ANNUAL REPORT

2017 2018

BIOCHANGE

Center for Biodiversity Dynamics in a Changing World

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CENTER FOR BIODIVERSITY DYNAMICS
IN A CHANGING WORLD

AARHUS
UNIVERSITY

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ANNUAL REPORT 2017/2018

VILLUM FONDEN

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INDEPENDENT RESEARCH FUND DENMARK

AARHUS UNIVERSITETS FORSKNINGSFOND
AARHUS UNIVERSITY RESEARCH FOUNDATION

BIOCHANGE
CENTER FOR BIODIVERSITY DYNAMICS IN A CHANGING WORLD

AARHUS UNIVERSITY

BIOCHANGE – Center for Biodiversity Dynamics in a Changing World
Annual Report 2017/2018

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WORDS FROM THE DIRECTOR

Dear readers,

It is my pleasure to present the first annual report from BIOCHANGE – Center for Biodiversity Dynamics in a Changing World. The center started in August 2017, with the official inauguration on November 9 the same year. The basis for starting the BIOCHANGE center was a VILLUM Investigator grant of nearly 40 million DKK (~5.4 million EUR) awarded to me by the VILLUM FONDEN for 2020-2023. Overall, my ambition with the VILLUM Investigator project is on improving our understanding and predictive capacity of the complex biodiversity dynamics under anthropogenic global change and their consequences for people and society, and based here on, on developing novel solutions to promote a biodiverse future.

To maximize progress on this challenging, crucial research area, I decided to build a research center around it, joining forces with a select team of innovative colleagues sharing this ambition and providing complementary expertise. These senior core members of the BIOCHANGE center are Professor MSO Felix Riede (archaeologist, expertise on human-environment relations and quantitative approaches), Associate Professor Signe Normand (ecologist, expertise on vegetation dynamics under climate change and new technologies for ecological field-based research), and Assistant Professor Alejandro Ordonez Gloria (ecologist, expertise in ecological Big Data and ecology-climatology integration), all at Aarhus University. All bring their own projects and funding to the center, which in essence is a committed research collaborative. The central idea in forming a center is that scientific progress is best achieved in a cooperative, interdisciplinary research environment of critical mass and with a strong focus on joint development of ideas and expertise sharing.

We have organized the research in BIOCHANGE around four themes: [1] Fundamental Biodiversity Dynamics, [2] Global Challenges, [3] Ecoinformatics and New Technologies, and [4] Interdisciplinary Innovation. Notably, we work towards breakthroughs in:

(i) our understanding and predictive capacity of the complex Anthropocene ecological dynamics that will determine future levels of biodiversity and ecosystem functioning, including the many crucial services to society, in a world with a large, rapidly growing human population and massive climate change,

(ii) our ability to employ the growing richness and quality of relevant Big Data, notably from remote sensing, to study, monitor and manage these dynamics, and

(iii) the ways nature and society interact, notably in terms of human dependence on nature and biodiversity and our capacity to design landscape development to promote biodiversity, ecosystem services and human well-being.

On the following pages, we present the organization and activities of BIOCHANGE. While it is still early days of the center, we have had a lot of progress and important outcomes already. I hope you will enjoy reading about it.

Jens-Christian Svenning, Professor,
VILLUM Investigator
Center Director at BIOCHANGE – Center for Biodiversity Dynamics in a Changing World

BIOCHANGE's four senior core members from left: Professor MSO Felix Riede, Associate Professor Signe Normand, Center Director Jens-Christian Svenning, and Assistant Professor Alejandro Ordonez Gloria.

Photo: Urs A. Treier, BIOCHANGE

Chair of VILLUM FONDEN Jens-Kann Rasmussen speaks at the official inauguration of two VILLUM Investigator grants at Aarhus University on November 9, 2018.

Photo: Lars Kruse, AU

Center Director Jens-Christian Svenning lectures on Biodiversity Dynamics in a Changing World and how his VILLUM Investigator grant will be used to establish the BIOCHANGE center.

Photo: Anne Blach Overgaard, BIOCHANGE

BIOCHANGE RESEARCH GOALS AND THEMES

BIODIVERSITY is what makes Earth habitable, and a wonderful place to live. Critically, however, it is eroding and facing strong future risks from the large, growing human population, intensifying human activities, and massive climate change. To safeguard and restore biodiversity, we need to improve our understanding and predictive capacity of the complex human-driven biodiversity dynamics and their consequences for people and society, and to develop novel solutions to promote a biodiverse future.

BIOCHANGE will address this crucial challenge via four linked research themes:

THEME 1:

FUNDAMENTAL BIODIVERSITY DYNAMICS

We aim to deepen our understanding of three phenomena that are likely to characterize future ecosystems, namely: (1) Transient biodiversity dynamics, as ongoing and future global change is likely to further increase ecological disequilibria. (2) Assembly and functioning of novel ecosystems, as such ecosystems without historical precedent are likely to become widespread due to globalization's transport of organisms around the world and due to the rise of anthropogenic novel environmental conditions. One crucial unresolved question that we will address concerns the biodiversity capacity of such ecosystems. (3) Megafauna ecosystem ecology, as there is a strong need to understand how the large animals affect the rest of biodiversity, ecosystem structure and even the whole biosphere, both from a fundamental perspective and because the planet is now experiencing both strong losses of large animals in much of the world (defaunation), but also comebacks via re-expansions and introductions elsewhere.

THEME 2:

GLOBAL CHALLENGES

Humanity is facing massive global challenges, as highlighted in the global sustainable development goals (SDGs). One of the most challenging is the looming, increasing risk of strong future climate change. We see this as one of the biggest future ecological risks, and while subject to much work and discussion, we think the scope is constantly underestimated. At the same time, our ability to forecast the consequences for biodiversity and ecosystems remains limited. Linking to theme 1 (Fundamental Biodiversity Dynamics), we aim to: (1) Strengthen our predictive capacity by developing forecasting models that robustly capture the likely widespread disequilibrial transient dynamics and assembly of novel ecosystems and are able to predict the impacts on ecosystem functioning and services, as well as (2) develop methods for society to optimize its responses to these dynamics.

THEME 3:

ECOINFOR-MATICS & NEW TECHNOLOGIES

We see the informatics revolution and the linked rapid development in sensor technologies as a key opportunity for achieving the urgently needed progress on how to tackle the massive and building pressure on the biosphere that we all depend on, as well as to address core unanswered questions in ecological science. Our research has two key foci: (1) Development of new and stronger ecoinformatics capabilities, to be able to realize the potential in the increasingly massive amounts of relevant data. There will be strong synergy with the GLOBAL CHALLENGES theme in developing forecast models, so that they are computationally efficient and can run on the massive high-resolution spatiotemporal data sets needed for maximum relevancy for landscape planning. (2) Exploiting the rising potential for extremely high-resolution analyses and modelling of dynamics in biodiversity, ecosystems and their services using novel sources of remote sensing.

THEME 4:

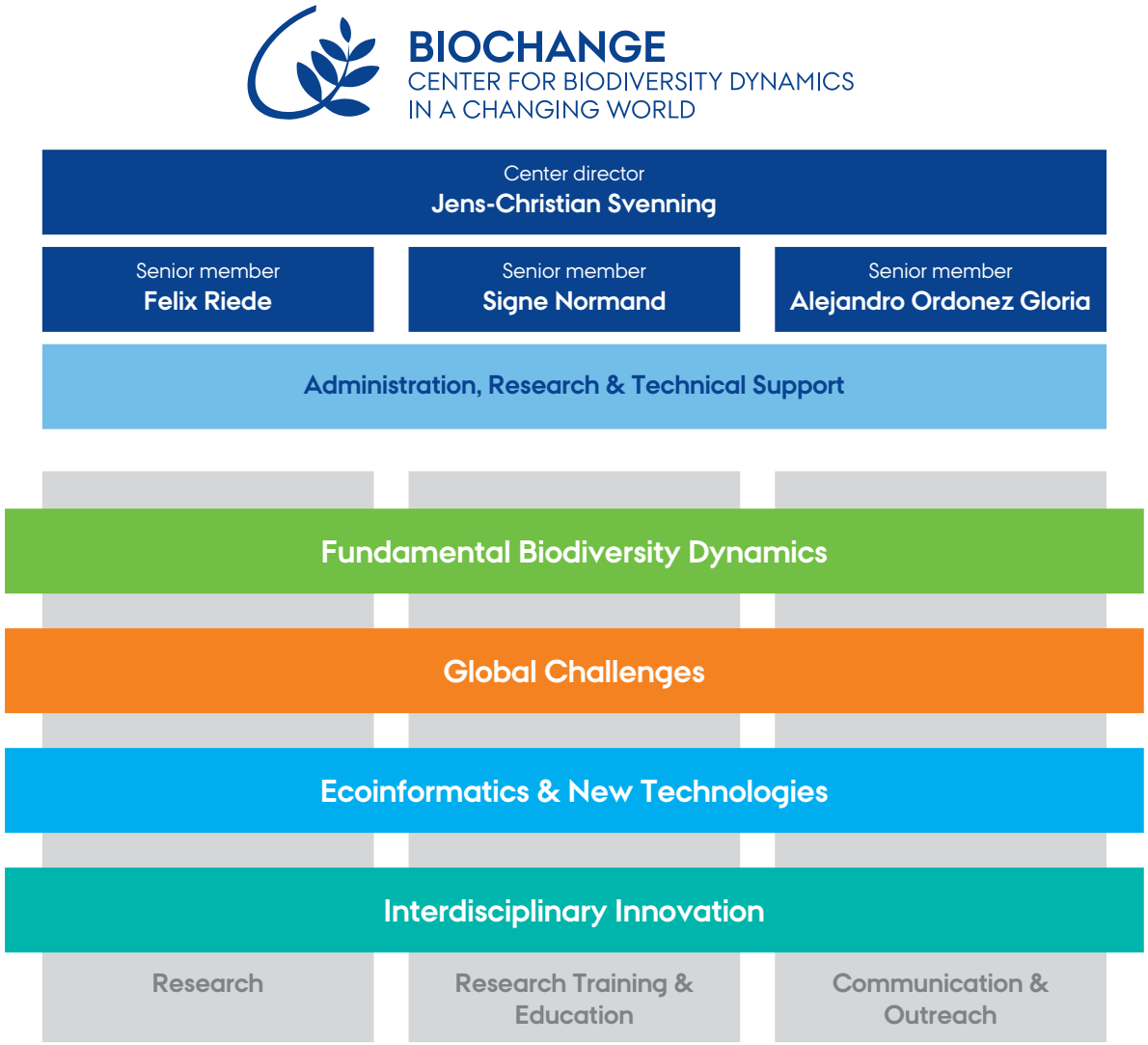
INTERDISCIPLINARY INNOVATION

Our research has focus on big, complex issues, integrating topics such as global change, ecoinformatics, and human-environment relations. This entails a strong need for interdisciplinarity, and our goal with this theme is to explore the potential of novel cross-disciplinary development of perspectives and methods in gaining new ground on important and often complex issues related to biodiversity dynamics in this fast-changing world. We will keep a strategically open agenda to keep exploring novel interdisciplinary possibilities, as we see this as essential for coming up with truly new ideas, new methods, and perspectives needed for breakthroughs on established questions. However, focus areas are:
(1) Enhance the collaboration with computer science to unfold the potential for Big Data studies on biodiversity and the global challenges. (2) Increase our understanding of human dependence on nature via application and integration of theory from a broad range fields, informatics, and remote sensing to study impacts of environment and biodiversity on societal development and human well-being. (3) Develop interdisciplinary research on landscape planning to safeguard biodiversity, ecosystem services and human well-being in an Anthropocene world with strong human population growth, strong urbanization, and looming massive climate change. This will involve linking fields such as ecology, geography, landscape architecture, economy, and medicine, often using spatial Big Data modelling with remote sensing data in a key role.

