Conference Agenda

Session

192S-2: Remote Sensing for Biodiversity Monitoring II

Time: **Tuesday, 25/Feb/2020: 10:30am - 12:30pm**
Session Chair: **Claudia Roeoesli**
Session Chair: **Marc Paganini**
Session Chair: **Gary N Geller**
Session Chair: **Michael E. Schaepman**

Location: **Dischma**
Parallel Session 115 m2 100 PAX

Session Abstract

Global observations and regular assessments are key to monitor and understand global biodiversity change and related drivers allowing to finally conserve biodiversity in space and time. Satellite based, remote sensing observations have demonstrated the capacity for global monitoring of biological diversity. This session discusses recent scientific progress and importance in using Earth observations from remote sensing platforms. Particular focus will be on priority setting of the choice and use of Earth observations as well as their complementarity and co-existence with in-situ measurements for global biodiversity assessment.

The Group on Earth Observation Biodiversity Observation Network (GEO BON) is currently developing a framework, based on the concept of Essential Biodiversity Variables (EBVs), for a global biodiversity observation network. We will discuss the contribution, development, production, operationalization and validation of remote sensing enabled EBV's (RS-enabled EBVs) to the EBV framework. Exemplary RS-enabled EBVs may include fragmentation, vegetation structure, canopy chlorophyll content or land surface phenology, but are not limted to these. Besides the development of algorithms and their implementation, the session invites also contributions discussing the relevance of such data products for policy makers, biodiversity indicator assessment, integration for biodiversity analysis and modelling, as well as assessing ecosystem services.

Presentations

10:30am - 10:47am

Mapping Human Impact On Forests At Global Scale

Myroslava Lesiv[1], Dmitry Schepaschenko[1], Marcel Buchhorn[2], Steffen Fritz[1]

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Current global tree cover maps do not distinguish f between natural forests, plantations, native or non-native trees, nor do they specify the degree of forest management intensity. The conversion and degradation of natural forests is not only considered among the greatest threats to biodiversity, but also an important source of greenhouse gas emissions. The lack of accurate spatial data on forest management globally is a serious obstacle to informing policies towards forest protection, sustainable forest management and forest restoration.

Whereas remotely sensed based datasets can depict tree cover and other land cover types, it has not yet been used to depict untouched forest and different degrees of forest management. We show for the first time that with sufficient training data a differentiation of different levels of forest management is possible.

Hence, in spring 2019 we launched a series of Geo-Wiki campaigns. We involved forest experts from different world regions to explore which forest information could be collected by visual interpretation of very high-resolution images from Google Maps and Microsoft Bing, including Sentinel time series and normalized difference vegetation index profiles. Based on the results of this analysis, we expanded the campaigns by involving broader group of participants, mainly people recruited from remote sensing, geography and forest research institutes and universities.

In total, we collected forest data for 130000 locations. Based on this data set, we developed a remotely sensed based global forest management layer at a 100m resolution for 2015. The map includes such classes as intact forests, forests with signs of human impact, including clear cuts and logging, replanted forest, woody plantations with a rotation period up to 15 years, oil palms and agroforestry. Overall accuracy is 75%.

We will present the results of the Geo-Wiki campaigns, the resulting map, and statistical area estimates of by continents and ecoregions.

10:47am - 11:04am

Biodiversity Effects at Novel Scales of Organization

Pascal A. Niklaus[1,2], Florian Altermatt[1,2], Merin Chacko[1], Sarah Mayor[1,2], Jacqueline Oehri[1,2], Michael Schaepman[2,3], Gabriela Schaepman-Strub[1,2], Bernhard Schmid[1,2,3]

[1]University of Zurich, Switzerland, Dept. of Evolutionary Biology and Environmental Studies; [2]University Research Priority Programme Global Change and Biodiversity; [3]University of Zurich, Switzerland, Dept. of Geography

A vast body of research has addressed the relationship between biodiversity and ecosystem functioning (B-EF) in plot-scale experiments with artificially established plant communities. These studies have generally shown that more diverse communities are more productive and that productivity is more stable through time. However, whether these B-EF relationships also apply in natural and human-dominated real-world landscapes that provide essential ecosystem services remains to be tested. Such real-world landscapes differ from experimental communities in many respects, including additional scales of space and ecological organization that may support or modify diversity-functioning patterns through emergent mechanisms.

B-EF research so far has focused on interactions among plant individuals and the diversity of communities has been described in terms of properties of these individuals, for example their species identity (metrics of species diversity) or their traits (metrics of trait diversity). However, complex landscapes can be seen as hierarchically organized, with levels ranging from genes to individuals, communities, ecosystems, all the way up to landscapes that integrate these ecosystems in a spatial mosaic.

