split at a characteristic angle of $\alpha = 2\pi/5 = 72^\circ$ [Devauchelle et al., 2012]. This case clearly emerges as a limiting case for regions with high recharge while in dry areas the angle is much lower.
Our analysis suggests that, climate manifests in the planform geometry and that contrary to most current theories, ground water flow seems to play an important role in the formation and evolution of channel networks on a continental scale. This result has important consequences for the understanding of global chemical weathering rates and the carbon cycle.

11:30 Daniel Trüssel (LUE)

Field Experiments with mobile GIS-Support; The GISsmox-project

Many courses from very different study programmes at ETH share the aspect of geospatial references: the learning contents are often natural or artificial objects or structures which occupy a unique spatial position at a given time. Filed trips are thus included in the curricula in order to connect theoretical concepts with the real world. They offer an ideal setting to ask and answer questions about a real object in its immediate local environment, e.g. "What are the advantages of an invasive plant compared to a native species at this location?". Often these issues are coupled with a spatial or temporal component and affect several objects of study, e.g. "How many individuals of the invasive species can we find in this area?" or "How fast is it spreading?". These questions are usually discussed during excursions based on pre-existing data or knowledge of the accompanying lecturers and students. Collecting a relevant spatial dataset on site in real-time and comparing it to available (online) information in order to discuss answers to relevant questions would, however, offer a much more active learning experience to students. Such scenarios have not been used on one-day excursions so far, probably due to the lack of suitable equipment and the time needed for consolidating datasets with a large number of students.
The wide spread of mobile devices with integrated GNSS (global navigation satellite systems, e.g. GPS) receivers opens up novel and easy-to-use options for collection, visualisation and interpretation of spatial data in a teaching context. With this technology, groups of students can now acquire large datasets in a real-time crowd-sampling approach on field trips and conduct analysis of their own dataset on site using their smartphones or tablets (while it is still fresh). Additionally, information based on augmented reality can be added.
GISsmox is an open project sponsored by Innovedum Fonds of ETH Zurich (www.innovedum.ethz.ch) and not restricted to only excursions. If you are interested in the crowd-sampling approach or in augmented reality (e.g. excursions, field work during Bachelor or Master Theses, or PhD), you are very welcome to contact us at gisteam@env.ethz.ch.

11:45 Chue Poh Tan (EM)

The Possibility of Aboveground Biomass Estimation using Remote Sensing Technology in Tropical Forest

Reducing Emissions from Deforestation and Forest Degradation (REDD+), whereby tropical forest protection and restoration serve to capture and store atmospheric carbon, has received considerable attention within the United Nations Framework Convention on Climate Change as a climate mitigation measure. Underlying the success of REDD+ is the ability to reliably and rapidly measure carbon content/biomass of forest. The tropical forest in Borneo, Malaysia is a mega biodiversity hotspot and has among the highest biomass densities but logging over the past few decades has dramatically decreased forest cover and therefore carbon storage potential. Considering the vast extend and poor accessibility of dense tropical forests, remote sensing technology is considered to be a potential tool for forests monitoring over large areas. In this talk, the challenges and possibility to reliably estimate the forest biomass using remote sensing technology will be discussed.

14:00 Andreas Hill (LUE)

Validation of Timber Volume Maps derived from LiDAR Data

Information about the spatial distribution of timber volume is a key factor for purposeful harvest planning. Whereas field surveys have been a standard approach for volume estimation, remote sensing data (particularly LiDAR) are providing an effective alternative. Remote sensing-based approaches offer the opportunity to create timber volume maps that represent the complex pattern of

spatial volume variability. However, a validation approach is required to ensure that the computed pattern corresponds to reality. The aim of our study was to additionally access the accuracy of timber volume classes which are often used to better represent the map predictions. As the use of constant class intervals does not account for the possibility that the precision of the underlying prediction model may not be constant across the entire volume range, these classification schemes can reveal severe differences in class accuracies. In order to avoid this phenomenon, we present an optimization technique that automatically identifies a classification scheme which accounts for the properties of the underlying model and the implied properties of the remote sensing support information.