ORGANIZATION AND STAFF

ORGANIZATION AND STAFF

BIOCHANGE members, associates, and guests at our kick-off seminar in April 2018. Photo: Urs A. Treier, BIOCHANGE



ORGANIZATIONAL DIAGRAM

BIOCHANGE is headed by Jens-Christian Svenning and includes three additional senior core members from Aarhus University: Professor MSO Felix Riede, Associate Professor Signe Normand, and Assistant Professor Alejandro Ordonez Gloria. The center is supported by a group of administrative, research and technical staff members. The center is organized around three main functions, namely Research, Research Training and Education, and Communication and Outreach. All activities of the functions in BIOCHANGE are centered on four main research themes: [1] Fundamental Biodiversity Dynamics, [2] Global Challenges, [3] Ecoinformatics & New Technologies, and [4] Interdisciplinary Innovation coordinated by the senior scientists of the Center.

ACADEMIC STAFF

Senior core members

Jens-Christian Svenning[1]

Center director, Professor, VILLUM Investigator, PhD

Macroecology, Global Change, Anthropocene, Rewilding, Megafauna, Vegetation, Ecoinformatics

svenning@bios.au.dk

Felix Riede[2,3]

Professor MSO, PhD

Geoarchaeology, Environmental Humanities, Cultural Evolution, Palaeolithic Archaeology

f.riede@cas.au.dk

Signe Normand[1,3]

Associate professor, VILLUM Young Investigator, PhD

Biodiversity, Vegetation Dynamics, Range Dynamic Modelling, Remote Sensing, Drones, Ecoinformatics

signe.normand@bios.au.dk

Alejandro Ordonez Gloria[1]

Assistant professor, PhD

Novel Ecosystems, Climate Change, Land Use Change, Paleoecology, Anthropocene, Functional Ecology

alejandro.ordonez@bios.au.dk

Postdocs

Andras Zlinsky[1]

Postdoc, PhD

LiDAR, Remote Sensing, Biodiversity, Vegetation Mapping, Wetlands

azlinszky@bios.au.dk

Anke Verena Zernack[2]

Postdoc, PhD

Physical Volcanology, Volcanic Stratigraphy, Tephrochronology, Volcanic Mass Flows, Volcanic Hazards, Human Impact of Volcanic Eruptions

a.v.zernack@cas.au.dk

Christian Steven Hoggard[2]

Postdoc, PhD

Archaeology, Lithic Technology, Shape Analysis, Palaeolithic, Human Evolution

C.Hoggard@cas.au.dk

Florian Rudolf Sauer[2]

Postdoc, PhD

Final Palaeolithic, GIS, Landscape Archaeology, Photogrammetry, Raw Material Economy

florian.sauer@cas.au.dk

Additional affiliations:

[1] Section for Ecoinformatics and Biodiversity – Department of Bioscience
[2] School of Culture and Society – Department of Archaeology and Heritage Studies
[3] Arctic Research Centre – Department of Bioscience
[4] Center for Massive Data Algoritmics – Department of Computer Science

Postdocs

Kai Kyle Yue[1]

Postdoc, PhD

Forest Ecology, Global Change Ecology, Plant Litter Decomposition, Biodiversity and Ecosystem Functioning

kyleyuechina@bios.au.dk

Koenraad Van Meerbeek[1]

Postdoc, PhD

Ecosystem Functioning, Functional Diversity, Nature Conservation, Ecosystem Stability

koenraad.vanmeerbeek@bios.au.dk

Kristine Engemann Jensen[1]

Postdoc, PhD

Green Space, Mental Health, Remote Sensing, GIS

engemann@bios.au.dk

Matt Davis[1]

Postdoc, PhD

Paleontology, Mammalogy, Phylogenetic Diversity, Functional Diversity, Scale Issues, Data Architecture

matt.davis@bios.au.dk

Postdocs

Robert Buitenwerf[1]

Postdoc, PhD

Savanna Ecology, Remote Sensing, Climate Change, Vegetation Ecology, Biogeography

buitenwerf@bios.au.dk

Robert John Lewis[1]

Postdoc, PhD

Methods in Ecology, Community Ecology, Species Distribution Modelling, Dark Diversity, Functional Traits, Climate Extremes

rob.lewis@bios.au.dk

Scott William Jarvie[1]

Postdoc, PhD

Trophic Rewilding, Reintroduction Biology, Global Change Biology, Species Distribution Modelling, Biophysical Ecology, Wildlife Management

sjarvie@bios.au.dk

Silvia Ceausu[1]

Postdoc, PhD

Ecosystem Services, Social-Ecological Systems, Conservation Policies, Human-Wildlife Conflict

silvia.ceausu@bios.au.dk

All portraits and photo editing by Urs A. Treier, BIOCHANGE

PhD students

Bjarke Madsen[1]

PhD student

Plant Diversity, Grasslands, UAS, Drone Ecology, Remote Sensing, LiDAR

bjarke.madsen@bios.au.dk

Ditte Arp Jensen[1]

PhD student

Global Change, Biodiversity, Gymnosperms, Species Distribution Modelling

dittearp@bios.au.dk

Emilio Berti[1]

PhD student

Megafauna, Food Webs, Ecological Networks, Community Dynamics, Rewilding

emilio.berti@bios.au.dk

Jesper Borre Pedersen[2]

PhD student

Archaeology, Late Glacial, Disequilibrium, Stone Age, Artefact Morphometrics

jesper.borre@cas.au.dk

Julia Carolina Mata[1]

PhD student

Animal Reintroduction, Herbivore Ecology, Species Distribution, Herbivore Diet

julia.mata@bios.au.dk

PhD students

Michael Munk[1]

PhD student

Remote Sensing, GIS, Human-Megafauna Conflict, Nature Management, Science Communication

munk@bios.au.dk

Oskar Liset Pryds Hansen[1,3]

PhD student

Biodiversity, Arthropod Ecology, Camera traps, Rewilding

oli@bios.au.dk

Pil Birkefeldt Møller Pedersen[1]

PhD student

Rewilding, Ecological Impacts, Large Herbivores, Eurasian Beaver, Vegetation Changes, Post-Release and Before-and-After Release Evaluation

pil.pedersen@bios.au.dk

Rasmus Østergaard Pedersen[1]

PhD student

Late Pleistocene Mammal Fauna, Ecoinformatics, Macroecology

rasmus.pedersen@bios.au.dk

Rowan Jackson[2]

PhD student

Norse Greenland, Climate Change Adaptation, North Atlantic

rowan.jackson@ed.ac.uk

PhD students

Samira Kolyaie[1]

PhD student

Remote Sensing, Image Analysis, GIS, Vegetation Mapping

samira.kolyaie@bios.au.dk

Simon D. Schowanek[1]

PhD student

Restoration, Conservation, Herbivory, Megafauna, Functional Traits

Simon.Schowanek@bios.au.dk

Vincent Fehr[1]

PhD student

Plant Ecology, Palms, Invasion Biology, Novel Ecosystems, Vegetation Dynamics

vincent.fehr@bios.au.dk

In addition, the center includes ten Bachelor and six Master students (further reading in section: Research training and Education)

ADMINISTRATIVE, RESEARCH, AND TECHNICAL SUPPORT STAFF

Anne Blach Overgaard[1]

Center Manager, PhD

Geographic Range Dynamics, Spatial Statistical Modelling, Global Change Ecology, Nature Conservation, GIS, Project Management

anne.overgaard@bios.au.dk

Dennis Pedersen[1]

Field coordinator, AC-TAP

Tropical Ecology, Organizing Field Work, Project Management

dp@bios.au.dk

Peder Klith Bøcher[1,4]

GIS- and Database coordinator, PhD

GIS, Remote Sensing, Handling, Analysis and Modelling of Geospatial Data

peder.bocher@bios.au.dk

Thomas Eggers-Kaas[2]

Research assistant

Archaeology, Stone Age, Photogrammetry, GIS

tek@cas.au.dk

Uffe Krogh[2]

Research assistant

Climate Adaptation, Environmental Humanities, Environmental History, Cultural History

ukrogh@cas.au.dk

Urs A. Treier[1,3]

Research Scientist, UAS4Ecology Lab Manager

Ecology, Remote Sensing, Population Biology, Vegetation Ecology, Biogeography

urs.treier@bios.au.dk

BIOCHANGE ASSOCIATES

Andreas Schweiger, Akademischer Rat a.Z.,
Plant Ecology, University of Bayreuth, Germany

Angela Luisa Prendin, Postdoc,
TeSAF Department, Padova University, Italy

Anne Bjorkman, Postdoc,
Senckenberg Biodiversity and Climate Research Centre (Bik-F),
Frankfurt, Germany

Brian Enquist, Professor,
Ecology and Evolutionary Biology, University of Arizona, USA

Camilla Fløjgaard, Researcher,
Section for Biodiversity and Conservation, Department of Bioscience, Aarhus University, Denmark

Cicimol Alexander, AIAS-COFUND Junior Fellow,
Aarhus Institute of Advanced Studies, Aarhus University, Denmark

Jian Zhang, Professor,
School of Ecological and Environmental Sciences, Shanghai, China

Josep M. Serra-Diaz, Assistant Professor,
AgroParisTech, Département SIAFEE, Université de Lorraine, France

Manuel Steinbauer, Professor,
GeoZentrum Nordbayern, Department of Geography and Geosciences Friedrich-Alexander University of Erlangen-Nürnberg (FAU), Germany

Mauro Galetti, Professor,
Department of Ecology, São Paulo State University, São Paulo, Brazil

Mette Vestergaard Odgaard, Postdoc,
Section for Agricultural Systems and Sustainability and Section for Integrated Geographical and Social Studies, Department of Agroecology, Aarhus University, Denmark

BIOCHANGE GUESTS 2017-2018

Ashley Pearcy, visiting Researcher,
Aarhus University, Denmark

Claudia Troiano, visiting PhD student,
Naples University, Italy

Katja Jäkle, Erasmus Student,
Technical University Munich, Germany

Ke Cao, visiting PhD student,
Beijing Normal University & Institute of Botany,
Chinese Academy of Sciences, China

Kourosh Ahmadi, visiting PhD student,
Tarbiat Modares University, Iran

Nora Escribano Compains, visiting PhD student,
University of Navarra, Spain

Sara Guadilla Saez, visiting PhD student,
Autonomous University of Barcelona, Spain

Yun Chen, visiting PhD student,
Henan Agricultural University, China

Xue Yin, visiting PhD student,
Sun Yat-sen University, China

BIOCHANGE ALUMNI 2017-2018

Postdocs

Andreas Schweiger, Akademischer Rat a.Z,
Plant Ecology, University of Bayreuth, Germany

Angela Luisa Prendin, Postdoc,
TeSAF Department, Padova University, Italy

Anne Bjorkman, Postdoc,
Senckenberg Biodiversity and Climate Research Centre (Bik-F),
Frankfurt, Germany

Josep M. Serra-Diaz, Assistant Professor,
AgroParisTech, Département SIAFEE, Université de Lorraine,
France

Timo Conradi, Postdoc,
Bayreuth Center of Ecology and Environmental Research
(BayCEER), University of Bayreuth, Germany

Wang Li, Postdoc,
Department of Plant Sciences, University of Cambridge, UK

PhD students

Sigrid Schøler Nielsen,
graduated on February 1, 2018

Shuqing Teng,
graduated on March 8, 2018
Postdoc, School of Life Sciences, Nanjing University, China

PORTRAITS OF SENIOR CORE MEMBERS

JENS-CHRISTIAN SVENNING

WHO ARE YOU?

My name is Jens-Christian Svenning. I am a broadly based ecologist and biogeographer, with strong interest in everything related to biodiversity, global change, restoration and self-willed nature, as well as Anthropocene complexities & human-nature interrelations. My work has led to a number of major recognitions, notably a consolidator-phase European Research Council (ERC) Starting grant in 2013, the Ministry for Higher Education and Science's Eliteforsk award in 2014, Queen Margrethe II's Science Award in 2016, a Carlsberg Foundation Semper Ardens grant in 2016, and a VILLUM Investigator grant in 2017.

POSITION AND BACKGROUND

I am professor in geospatial ecology and VILLUM Investigator, director for BIOCHANGE – Center for Biodiversity Dynamics in a Changing World, as well as head of Section for Ecoinformatics & Biodiversity, all at Department of Bioscience, Aarhus University. I obtained my PhD in 1999 in tropical plant community ecology, based on work on palms in the tropical forests of Ecuador.