To test for diversity effects at the landscape level in study areas in Europe and North America, we selected landscapes that differed systematically in land-cover composition. We inferred vegetation activity and land-surface phenology in these landscapes based on MODIS vegetation indices, at a spatial resolution of 250 m. Analyses of these data indicate that interactions among entire ecosystems indeed promote landscape level functioning, and that at least part of these effects depends on emergent mechanisms independent of species diversity. These effects may represent a novel class of mechanisms that underpin diversity effects at the landscape level. We contend that landscape-level diversity–functioning relationships deserve increased attention, not least because they underlie the delivery of ecosystem services to humans.

11:04am - 11:21am

Merging Spectral and Phylogenetic Diversity to Assess Macrophyte Traits and Functions Along Ecological Gradients

Paolo Villa[1], Andrea Coppi[2], Rossano Bolpagni[3], Maria B. Castellani[2], Alice Dalla Vecchia[3], Lorenzo Lastrucci[4]

[1]National Research Council (CNR), Italy; [2]University of Florence, Italy; [3]University of Parma, Italy; [4]Natural History Museum, University of Florence, Italy

As littoral and riparian environments are in decline and survival of many aquatic plants is threatened by anthropic activities all over the globe, the conservation of macrophyte diversity should be considered a priority, because of their key role in freshwater ecosystems.

High-throughput techniques, such as remote sensing spectroscopy, genetics and phylogenetics, have been explored in the last decade to support and enhance operational diversity monitoring. These techniques have opened new ways of measuring biodiversity, especially in forest and grassland systems, but a sound link between spectral and phylogenetic features with plant functional characteristics has yet to be established.

The idea behind macroDIVERSITY, a new national project, funded by the Italian Ministry of Education, University and Research (2020-2023), is that phylogenetic and spectral diversity measures can be integrated into a multidimensional data-driven framework for mapping plant traits and functions across scales and gradients.

To this objective, we will collect data on macrophyte traits, diversity, and spectral reflectance from plots sampled over selected lakes and wetlands in Italy, according to robust experimental design. A fully resolved supertree, obtained from DNA markers analysis integrating available data and new sequencing, will be used for assessing the evolutionary diversity of the species assemblage, highlighting the phylogenetic signal in the context of the community traits information. Hyperspectral imaging data acquired from proximal platforms and airborne drones at centimetre scale will be used for modelling bio-chemical and functional macrophyte traits (e.g. canopy morphology, productivity, pigments and nutrients content). Environmental parameters collected and diversity metrics derived will be eventually merged into a machine-learning framework for mapping macrophyte functional diversity (richness and divergence).

The project outcomes are expected to impact on applied ecology studies focusing on delineating plant diversity using remote sensing data, and investigating the role played by species interactions and community complexity in regulating aquatic ecosystem quality.

11:21am - 11:38am

Global, High-resolution, Annual Data On The Extents Of 75 Terrestrial, Marine, And Freshwater Ecosystem Types

Carsten Meyer, Ruben Remelgado

German Centre of Integrative Biodiversity Research (iDiv), Germany

Widespread changes in the area, fragmentation, and integrity of ecosystems are a major driver of biodiversity change and loss of ecosystem services worldwide. These changes are expected to further accelerate under future land-use and climate changes, potentially leading to widespread environmental degradation and socioeconomic hardship. Detailed information on global, spatiotemporal dynamics in the extents of major ecosystem types is thus essential to understand, anticipate, and address a broad range of environmental problems. Accordingly, the Group of Earth Observations Biodiversity Observation Network (GEO BON) identified the development of global data products on ecosystem extents as an Essential Biodiversity Variable, and a priority for global biodiversity monitoring. We will present a series of global, high-resolution gridded data cubes that capture the annual areas of occupancy for each of 75 standardized terrestrial, marine, and freshwater ecosystem types over a 24-year period. To achieve this high thematic detail, we built on decades of global environmental mapping efforts by integrating 24 global products (>200 TB in total, mostly remote-sensing derived) covering land-cover, hydrology, climate, NDVI, elevation, coastal and stream topography, soil, and other environmental dimensions. The depicted ecosystem types conform to the habitat classification scheme of the International Union for Conservation of Nature’s Red List of Threatened Species, assuring interoperability with ongoing assessments of the species habitat preferences. Exemplary application fields include monitoring of species habitats to support conservation interventions, testing hypotheses on biodiversity-change drivers and mapping of global ecosystem services. We will characterize recent dynamics in selected ecosystems to showcase the potential of the presented datasets, which will be published soon as open-access products following FAIR principles. Finally, we will discuss an envisioned community-driven curation and quality-assurance system for the continuous further improvement of these products.