14:15 Lisa King (EM)

Land use transition and prospects for forest recovery

Deforestation is a major source of carbon emissions and a leading cause of biodiversity loss. The reverse phenomenon of net reforestation observed in multiple countries around the world, however, is less studied. Also termed “forest transition”, it can originate as a result of regrowth on abandoned farmland or through active reforestation in response to a perception of scarcity of forest goods and services. We are interested in better understanding the underlying patterns of national forest transitions and the tradeoffs associated with different forms of reforestation, from natural regrowth on previously forested lands to erosion control programs and timber plantations. I will be presenting some examples of national land use transitions and the tradeoffs between different forest types and agricultural land, along with some of the main data challenges. Given the growth of initiatives supporting investments in reforestation, such as the United Nations Reducing emissions from deforestation and forest degradation (REDD) and the Bonn Challenge, it is important to better understand the implications of different forms of reforestation for food security and conservation efforts and how best to prioritize these investments.

14:30 Marek Vaculik (SP)

The importance of silicon for higher plants

Although silicon (Si) is not considered as an essential element for plants in general, the beneficial effect of this element has been demonstrated for many plant species, especially from Poaceae family. In addition to the importance of Si in plant nutrition, optimal growth and development, it plays a significant role in the alleviation of various symptoms of biotic as well as abiotic stresses. It was shown that Si can decrease the negative effects of various heavy metals and toxic elements like aluminium (Al), lead (Pb), chromium (Cr) or arsenic (As) and prevent their uptake into the plant tissues. Accumulation of heavy metals in agricultural crops represents a serious threat for food production. Cadmium (Cd) is relatively easily taken up by plants through roots. This un-essential element causes several harmful effects on plant growth and development. On the contrary, zinc (Zn) is an essential microelement and is required by plants for normal growth and development, however it becomes toxic when present in excess. The aim of our work was to investigate the effect of Si on growth of important agricultural crops when grown in excess of Cd or Zn.
We found that Cd negatively affected root and shoot biomass and this was alleviated by Si addition. Differences in Cd uptake and translocation related with the development of apoplasmic barriers in exo- and endodermis of roots. The addition of Si decreased symplasmic and increased apoplasmic distribution of Cd in maize leaves. These results indicate a decreased availability and toxicity of Cd for leaf cells. We also found that Zn significantly reduced both root and shoot biomass of hydroponically grown wheat plants and application of Si to Zn-treated plants enhanced plant biomass, especially in the shoot. Similarly, addition of Si decreased the concentration of Zn in root and shoot tissues at lower Zn, however no significant differences were observed in higher Zn. Additionally, changes in the chlorophyll and carotenoids concentrations confirm our findings that Si can partially mitigate the negative effect of Zn in wheat plants.

14:45 Siul Ruiz (STEP)

Soil bioturbation by earthworms and plant roots – energetic considerations for plastic deformation

Soil structure is a critical factor in agriculture for determining hydrological and ecological functions including water storage, deep recharge and plant growth. Compaction is known to adversely impact the resulting hydrology and crop productivity as well as other ecological functions of this habitat. An important class of soil structural restoration processes are related to biomechanical activity associated with borrowing of earthworms and root proliferation in impacted soil volumes. This study utilizes mechanical processes in order to simulate earthworm and plant root bioturbation in order to determine the mechanical energy investments into the system. As a model process, we consider steady state plastic cavity expansion to determine the burrowing pressures of earthworms and plant roots under various soil conditions. Cavity expansion models are then linked with cone penetration in order to quantify the burrowing process of plant root growth or earthworm locomotion related to different penetration angles. The associated cavity pressures and expanded radii determined the amount of mechanical energy invested for bioturbation under different hydration conditions and root/earthworm geometries. By considering earthworm physical and ecological parameter such as population density, burrowing rate, and burrowing behavior, we use the mechanical energy to infer estimations of necessary soil organic matter requirements for earthworm respiration, motility, and communities. Results illustrate a reduction in strain energy with increasing water content and trade-offs between pressure and energy investment for various root and earthworm geometries and soil hydrological statuses. This study also provides a quantitative framework for estimating the associated energy requirements (soil organic matter, plant assimilates) needed to sustain structure regeneration by earthworms and plant roots, and highlights the potential mechanical limits of such activities.