MAIN RESEARCH AREAS

I have developed a research agenda on biodiversity dynamics in a changing world focused around four linked themes: [1] Fundamental biodiversity diversity, [2] Global challenges, [3] Ecoinformatics and new technologies, and [4] Interdisciplinary innovation, i.e., the themes I have chosen as the focal themes for BIOCHANGE.

MAIN RESEARCH QUESTIONS

As regards my prior research, a major achievement is my contribution to mainstreaming historical contingency and disequilibrium dynamics into ecology and global change biology. Some of the important discoveries and results that I have spearheaded in the period prior to BIOCHANGE include: (i) evidence for the role of climate stability in shaping Earth's biodiversity patterns and associated functional capacity (in part jointly with BIOCHANGE senior members Signe Normand and Alejandro Ordonez Gloria), (ii) that the massive prehistoric megafauna losses are linked to human expansion and have had strong ecosystem effects, (iii) development of a clear concept and research agenda for rewilding, and (iv) a predictive framework for where climate change is likely to force the emergence of novel ecosystems (jointly with BIOCHANGE senior member Alejandro Ordonez Gloria).

FUTURE PLANS

My future plans concentrate on developing the above four research themes. More specifically, I will have key focus on (1) transient biodiversity dynamics, trophic changes (notably megafauna losses and comebacks), and novel ecosystems, (2) developing next-generation predictive models in relation to current and future climate change, (3) advancing my team's ecoinformatics capabilities and exploiting the rapidly rising potential for extremely high-resolution spatiotemporal analyses, and (4) novel interdisciplinary work. For the latter, my focus will be on (a) ecological Big Data, (b) human-nature inter-relations (notably the role of exposure to nature and biodiversity for human mental health and well-being), and (c) interdisciplinary landscape planning to safeguard biodiversity, ecosystem services and human well-being in the face of strong current and future human population growth, societal dynamics, and climate change. Overall, I put strong emphasis in combining basic studies in these areas with coupled direct work on real-world problems and their solutions in terms of biodiversity conservation, ecological restoration, and socio-ecologically sustainable landscape development.

KEY PAPERS

Engemann, K., C.B. Pedersen, L. Arge, C. Tsirogiannis, P.B. Mortensen, and **J.-C. Svenning**. 2018. Childhood exposure to green space – A novel risk-decreasing mechanism for schizophrenia? Schizophrenia Research. (e-pub ahead of print).

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Sandom, C.J., R. Ejrnæs, M.D.D. Hansen, and **J.-C. Svenning**. 2014. High herbivore density associated with vegetation diversity in interglacial ecosystems. Proceedings of the National Academy of Sciences 111:4162-4167.

Svenning, J.-C., P.B M. Pedersen, C.J. Donlan, R. Ejrnæs, S. Faurby, M. Galetti, D.M. Hansen, B. Sandel, C.J. Sandom, J.W. Terborgh, and F.W. M. Vera. 2016. Science for a wilder Anthropocene: Synthesis and future directions for trophic rewilding research. Proceedings of the National Academy of Sciences 113:898-906.

Photo: Anne Blach Overgaard, BIOCHANGE

FELIX RIEDE

WHO ARE YOU?

My name is Felix Riede; I was born and raised in Germany but have for the last nine years lived in Denmark with my Danish-American wife and our two boys, Alexander (6) and Oskar (2).

POSITION AND BACKGROUND

I received my entire university education in the UK with first a BA from Durham, then an MPhil and PhD from Cambridge (with a period as visiting scholar at KU), all straddling the interface between the human, biological and environmental sciences. After a stint as Junior Research Fellow at Wolfson College and the Leverhulme Centre for Human Evolutionary Studies (Cambridge), I became British Academy Postdoctoral Fellowship at the Centre for the Evolution of Cultural Diversity (UCL). In 2009, I joined Aarhus University, initially as Assistant, then Associate Professor, with visiting appointments at Harvard and Cambridge. After having been Head of Department for a few years, I recently became Professor MSO of Environmental Humanities with focus on the archaeology of climate change.

MAIN RESEARCH AREAS

I am director of the Centre for Environmental Humanities and core member of BIOCHANGE. On a daily basis, I head the Laboratory for Past Disaster Science, funded by the Independent Research Council Denmark that investigates how past extreme environmental events – especially volcanic eruptions – have impacted human communities in Europe and elsewhere and how this evidence can be brought forward into current debates about climate change, resilience and vulnerability.

MAIN RESEARCH QUESTIONS

My work is focused on human-environment relations, on biocultural adaptations and how to study them in human societies, especially those of the past. I am a dedicated interdisciplinarian and I work with Neanderthals and with the early human forager groups in northern Europe after the end of the last ice age. I also have an interest in the Anthropocene and how we can approach this in many ways controversial epoch archaeologically. I am keen on bringing sophisticated quantitative and natural science methods to the humanities in general and archaeology in particular.

FUTURE PLANS

Until the end of 2020, I am quite well-funded through my current Sapere Aude grant. I am also exploring the possibilities of getting the Environmental Humanities more firmly established in Denmark. It's an emerging discipline that precisely because of its 'undisciplined' nature falls somewhat between the traditional funding chairs. In parallel, I am also applying to the ERC Consolidator Grant scheme in order to further pursue my research into how we can apply distribution modelling tools and other quantitative methods from evolutionary biology to archaeology.

KEY PAPERS

Benito, B.M., J.-C. Svenning, T. Kellberg-Nielsen, **F. Riede**, G. Gil-Romera, T. Mailund, P.C. Kjaergaard and B.S. Sandel. 2017. The ecological niche and distribution of Neanderthals during the Last Interglacial. Journal of Biogeography 44:51-61.

Normand, S., T.T. Høye, B.C. Forbes, J.J. Bowden, A.L. Davies, B.V. Odgaard, **F. Riede**, J.-C. Svenning, U.A. Treier, R. Willerslev, and J. Wischnewski. 2017. Legacies of historical human activities in Arctic woody plant dynamics. Annual Review of Environment and Resources 42: 541-567.

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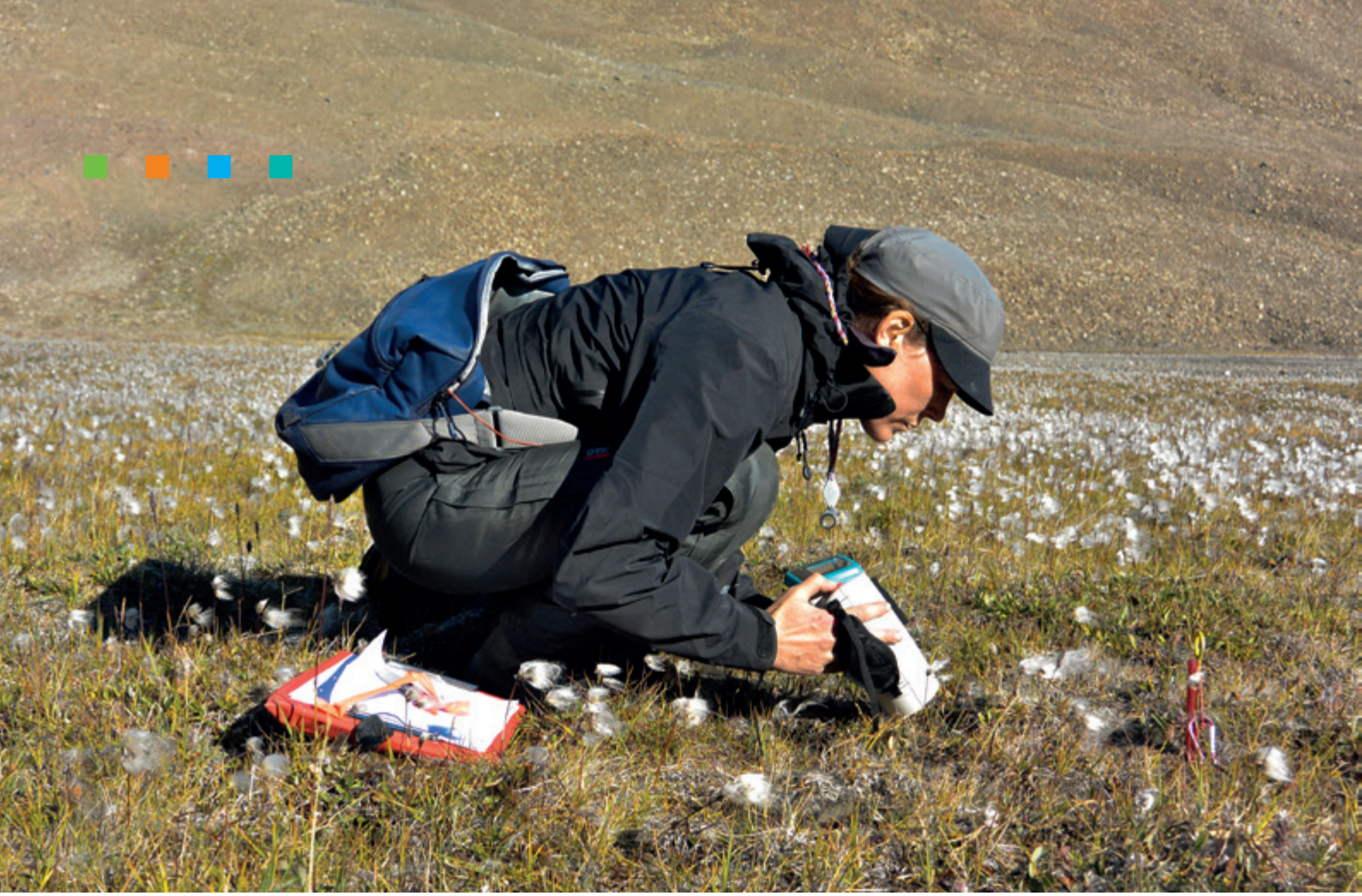
Photo: Dehlia Hannah



SIGNE NORMAND

WHO ARE YOU?

I am Signe Normand. I was born in Aarhus and lived the first six years of my life next to the botanical garden and greenhouses here in Aarhus. Later, I lived in other parts of Denmark (Grenaa & Ribe), Norway, US and Switzerland. I have been back in Aarhus for 4 years, and live down town with my swiss husband and our three children; Liv (9), Sia (7) and Noe (2).

POSITION AND BACKGROUND

My fascination for living organisms, especially plants, started in my early childhood when my grandfather introduced me to the wonders of nature. Later I went to boarding school focused on biology, and after high school, I moved to Norway for one year where I attended a Folk High School specializing in outdoor life and sustainable use of nature.

I studied Biology at Aarhus University, earning a Bachelor's degree by studying Palms in the Amazon, and afterwards a Master's and PhD degree by studying the distribution and diversity patterns of the European flora. After receiving my PhD degree, I went onto a postdoc position at the Swiss Federal Research Institute for Forest, Snow and Landscape. Since 2014, I have been back at the Section for Ecoinformatics and Biodiversity, and am now Associate Professor in Botanical Macroecology and have established a research group focused on vegetation dynamics as well as the UAS4Ecology, a research facility using the emerging unmanned aerial system (UAS) technology to answer questions in ecology. In addition, I am the daily leader of the application initiative in the Danish Drone Infrastructure and associated with Arctic Research Center, Aarhus University.

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Photo: Laerke Stewart

MAIN RESEARCH AREAS AND QUESTIONS

I am a macro- and vegetation ecologist dedicated to understanding patterns of species' occurrence and biodiversity and to provide methodological progress to bring more realism to models and predictions of biodiversity dynamics. I have studied these questions from the tropics to the Arctic, where most of my research effort and fieldwork have been centered in recent years. I mainly utilize remote sensing, range dynamic models, dendro- and trait-based ecology. The goal of my research is to find answers to fundamental questions in ecology, but also to inform nature conservation about the impact of global change on biodiversity. My current research has three main components: (i) empirical studies to gain insight on the factors and processes determining ecological patterns across space and time; with a special focus on the role of non-equilibrium and transient dynamics as well as scale-dependencies. (ii) gaining insight on current and future range dynamic through models of species post-glacial migration patterns after the Last Glacial Maximum, and (iii) utilizing LiDAR and hyperspectral sensors in combination with air- and satellite-borne remote sensing for monitoring, understanding, and predicting vegetation and biodiversity dynamics across space and time.