11:38am - 11:55am

Towards Automated Mapping and Modelling of Habitat Types at the National Extent for Switzerland

Bronwyn Price, Nica Huber, Robert Pazur, Christian Ginzler

Swiss Federal Research Institute WSL, Switzerland

Habitats are increasingly used to assess the status of biodiversity. Mapping the distribution of habitats is vital for successful conservation, management and monitoring of biodiversity. The habitat classification of Delarze, Gonseth et al. (2015) is the most widely used in Switzerland. While there has been some regional modelling of this classification, there is currently no spatially explicit map of these habitats across Switzerland. This study will take advantage of advances in remote sensing technologies and develop a semi-automated methodology to map the current extent of habitat types in Switzerland, taking into account impacts of human disturbances and interventions. We employ an extensive suite of earth-observation and mapping data as inputs in an approach involving habitat distribution modelling, image segmentation and classification. High-resolution 3D information from digital aerial photogrammetry allows differentiating shrubs and trees and identifying buildings. Phenological dynamics are determined from seasonal variation in vegetation indices (e.g. NDVI), derived from high temporal resolution Sentinel-2 satellite imagery. Data describing climate, topography, soil and land use (from the topographic landscape model TLM) provide additional covariates. Habitat distribution models are developed via machine learning approaches trained with field data available from large scale Swiss vegetation and biodiversity monitoring programmes. Within the software eCognition, airborne orthoimagery (1m resolution) is segmented into ‘image primitives’ on the basis of reflectance in the RGB and NIR bands, and values of the metrics NDVI and NDWI. In a rule-based approach, habitat types can be assigned to segments based on the input data and distribution models, resulting in a high spatial resolution Swiss-wide map of habitat types. This semi-automated approach can be re-applied with updates of the base data at specified time intervals, enabling use for monitoring purposes. The methodology has been tested in a first national-scale prototype.

11:55am - 12:12pm

Monitoring, Understanding And Forecasting Global Biomass Flows Of Aerial Migrants Using Continental Networks Of Weather Radars

Silke Bauer[1], Felix Liechti[1], Baptiste Schmid[1], Judy Shamoun-Baranes[2], Andrew Farnsworth[3], Peter Desmet[4], Jarmo Koistinen[5]

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Trillions of animals, encompassing thousands of tons of animal biomass, move annually through the air above our planet. Through a variety of transport and trophic effects, migratory animals can uniquely alter nutrient and energy flow, food-web topology and stability, and represent a powerful yet underappreciated dimension of biodiversity that also represent services and disservices to human infrastructure, agriculture and welfare at a global scale.

Many migrant populations have alarmingly declined over past years, and these declines often go undetected, especially if they concern non-charismatic species or those with a clandestine life-style. Furthermore, their aerial and terrestrial habitats have changed dramatically over the past decades and are expected to change further, particularly from rapid climate change, increased urbanization, wind energy installations, and habitat fragmentation. Preserving migrants' roles in structure and functioning of ecological communities as well as better using their services and reducing their disservices requires long-term and large-scale monitoring tools for quantifying migrations across continents and the identification of the drivers behind changes in movement patterns and migrant abundances.

Existing continental networks of weather radars provide an excellent opportunity to achieve these aims as they also detect "biological targets" and therefore, can assess migration traffic rates and biomass transported. In a BioDivERsa-project, we will tap these resources and quantify biomass flows of aerial migrants across Europe and North America and relate timing and intensity of movements to a suite of atmospheric, climatic and landscape variables. We present preliminary results, outline scientific and societal challenges that we will address, and relevant stakeholders for whom there are numerous future opportunities to leverage such research.

12:12pm - 12:29pm

Detecting Bark Beetle Infestation Using Plants Canopy Chlorophyll Content Retrieved from Remote Sensing Data

Roshanak Darvishzadeh[1], Abebe Mohammmed Ali[1,2], Andrew Skidmore[1,3], Haidi Abdullah[1], Claudia Roeoesli[4], Marco Heurich[5], Marc Paganini[6]

[1]University of Twente, Netherlands, The; [2]Wollo University, Ethiopia; [3]Macquarie University, Australia; [4]university of Zurich, Switzerland; [5]Bavarian Forest National Park; [6]European Space Agency

The European bark beetle (Ips typographus, L.) is a potentially severe invasive species in the UK and North America. It is resulting in a high degree of fragmentation, forest productivity, and phenology. Understanding its biology, as well as developing early detection based on its behavior, is an important aspect of its successful management and eradication. Bark beetle infestation causes changes biochemical and biophysical characteristics such as chlorophyll water and nitrogen content. This study showcases the potential of the Canopy Chlorophyll Content (CCC) product derived from remote sensing datasets to detect early bark beetle infestation in Bavarian forest national park. We generated time series CCC maps from RapidEye and Sentinel-2 images of the study area through Radiative transfer model inversion. The CCC products were then classified into infested and healthy using CCC mean and variance collected in 2015 and 2016 from infested and healthy Norway spruce trees in the Park. Reference data obtained from processing and interpretation of high resolution (0.1m) color aerial photographs were used to validate the accuracy of the infestation maps. Our results demonstrated that CCC products as derived from remote sensing data were a rigorous proxy to early detect bark beetle infestation. Validation of the infestation maps revealed > 70% classification accuracy throughout the time-space. Hence, CCC products play a significant role to understand the dynamics of the infestation and improve the management of bark beetle outbreaks in forest ecosystem. Despite these promising results, other plant traits such as dry matter content and Nitrogen content will need to be investigated as additional predictors, which may considerably improve the accuracy of early detection of bark beetle infestation using remote sensing derived products.