16:00 Kerstin Hockmann (SP)

Antimony leaching from drained and waterlogged shooting range soil: a field study

Many soils polluted by antimony (Sb) are subject to fluctuating waterlogging conditions; yet, little is known about how these affect the mobility of this toxic element under field conditions. Here, we compared Sb leaching from a calcareous shooting range soil under drained and waterlogged conditions using four large outdoor lysimeters. After monitoring the leachate samples taken at bi-weekly intervals for >1.5 years under drained conditions, two of the lysimeters were subjected to waterlogging with a water table fluctuating according to natural rainfall water infiltration. Antimony leachate concentrations under drained conditions showed a strong seasonal fluctuation between 110 µg l-1 in summer and <40 µg l-1 in winter, which closely correlated with fluctuations in dissolved organic carbon (DOC) concentrations. With the development of anaerobic conditions upon waterlogging, Sb in leachate decreased to <10 µg l-1 Sb and remained stable at this level. Antimony speciation measurements in soil solution indicated that this decrease in Sb(V) concentrations was attributable to the reduction of Sb(V) to Sb(III) and the stronger sorption affinity of the latter to Fe phases. Our results demonstrate the importance of considering seasonal and waterlogging effects in the assessment of the risks from Sb-contaminated sites.

16:15 Minsu Kim (STEP)

Microbial Biodiversity on Hydrated Soil Surfaces

Dynamic changes in soil water content greatly affect microbial life in soil. Aqueous phase connectivity within soil pore spaces affects ranges of microbial dispersion and shapes nutrient diffusion fields. We developed a biophysical model for systematic study of effects of hydration cycles on relative abundance and species distribution. We represent soil surface heterogeneity as roughness patches that retain different amounts of water at given matric potential values. The model considers local

growth rates of motile individual microbial cells, whose growth is based on nutrient interception and on physiological parameters drawn from an initial prescribed distribution. The surface patch model was subjected to cycles of wetting and drying events (mimicking observations). The relative abundance as well as other diversity metrics of the evolving microbial community were obtained from the local interactions. Results show a decrease in overall microbial diversity following wetting events and recovery after drainage and drying. The results were in qualitative agreement with observations in desert soil following rainfall events.

16:30 John Garcia (EM)

A context-specific and data-efficient approach for quantifying biodiversity benefits under REDD+

Reducing emissions from deforestation and forest degradation (REDD+) initiatives are climate change mitigation strategies that could greatly contribute to reduce carbon emissions originated from land-use changes in the tropics. These policies have also received wide attention among conservationists because they have the potential to not only conserve carbon stocks but also boost forest biodiversity conservation. In fact, the importance of the biodiversity co-benefits of REDD-protected forests has gained recognition at international negotiations. However, REDD+ researchers and practitioners still lack a comprehensive method for quantifying the biodiversity implications of REDD+. As such, current REDD+ schemes include only biodiversity considerations as qualitative 'safeguards', that can be evaluated and monitored, but offer no quantitative method of assessing change in species extinction risks or biodiversity loss.
In this presentation, we demonstrate the application of a mathematical model that can be used to predict the marginal value of a REDD+ protected forest for biodiversity conservation. This model combines the use of tailored remote sensing information on changes in land cover and forest connectivity, and taxon-specific ecological data to quantify the biodiversity payoffs of protecting a forest under REDD+. We present the application of this analysis on 2 established REDD+ projects, and discuss the use of this methodology when designing national REDD+ policies that aim to minimize tradeoffs between reducing carbon emissions and conservation outcomes.

16:45 Olga Churakova (FE)

Long- and short-term variability of d18O in tree organic matter of mountain pine and larch trees from the Swiss National Park

In my talk I will present parts of the results of a Marie-Heim Vögtlin project focusing on the understanding of the 18O/16O isotopic signature in tree tissues to study climatological, physiological and environmental changes on seasonal to long-term scales.
The seasonal variability in 18O/16O of organic matter in needles and twigs of mountain pine (*Pinus mugo var. uncinata*) and larch (*Larix decidua*) trees was related to changes in climate conditions during summer 2013.
To reveal the main climatic factors driving tree growth of pine and larch trees in the Swiss National Park tree-ring width chronologies were built and bulk 18O/16O wood chronologies were analyzed and correlated with climatic parameters over the last 100 years.