FUTURE PLANS

Several grants have enabled me to build up my independent research group and infrastructure, The Villum Young Investigator programme, The Carlsberg Foundation Distinguished Associate Professor Fellowships, Aarhus University Research Foundation Associate Professor Starting Grant, and until 2022 I am funded by a Sapere Aude grant from the Danish Council for Independent Research with focus on climate change impacts on Arctic shrub dynamics.

ALEJANDRO ORDONEZ GLORIA

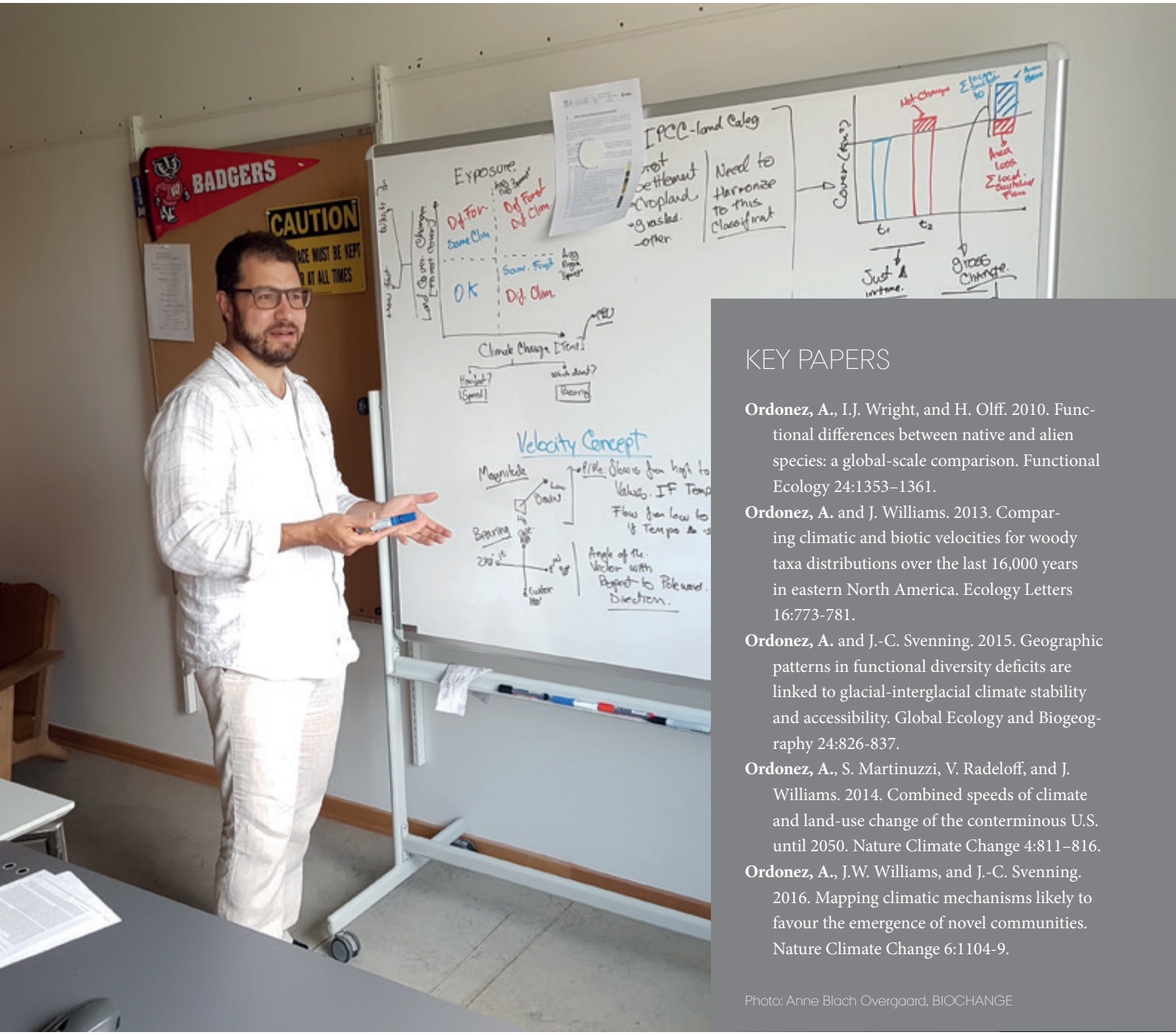

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Photo: Anne Blach Overgaard, BIOCHANGE

WHO ARE YOU?

My name is Alejandro Ordonez Gloria, but most people call me Alejo. I was born and raised in Colombia, but over the last 13 years, I have been moving across multiple countries and continents (the USA, The Netherlands, Australia, and Northern Ireland). Today, my Dutch wife, our baby boy, and I are happy to call Aarhus home.

POSITION AND BACKGROUND

I am a recently appointed Assistant Professor at the Department of Bioscience at Aarhus University (AU). I am a biologist by training and received a BSc from the Pontificia Universidad Javeriana (Colombia). After a period working in the private sector in my home country, I moved to the Netherlands where I received my MSc and PhD from the University of Groningen. In 2011, I became the Climate People and Environment Post-Doctoral researcher at the University of Wisconsin Madison. This position was followed by a 4-year Post-Doctoral appointment (2013-2017) at AU as part of the ERC funded HISTFUNC project lead by Jens-Christian Svenning. In 2017, I became lecturer in Global Change Biology at Queens University Belfast, but later that year, I moved back to AU as Assistant Professor and became a core member of BIOCHANGE.

MAIN RESEARCH AREAS

I am a global change ecologist, and my research focuses on quantifying and explaining how environmental changes shape diversity patterns, how these changes can affect ecosystem functions and services, and what the implications of such changes are for conservation and agri-food systems. With my work, I aim to provide knowledge-based advice on how to manage nature under Earth's changing ecological and climatic conditions. In doing so, I have shown the lasting effects of past natural and anthropogenic driven environmental changes on biodiversity.

MAIN RESEARCH QUESTIONS

The central theme of my most recent published work has been determining the influence of paleoclimate on past and present-day patterns in biodiversity and ecosystems. For this, I have used a broad geographical and temporal perspective centred on extensive comparative studies. The second theme in my work has been the development of metrics useful to describe how current and future environmental changes will shape diversity patterns, when and where novel ecosystems will emerge, and evaluate the ecological implications of alternative global change scenarios.

FUTURE PLANS

The central question gilding my upcoming work is 'how should humanity respond to the challenges imposed by global changes?'. For this, I will focus on establishing when, where, and how environmental and biological tipping points are crossed, and the consequences of these changes for critical ecological processes and the services ecosystems provide.


RESEARCH

VILLUM INVESTIGATOR PROJECT:

BIODIVERSITY DYNAMICS IN A CHANGING WORLD

Principal investigator: Jens-Christian Svenning

Earth is a living planet and what makes it not just a livable, but a wonderful place to live is its rich biodiversity. This natural and biocultural heritage is now under massive pressure from human resource use and associated anthropogenic pressures, with a strong risk that these pressures will become even stronger in the future. To safeguard Earth's biodiversity is one of the most pressing and difficult challenges facing humanity, e.g., as outline din the global sustainable development goals (SDGs). With the VILLUM Investigator project the ambition is to improve our understanding and predictive capacity of the complex biodiversity dynamics under anthropogenic global change and their consequences for people and society, and based hereon, on developing novel solutions to promote a biodiverse future.

The project has four linked themes, which are the same as for the BIOCHANGE center overall:

[1] Fundamental Biodiversity Dynamics
[2] Global Challenges
[3] Ecoinformatics and New Technologies
[4] Interdisciplinary Innovation

Within these we have key focus on [1] transient biodiversity dynamics, trophic changes (notably megafauna losses and comebacks), and novel ecosystems, [2] developing next-generation predictive models in relation to current and future climate change, [3] advancing the team's ecoinformatics capabilities and exploiting the rapidly rising potential for extremely high-resolution spatiotemporal analyses, and [4] novel interdisciplinary work. For the latter, the focus will be on (a) ecological Big Data, (b) human-nature inter-relations (notably the role of exposure to nature and biodiversity for human mental health and well-being), and (c) interdisciplinary landscape planning to safeguard biodiversity, ecosystem services and human well-being in the face of strong current and future human population growth, societal dynamics, and climate change.

Although the project started less than 1 year ago, we have achieved strong progress, both organizationally and scientifically. Most importantly, we have been able to launch the BIOCHANGE center based around this project and aimed at realizing its important and challenging goals. In terms of human resources, a center manager, three postdocs, and two PhD students have been employed directly on the project, while many others are also contributing via the overall center as well as via external collaborations. Several key studies have already been published, with much more started and well under way.

The project is funded by VILLUM FONDEN, with 39,987,212 DKK and runs 2017-2023.

Further reading:
http://bios.au.dk/om-instituttet/organisation/oekoinformatik-biodiversitet/projects/biochange/research/villum-investigator-project/

VILLUM FONDEN

MEGAPAST2FUTURE:

14

MEGAFAUNA ECOSYSTEM ECOLOGY FROM THE DEEP PREHISTORY TO A HUMAN-DOMINATED FUTURE

Principal investigator: Jens-Christian Svenning

Prior to the global expansion of Homo sapiens, ecosystems across the world teemed with large animals (megafauna). Elephants, for example, occurred from Patagonia to the British Isles and the Cape until just 10,000 years ago. Since then megafaunas have declined dramatically, a decline that continues to the present day, driven by land conversion to agriculture to feed growing human populations and unsustainable hunting. In some regions, however, declines have been replaced by comebacks (e.g., re-expansion of wolves in Europe). At the same time, evidence is emerging that megafaunas may be crucial for ecosystem function and may even affect the Earth's climate and nutrient cycling. Reflecting this, it is increasingly, but controversially argued that megafaunas should be reintroduced to restore their ecological functions (rewilding). Human impacts are now so pervasive that officially defining a new geological epoch (the Anthropocene, epoch of man) for the present is being considered. Given intensifying human impacts on Earth's environment – with pronounced increases in the human population and strong climate changes likely across the 21st century – we are now at a crossroads for Earth's megafauna. Do we let it become lost, or do we attempt to restore it and its functional importance?

The project focuses on developing a solid, synthetic understanding of megafauna ecosystem ecology and its potential role in developing a sustainable, biodiverse future. To this end, MegaPast2Future aims to develop new theory on the role of megafauna in ecosystems (work package 1), provide a novel understanding of the evolutionary and biogeographic development of the world's megafaunas and their ecosystem importance (work package 2), do field-based testing of key theory and hypotheses (work package 3), and assess and improve the scope for human-megafauna coexistence in the Anthropocene (work package 4). Given the complexity of the problem, the methodology is interdisciplinary, integrating macroecology, theoretical ecology, paleobiology, experimental ecology, geography, economics, and conservation. The project contributes to theme 1 (Fundamental Biodiversity Dynamics) and theme 4 (Interdisciplinary Innovation) of the BIOCHANGE center.

The project is still less than halfway, but much has already been achieved. Core field sites have been established in Denmark, Argentina, and Kenya, with much fieldwork already well in progress; we have held a successful international megafauna symposium, a likewise successful megafauna PhD course, as well as carried out a lot of public outreach. Several key studies have already been published, with much more started and well under way.

The project is funded by the Carlsberg Foundation 'Semper Ardens' research project, with 13,777,082 DKK and runs 2016-2020. It currently employs three postdocs and three PhD students with three additional postdoc positions being filled this year.

Further reading: http://bios.au.dk/om-instituttet/organisation/oekoinformatik-biodiversitet/projects/biochange/research/villum-investigator-project/

CARLSBERG FOUNDATION

MegaPast2Future

Photo: Michael Munk, BIOCHANGE

TREECHANGE:

TREE DIVERSITY DYNAMICS UNDER CLIMATE CHANGE

2 3

Principal investigator: Jens-Christian Svenning

The big question that we will address is: 'How will tree species diversity react to future global climate change?' Forests are among the most important ecosystems on Earth, harbouring a substantial proportion of biodiversity and providing vital ecosystem services such as carbon sequestration, climate regulation, erosion protection, and timber and non-timber forest products. The diversity of tree species plays a central role in forest ecosystems and for the subsistence of millions of people in rural communities worldwide. Part of the challenge in understanding drivers of tree diversity is that we do not have a complete picture of the current tree distribution and diversity of tree species worldwide.

To improve our understanding of global tree distributions, we will apply advanced SDM-based approaches with thorough handling of spatial autocorrelation, pseudo-absences and model complexity to the c. 65,000 identified tree species globally. For those species with very few records, we will complement the use of SDMs with functional traits and phylogeny to provide insights on species range responses to climate. Specifically, we will use gap filled trait data to understand climatic responses for rare species – where there are too few records to implement the SDM approach with confidence. In an additional step, this will potentially allow estimating climatic-response functions, which will then be projected under different climate change scenarios and evaluate shifts in tree diversity under climate change. The project contributes to theme 2 (Global Challenges) and theme 3 (Ecoinformatics and New Technologies) of the BIOCHANGE center.

During the first year of the project we have achieved good progress, notably we have built a comprehensive, quality-checked data base on Earth's tree species, covering c. 50,0000 tree species and including 37 million species occurrence records as well as large amounts of data on functional traits and phylogeny. We have also published the first paper on the project, in Forest Ecosystems: https://forestecosyst.springeropen.com/articles/10.1186/s40663-017-0120-0.

Ceiba trichistandra, endemic kapok tree from western Ecuador and Peru.

Photo: Jens-Christian Svenning, BIOCHANGE

Very rare hop-hornbeam *(Ostrya rehderiana)* from eastern China, just four mature individuals left in situ (3 in this picture, the fourth close by).

Photo: Jens-Christian Svenning, BIOCHANGE

The project is funded by Danish Council for Independent Research | Natural Sciences, with 2,587,678 DKK and runs 2016-2019. It has one postdoc employed, and is done in collaboration with BIOCHANGE alumni Pep Serra Diaz (associate professor, AgroParisTech) as well as a suite of international collaborators.

Further reading: http://bios.au.dk/om-instituttet/organisation/oekoinformatik-biodiversitet/projects/biochange/research/

DANMARKS FRIE FORSKNINGSFOND
INDEPENDENT RESEARCH FUND DENMARK

LAPADIS PHASE 2:

APOCALYPSE THEN? THE LAACHER SEE VOLCANIC ERUPTION (13,000 YEARS BEFORE PRESENT), DEEP ENVIRONMENTAL HISTORY AND EUROPE'S GEO-CULTURAL HERITAGE

Principal investigator: Felix Riede

This project is funded by the Independent Research Council Denmark's Sapere Aude Starting Grant instrument and represents phase two of LAPADIS – the Laboratory for Past Disaster Science. In the project, we conduct ground-breaking research centred on a cataclysmic environmental event that punctuated an early period on Nordic prehistory – the Laacher See volcanic eruption that occurred c. 13,000 years ago in present-day Germany, and its impact on communities in Europe and especially in southern Scandinavia – and on this basis to develop novel outreach engagements that make Europe's geo-cultural heritage work for environmental literacy.

By exploring in parallel and unprecedented detail the cultural and geological dynamics of the Laacher See eruption and its suggested consequences, this project will lead to (1) a significantly improved understanding of this last major continental European eruption, and (2) allow us to test the dual hypothesis of its regionally varying human impact in Central Europe and southern Scandinavia respectively. This project will (3) provide a robust historically informed evidence-base for an engagement of deep-time Environmental Humanities with the profound ethical predicaments of present and future climate change and climate catastrophe.

Over the last few months, members affiliated with the 'Apocalypse Then?' project have begun three-dimensional scanning and analyses of stone tools from ten archaeological sites around Denmark and Germany. In doing such, they hope to better understand the nature and structure of hunter-gatherer communities during the Stone Age.

Specifically, they will be recording archaeological material using a powerful, user-friendly photogrammetric technique termed structure-from-motion (SfM). In this, static high-resolution photographs are taken around an object, rotating on a calibrated turntable (Fig. 1). These photographs (n = 72) are then processed through various photo-editing scripts, before stitched together to create an accurate 3D model (Fig. 2). Using the models, the team will record a number of attributes associated with the stone tools to better understand how and why the toolkits of different hunter-gatherer populations differ, and how they change according to immediate societal and environmental change, for example the Laacher See volcanic eruption c. 13,000 BP. All models produced are uploaded to the internet, providing a robust dataset of artefacts for future researchers, and a digital platform for the public to examine past hunter-gatherer stone tools for themselves.

In pushing the boundaries of archaeological analyses, these models will then be subject to three-dimensional shape analysis (geometric morphometrics), a powerful statistical framework for capturing the morphological variance of specimens. When coupled with the attribute analysis these two techniques will be the first to examine the behaviour of hunter-gatherer communities through such a resolution.

Recording commenced in April 2018, with a project deadline of September 2018.

It currently employs three postdocs and one research assistant in close collaboration with other senior scientists at Aarhus University.

Figure 1. The structure-from-motion set-up (Camera: 50MP Canon EOS Full Format).
Photo: Christian Steven Hoggard, BIOCHANGE

Figure 2. An example of a blade from the Late Glacial site of Søvind, Denmark. Left: the original blade. Right: the three-dimensional model created through structure-from-motion (SfM).
Photo: Christian Steven Hoggard, BIOCHANGE

The project is funded by Danish Council for Independent Research | Natural Sciences, with 6,926,238 DKK. It currently employs three postdocs and one research assistant in close collaboration with other senior scientists at Aarhus University.

Further reading: http://projects.au.dk/lapadis/

LAPADIS
LABORATORY FOR PAST DISASTER SCIENCE

DANMARKS FRIE FORSKNINGSFOND
INDEPENDENT RESEARCH FUND DENMARK

CEH:

CENTRE FOR ENVIRONMENTAL HUMANITIES

2

Principal investigator: Felix Riede

The Aarhus University Centre for Environmental Humanities (CEH) is concerned with re-engaging the environment in disciplines such as history, religion, literature and media, ethics, archaeology, anthropology, education, and artistic practice – all with a specific interest in reflecting on present concerns in a deep historical perspective. In the face of the profound environmental crises that loom large in politics and the popular imagination, exploring the cultural interfaces of different societies and their surroundings, synchronically and diachronically, has attained a new urgency. The AU CEH aims to bring together hitherto isolated Environmental Humanities scholars at Aarhus University, and to provide a major longer-term catalyst for the diverse research conducted under its aegis. The CEH has been seed-funded directly from the School of Culture and Society and currently host an International Network Programme grant from the Danish Agency for Science and Higher Education for developing Aarhus-Cape Town Environmental Humanities Partnership.

Project PI Felix Riede presenting the first results from the C2C CC project at the major European Archaeologists' Association meeting in Maastricht in late 2017.
Photo: Rowan Jackson, BIOCHANGE

Danish Agency for Science and Higher Education supports the Aarhus-Cape Town Environmental Humanities Partnership with 272,197 DKK (International network Program instrument), and the Committee for Research and External Cooperation at Aarhus University with 274,135 DKK. Finally, the School for Culture and Society supports with internal funds.

Further reading: http://ceh.au.dk

CEH
CENTRE FOR
ENVIRONMENTAL HUMANITIES

C2C CC:

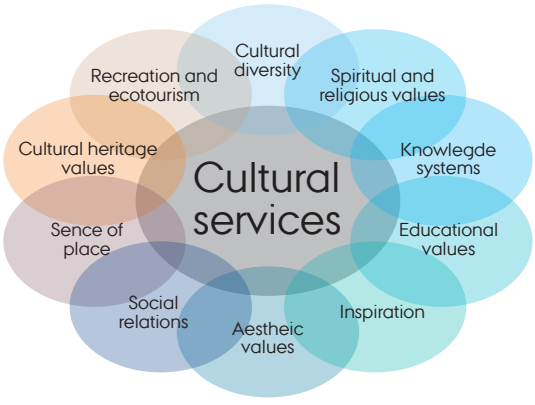
COAST TO COAST CLIMATE CHALLENGE SUBPROJECT C24: CLIMATE HISTORY | CULTURE HISTORY

Principal investigator: Felix Riede

As part of a large EU Life funded project anchored in the Region of Central Denmark, this aims to provide a historically informed and evidence-based dissemination platform for C2C Climate Challenge that facilitates citizen-near adaptation and long-term behavioural change. The project couples existing environmental and cultural historical datasets together in order to provide evidence-based snapshots of past environmental conditions and human responses. With a focus on hydrological changes in inland (river, lake) and coastal contexts, C24 connects directly with other C2C CC projects and makes use of existing dissemination platforms (e.g. the Klimatorium and AquaGlobe) in order to showcase the overall project nationally. At the same time, this project reaches out to a wider international network through workshops and participation in international conferences. Finally, the project will add value to C2C CC overall by translating climate history into components useable also in sustainable growth via tourism.

AquaGlobe: Skanderborg Municipality's new water management services centre – the AquaGlobe – is one of the project's designated exhibition windows where climate history and culture history meet.

Image: http://cubo.dk/projekt/aqua-globe-skanderborg/



Parallel to the notion of ecosystem services, cultural services can and must be thought of when considering climate change adaptation. Our sub-project of the wider C2C CC initiative focuses on these nonmaterial benefits to livelihoods, behavior and sustainability.

Redrawn from https://www.tandfonline.com/doi/full/10.1080/13505033.2017.1342069)

The project is supported by the EU LIFE-program with approximately 52 million DKK and has a total budget of c. 90 million DKK.

It currently employs one research assistant.

HumanColonisation:

1

PATTERNS AND PROCESSES OF DISPERSAL, CULTURAL CHANGE AND DEMOGRAPHIC COLLAPSE IN THE EARLIEST HUMAN COLONISATION OF PALAEARCTIC SOUTHERN SCANDINAVIA

Principal investigator: Felix Riede

This PhD project focuses on the first presence of modern humans in southern Scandinavia during the Late Glacial (14,500-14,000 years ago), linked to the so-called Hamburgian culture. A reindeer specialised hunter-gatherer culture, generally understood as reflecting a culture-historical epoch with an unbroken use of the recently deglaciated landscape.

The Hamburgian culture is traditionally divided into an earlier, more eastern 'classic' and a later, more north-western 'Havelte' phase, and ends abruptly at around 14,000 years ago. Rather than differing substantially in their lithic repertoire or their subsistence economy, however, the two phases of the Hamburgian culture diverge only in their diagnostic projectile point forms. A chronological as well as spatial overlap is also observed, making the basis for, and meaning of, this division of phases somewhat problematic. Currently, no robust answer for this clear yet curious division exists.

The project proposed here therefore seeks novel explanations for the shift from 'classic' to 'Havelte' and the latter's sudden disappearance. The hypothesis of the project is that (i) the change from 'classic' to 'Havelte' was driven by a dispersal process linked to individual decision making, and that (ii) the disappearance of the 'Havelte' phase and with it the entire Hamburgian culture, can plausibly be linked to a demographic collapse. The project aims to address these questions by:

- using a mixed-method approach to identify the artefactual signatures of individuals in order to quantify and hence qualify the technological and morphological variability inherent in the Hamburgian culture;
- deploying ethnographic data on hunter-gatherer demographic collapse as part of quantitative models that reconstruct past population dynamics;
- using climate datasets of the Last Glacial Maximum with the archaeological data of the Hamburgian culture, in order to evaluate the relationship between the archaeological record and climate conditions in time and space and by doing so, construct distribution models for the Hamburgian culture.

An artist's depiction of the earliest settlers in Scandinavia.
Credit: Sune Elskær; © Danish Heritage Agency/Kulturstyrelsen.

The aim of the project is therefore to generate new empirical data through these multi-scalar analytical tracks. If the hypothesis is correct, we will need to significantly re-think how we conceptualise Palaeolithic 'cultures' in general, how we see hunter-gatherers adapting to climate change and how vulnerable such groups are to changing climates. This particular and iconic episode of the 'first immigration' of people into what is today Denmark may need to be substantially revised.

It currently employs one PhD student supported by an AU Arts Faculty PhD Fellowship, who is co-supervised by other senior scientists at Aarhus University among others Associate Professor Signe Normand from BIOCHANGE.

BIOSENS:

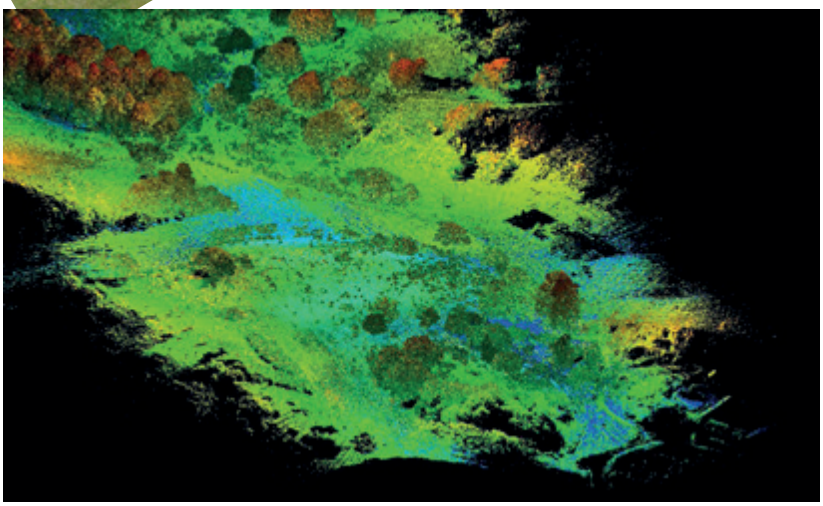
SENSING BIODIVERSITY CHANGE AND ITS DRIVERS

Principal investigator: Signe Normand

Photo: Normand/Treier

Overview of the biodiversity experiment close to Bern, Switzerland. The experiment consists of 336 plots of 2×2 meters with 20 different plant species sown in combinations of 1 to 20 species.
Orthomosaic created by Urs A. Treier.

The newest sensor technology mounded on drones (Unmanned Aerial System, UAS) provides novel opportunities for assessing how biodiversity and its drivers change at ultra-high spectral (wavelengths in nanometres), structural (dense 3D point clouds), spatial (millimeter to meters), and temporal (days to years) resolution. In particular, combining measurements of highly differentiated spectrometric signals and detecting the range of emitted laser light pulses, show great potential for simultaneously assessing the functional, structural, and taxonomic components of biodiversity, as well as its environmental drivers (e.g. hydrology, topography, nutrient status). BIOSENS is one of the first projects worldwide that combines the newest hyperspectral and LiDAR sensor technology for UAS with a detailed assessment of temporal and spatial changes in local diversity and ecological parameters. Specifically, repeated drone-flights will be conducted across a controlled grassland experiment (in Bern, Switzerland), with controlled levels of plant diversity, as well as a natural grassland with substantial variation in plant diversity, vegetation structure, function, and ecological factors (Rewilding area, Mols, Denmark). Simultaneously, highly detailed and spatially explicit information on plant diversity, structure, and traits (e.g., biomass, biophysical, biochemical, and morphological traits, as well as physiological stress and plant health) will be measured with traditional ecological methods and hand-held hyper-spectral sensors.



LiDAR point cloud from parts of the Mols Rewilding area. The data was collected with the YellowScan LiDAR sensor mounted on a octocopter.
Photos: Normand/Treier

The project is funded by the Carlsberg Foundation Distinguished Associate Professor Fellowships from 2017-2020. It currently employs one postdoc and one PhD student.

CARLSBERG FOUNDATION

DRONE ECOLOGY:

THE MISSING LINK FOR CROSS-SCALE INTEGRATION IN ECOLOGY

13

Principal investigator: Signe Normand

How and why the fate of individuals, populations and species vary across space and time is a fundamental question in ecology. Currently, a prominent gap exists in our knowledge on the local dynamics of individuals, their drivers, and how they scale to the dynamics of species distributions across space (centimeters to biomes) and time (years to millennia). Closing the scale gap is essential for understanding vegetation dynamics under global change and their related biodiversity, ecosystem, and societal consequences. The aim of this project is two-fold: (i) investigating the degree to which drone-based remote sensing contribute to closing the scale-gap and add distinctive insight on vegetation dynamics by analyzing a unique data set of ground-based observations of vegetation composition and drone-imagery sampled across Greenland, (ii) establishing and consolidating the infrastructure and competences needed for mastering unique and innovative applications of drone-based remote sensing to answer questions in ecology. The project substantially contributed to establishment of the UAS4Ecology Lab, a research facility using unmanned aerial system (UAS) technology in combination with novel sensor technology (see BIOSENS) to address ecological questions.

Photo: Normand/Treier

The project is funded by the Aarhus University Research Foundation Starting Grant from 2016-2019. It currently employs one PhD student and one research assistant.

AARHUS UNIVERSITETS FORSKNINGSFOND
AARHUS UNIVERSITY RESEARCH FOUNDATION

sDYN:

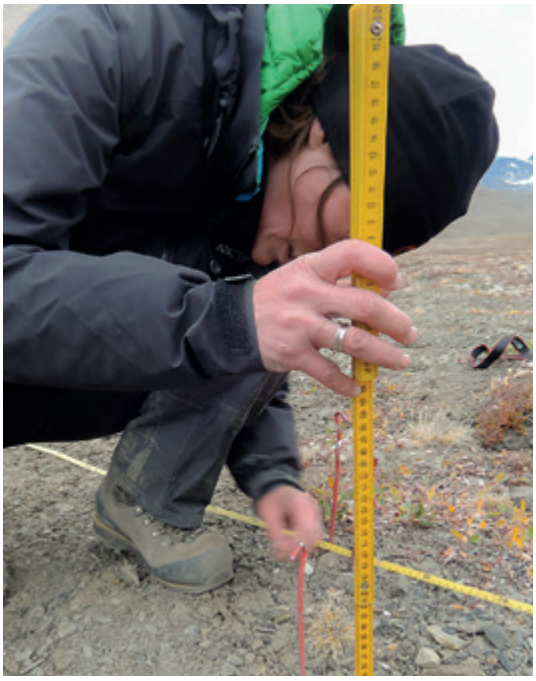
CROSS-SCALE INTEGRATION OF ARCTIC SHRUB DYNAMICS

Principal investigator: Signe Normand

Climate warming is expected to have pronounced effects on the functioning of Arctic ecosystems. However, evidence show substantial variation in the response of woody plants to recent warming across sites. sDYN will provide new insight on Artic shrub dynamics, and their variation across space and time by a novel integration of satellite- and drone-based remote sensing, functional traits, dendroecology, and dynamic modelling. The empirical basis for this integration is a unique data set on growth, recruitment, cover, and functional traits collected simultaneously with drone-based surveys at multiple sites across large-scale climatic gradients in Greenland, a large randomly stratified sample of vegetation cover across Greenland, and new cross- and landscape scale mapping of shrub dynamics, and their geophysical drivers. sDYN is expected to provide the scientific basis for an improved understanding and predicting of ongoing and future vegetation dynamics in the Arctic.

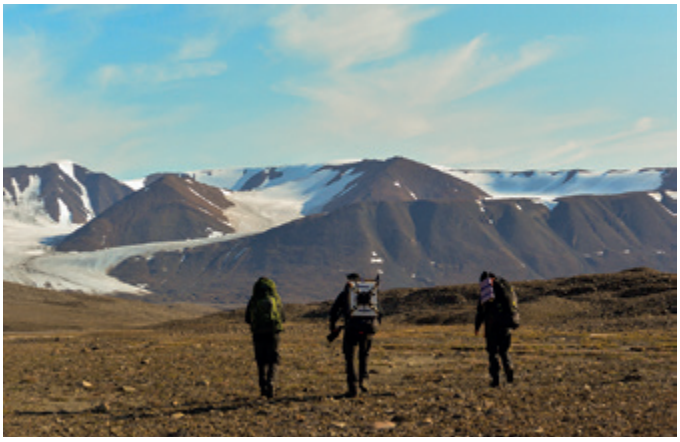
The project is funded by the Sapere Aude Research leader grant, Danish Council for Independent Research from 2018-2022. One postdoc and two PhD students will be employed in this project, which closely collaborates with several international collaborators and BIOCHANGE associate, postdoc Angela Luisa Prendin.

DANMARKS FRIE FORSKNINGSFOND
INDEPENDENT RESEARCH FUND DENMARK



Impression from field work in Northeast Greenland in 2016.

Photos: Sigrid Nielsen, Laerke Stewart, and Normand-Treier



MMSDI:

MAASAI MARA SCIENCE AND DEVELOPMENT INITIATIVE

1 2 4

Chair: Jens-Christian Svenning

The Greater Mara Ecosystem in Kenya is facing a multitude of interconnected, complex challenges, which can be divided into four main categories: (1) land use and climate challenges, (2) ecosystem challenges, (3) political and economic challenges, and (4) human and cultural challenges. The Maasai Mara Science and Development Initiative is an African-European cooperation between University of Nairobi, Aarhus University, Mararianta Community (in Mara North, Maasai Mara), and Karen Blixen Camp Trust in Maasai Mara, Kenya, initiated to address these through interdisciplinary research and development activities. Therefore, the Maasai Mara Science and Development Initiative operates as a multi-stakeholder platform with representatives from academics, business, organizations and local citizens as members of the core structure of the initiative. Governmental institutions are supporting the initiative through a High Level Advisory Board and MMSDI works closely with Maasai Mara Wildlife Conservancies Association. The overall aim of the partnership is to develop initiatives with a clear goal: to contribute to conserving the Greater Mara ecosystem with its rich wildlife and culture through interdisciplinary research and development initiatives. It is the hope that intense knowledge exchange with the many stakeholders of the Maasai Mara will give valuable inputs to the research about core challenges and research questions and provide data to the research projects. In return, research outputs can support decision makers in developing sustainable solutions.

The initiative was founded in 2014 as a response to the urgent need for action in the area. It is funded by the individual members conducting research in the area supported by the Karen Blixen Camp in Mara North. Center director Jens-Christian is chair of MMSDI and several members of BIOCHANGE are involved in the initiative.

Local stakeholders and MMSDI at a recent research meeting at Karen Blixen Camp, Maasai Mara, Kenya in February 2018.

Photo: Anne Blach Overgaard, BIOCHANGE

MMSDI board meeting 2018 – from left: Chair Jens-Christian Svenning (Aarhus University), Jesper Stagegaard (Karen Blixen Camp Trust), David Noosaron (Mararianta Community), Dr. Alice O. Odingo (University of Nairobi), and Professor Richard Odingo (University of Nairobi).

Photo: Anne Blach Overgaard, BIOCHANGE

MMSDI meeting for the Aarhus group members in December 2017 at BIOCHANGE, Aarhus University. PhD student Michael Munk and MSc Student Line Bøgelund Bang report back from recent field trips to the Mara, Kenya.

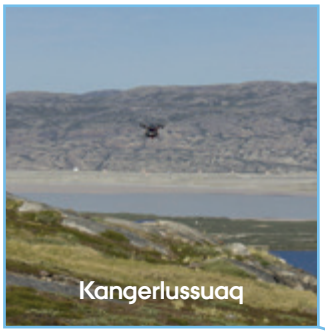
Photo: Anne Blach Overgaard, BIOCHANGE

Further reading:
http://maasaimarascience.org/

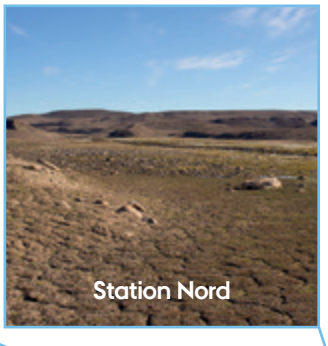
Maasai Mara
Science and Development Initiative

FIELD CAMPAIGNS


Igaliku


Kangerlussuaq


Zackenberg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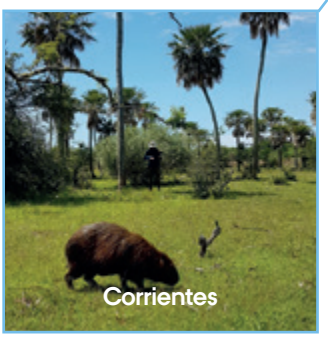
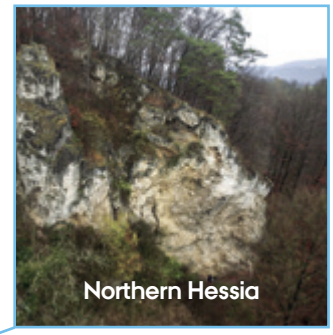
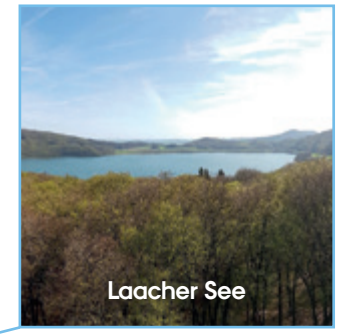
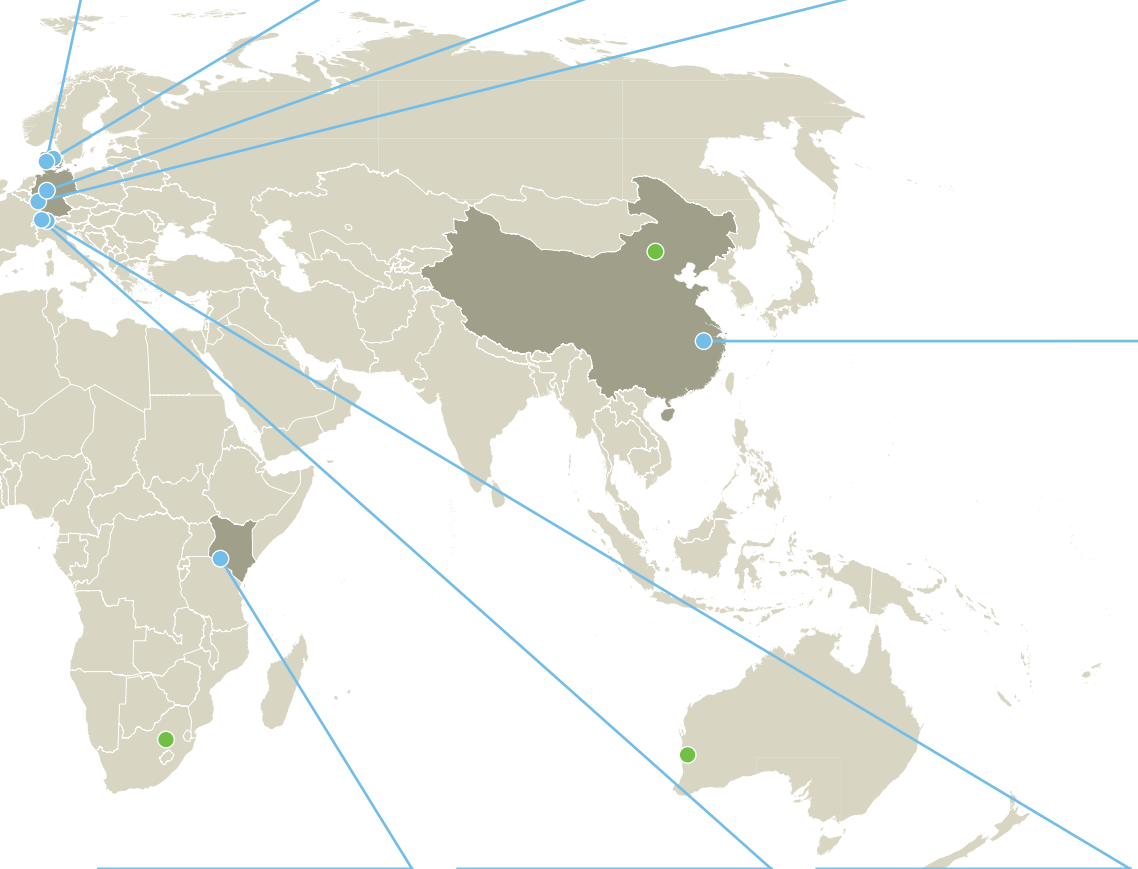

Corrientes







Map of the distribution of current (●) and planned future (●) field sites across the World. BIOCHANGE conducts research in many parts of the World spanning the Arctic to the Tropics. On the following pages, we describe a select of current field campaigns conducted in 2017-2018.

Map and photo editing by Michael Munk; insert photos by Normand-Treier, Anne Blach Overgaard, Bjarke Madsen, Vincent Fehr, Felix Riede, Rowan Jackson, Florian Rudolf Sauer, Anke Verena Zernack, Peder Klith Bøcher, and Jens-Christian Svenning, BIOCHANGE

MAASAI MARA – A WORLD-FAMOUS NATURAL HERITAGE SITE UNDER PRESSURE

MAASAI MARA, KENYA

The Maasai Mara in Kenya (Fig. 1) is one of the World's most famous natural areas, due its rich savanna wildlife including its million-plus migration of wildebeests and zebras. However, the Mara savanna ecosystem is under increasing pressure. Wildlife numbers are declining, and local pastoralist populations are strongly growing and undergoing strong societal changes. The traditional pastoral lifestyle is changing and private land subdivided into smaller plots, which are often fenced and hinders the movement of larger animals and competing with increasing numbers of livestock.

Our research aim is to better understand the Mara ecosystem dynamics, including the roles of its wild megafauna, and the Maasai and their livestock in shaping biodiversity, ecosystem structure, processes, and services, such as fire spread, carbon sequestration, water infiltration, evaporation, erosion control and the availability and quality of grass, with the aim of providing a scientific basis for a future ecologically sustainable management of this key natural heritage site.

Two field campaigns have been conducted in Maasai Mara since the start of BIOCHANGE, in November 2017 and February 2018. The main aim has been to build a baseline for time series studies and calibrate satellite remote sensing data for classification studies with collected ground validation data. A second aim was to establish contacts to local stakeholders and expand the collaboration with scientists and managers in the local community, and promote interdisciplinary research relevant for region specific conservation.

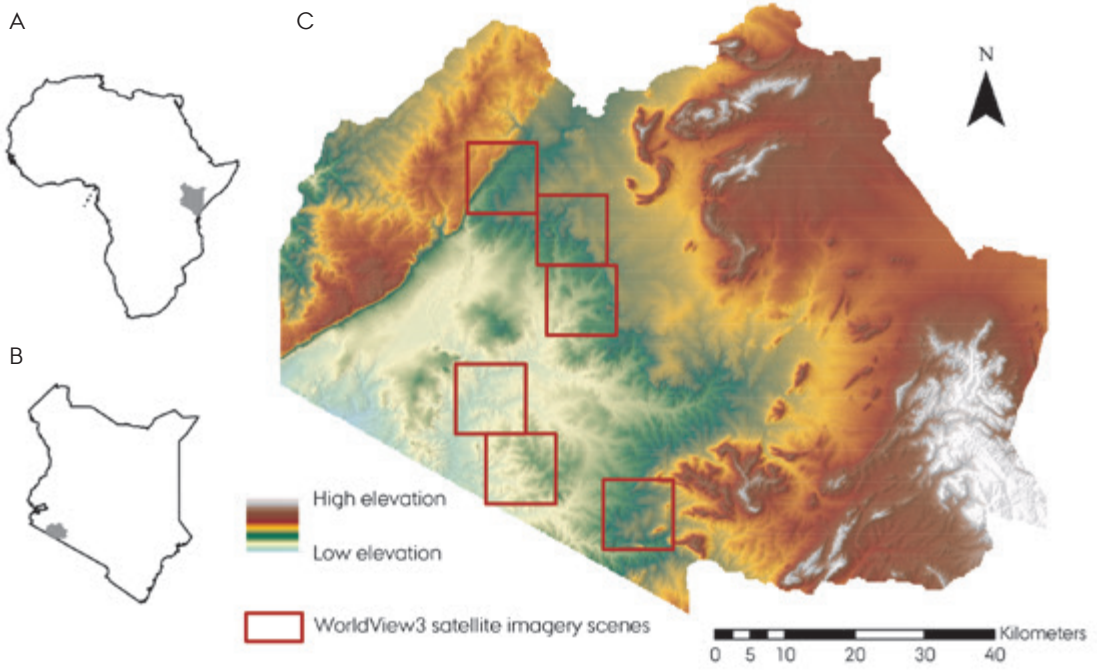


Figure 1. Maps of (A) Kenya, (B) Maasai Mara and (C) the extent of six high-resolution WorldView 3 satellite scenes that were purchased to support ongoing work.

Map: Michael Munk, BIOCHANGE

Figure 2. Three-dimensional vegetation structure from terrestrial laser scanning of (A) savanna vegetation and (B) a large and freestanding tree.

Image: Michael Munk, BIOCHANGE

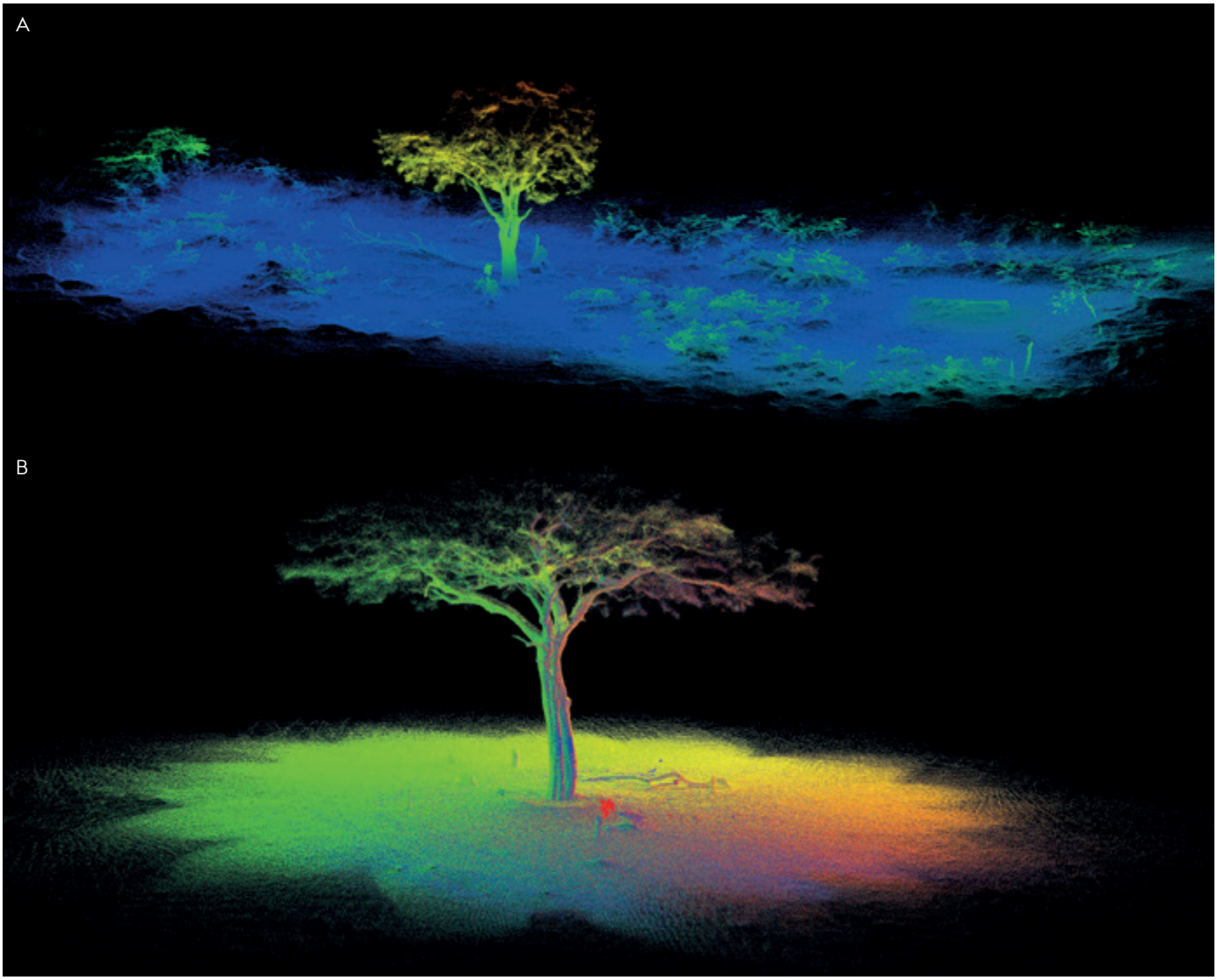


Figure 3. Characterizing the major vegetation types in Maasai Mara: (A) woody vegetation, (B) shrubland and (C) grassland. Vegetation sampling techniques: (D) terrestrial laser scan of large, freestanding trees, (E) measuring vegetation structure, and (F) terrestrial laser scanning in shrubland. Ecological impacts of megafauna and humans on biodiversity in Maasai Mara: (G) elephant-impact on acacia trees, (H) giraffe in landscape with high human impact, and (I) cattle herds grazing side-by-side with wildlife.

Photos: Michael Munk (A-E,G-I) and Anne Blach Overgaard (F), BIOCHANGE

Figure 4. Three types of satellite imagery that we exploit in our studies, each with strengths and weaknesses. (A) Landsat, with medium spatial resolution (30 m) but long-time series (1980s). (B) Sentinel 2, higher spatial resolution (10 m), high temporal interval (5 days at equator) but short time series (since mid-2015). (C) World-View 3, very high spatial resolution (1.24 m) but a once-off snapshot.
Map: Michael Munk, BIOCHANGE

We used a handheld terrestrial laser scanner to measure three-dimensional vegetation structure in plots and of single standing trees (Fig. 2). In addition, we measured vegetation structure (e.g. number of species, height, canopy cover and diameter), animal impact (e.g. GPS locations of trees knocked over by elephants) and human impact (e.g. ground documentation of bare soil and vehicle tracks) in areas with contrasting herbivore pressure and land management (Fig. 3).

This data will be used in combination with high-resolution satellite imagery (Fig. 4) to extrapolate the 3D vegetation structure to the landscape scale to be able to map patterns and dynamics in vegetation structure over time.

By linking observed patterns of vegetation structure to potential drivers such as animal density, fire frequency, climate and atmospheric CO_2, we will learn more about the processes that determine savanna vegetation dynamics. Ultimately, this will help to plan and prepare for ongoing and future change (e.g. climate and land use), with the aim of safeguarding biodiversity, ecosystem functioning and compatible human livelihoods.

TROPHIC REWILDING IN THE GLOBAL SOUTH

CORRIENTES, ARGENTINA

Trophic rewilding is a new idea for ecological restoration, and is centered around restoring the top-down trophic processes via re-establishment of missing species (typically megafauna) to promote self-regulating biodiverse ecosystems. Although mostly explored in Europe and to a lesser extent Australia and North America, the idea is of global relevancy due the generality of ecological principles it rests on and the worldwide historical megafauna losses. In this project, we focus on a key understudied biome, namely the South America savannah region. South America formerly harboured a very rich megafauna, but was depleted of most of it as humans colonized the continent at the end of the Pleistocene (± 12,000 years ago), with further losses continuing up through history to the present day. Surviving species persist only at low densities, often in small refugia or on unproductive land, and even its most intact savannah regions coming nowhere near African savannas in terms of megafauna diversity. The loss of megafauna resulted in the loss of ecological functions, for example, seeds of some trees are so large that they can only have been dispersed by extinct giant ground sloths, proboscideans, and similar megaherbivores. However, the large-scale ecological consequences of losing megafauna remain understudied, hampering planning, restoration and management toward a biodiverse future. At our field-sites in Argentina's Corrientes province (Fig. 1), we work toward filling these knowledge gaps.

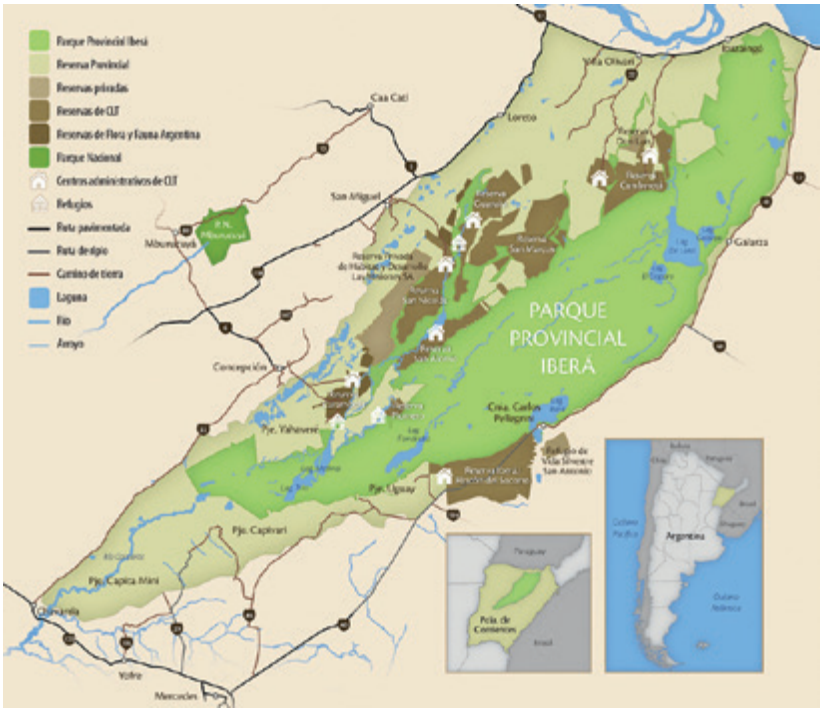


Figure 1: Map of Argentina, Corrientes and field sites.

Map credit: http://www.proyectoibera.org

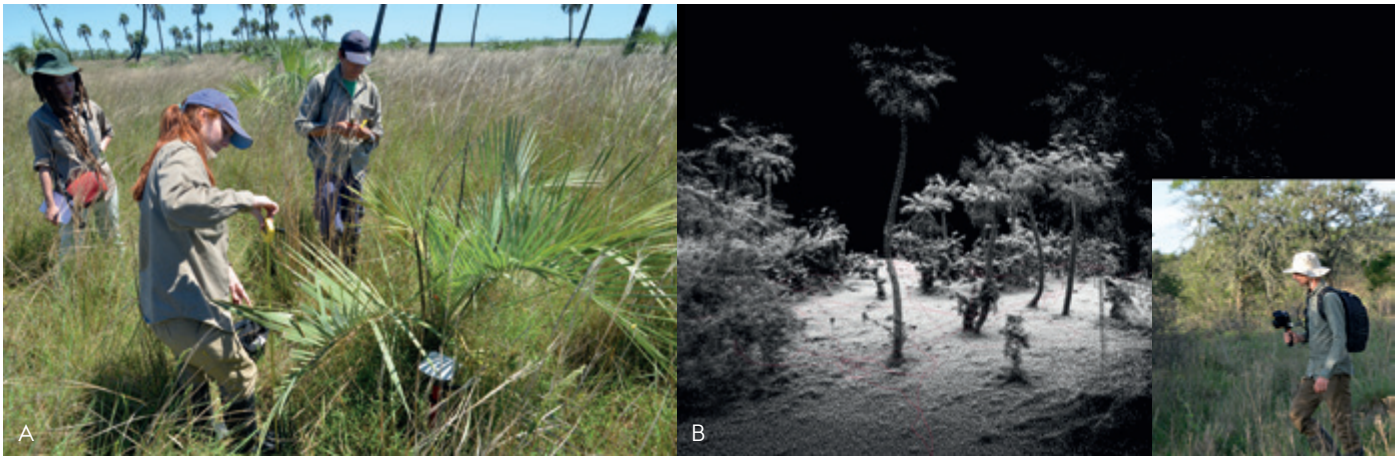


Figure 2. Traditional plots to measure vegetation structure and community composition (A) and 3D image from terrestrial laser scanning (B) – insert – terrestrial laser scanning in progress.
Photos Dennis Pedersen and Jens-Christian Svenning, BIOCHANGE

A particularly important unanswered question is to what extent the loss of megafauna has changed vegetation structure, as vegetation forms the backbone of terrestrial ecosystems. The ratio and spatial distribution of e.g. forest, savanna and grassland has large consequences for overall biodiversity and also for ecosystem functioning, e.g. carbon sequestration and fire frequency.

One of our field sites, Rincon del Socorro, is a private reserve with an active rewilding program where locally extinct species such as lowland tapir, pampas deer and collared peccary are reintroduced. The other Mburucuya National Park is more of a passive rewilding site, with both localities being former ranches. Locally surviving megafauna such as capybara and marsh deer, South America's largest deer, have experienced strong population comebacks in response to the increased ecological restoration, including protection from hunting. Adding complexity, non-native large herbivores notably feral pigs and Asiatic axis deer also occur and can be abundant. To assess impacts of increasing megafauna density we characterize vegetation structure using a combination of traditional (vegetation plots) and novel (terrestrial laser scanning) methods (Fig. 2). We also established an experiment, where we measure herbivore impact on vegetation by excluding megafauna such as capybaras from small fenced areas (Fig. 3). To gain a better understanding of the (potential) impact of different herbivore species, we quantify diet composition. Using DNA meta-barcoding on faecal material from all major herbivores in the system, we can identify consumed plant species (Fig. 4).

Results from these studies will improve macro-scale understanding of herbivore impacts on ecosystems and help guide the design and implementation of rewilding programmes.

A

Figure 3. (A) Herbivore exclosure on a capybara grazing lawn. (B) Night-time activity around exclosure plots recorded using a camera trap.

Photos: Robert Buitenwerf, BIOCHANGE

Figure 4. Vial with herbivore dung drying in silica beads, in preparation of DNA extraction and sequencing. Photo Robert Buitenwerf, BIOCHANGE

PALMS AS GENERATORS OF NOVEL ECOSYSTEMS

TICINO, SWITZERLAND

Human activities are increasingly generating novel ecosystems without historical precedent, notably by moving species around the world. While the increasing emergence of novel ecosystems is widely recognized, our understanding of their ecological properties and capacity for sustaining biodiversity remain rudimentary. Here, we address this key question, focusing on palms due to the ecological and societal importance. The fact that palms are of high value for humans (e.g. as ornamental plants or by providing food, building material, handcrafts, fuel and medicine) has led to an expanded distribution of many palm species into regions far away from their natural habitat, with some species being recognized as naturalized or even invasive. Palms are often keystone species in ecosystems where they occur naturally, interacting with the local biota e.g. through mutualistic relationships. Due to their distinctive architecture, palms shape the vegetation structure in a particular way. Based on these reasons, we expect that non-native palms may strongly affect composition, interactions and functioning of ecosystems, finally resulting in novel ecosystems.

Here, we aim to uncover ecosystem effects of non-native palms by focusing on five non-native invasive palm species in five different biomes around the world. This entails extensive fieldwork in four different countries. Switzerland, Brazil,

Figure 1. The Chinese windmill palm (*Trachycarpus fortunei*) is building dense thickets at an alluvial site in southern, Switzerland.
Photo: Vincent Fehr, BIOCHANGE

Figure 2 (left). Marked edge of a palm invaded plot in southern Switzerland.
Photo: Vincent Fehr, BIOCHANGE

Figure 3 (right). Artificial caterpillars consisting of plasticine are placed on different parts of a non-native palm.
Photo: Vincent Fehr, BIOCHANGE

Mexico and in the US (California and Hawaii). Due to the key roles of palms, we will examine a broad range of ecosystem components and variables (e.g. richness of plants, arthropods and soil inhabiting cryptic groups, vegetation structure, light regime and litter accumulation) ,which we hypothesize may respond to the presence of non-native palms in invaded plots and uninvaded control plots. In March 2018, we initiated fieldwork for the project in Switzerland, where the Asiatic windmill palm is invading temperate broad-leaved forests very successfully. We apply novel sampling techniques such as a handheld 3D laser scanner to measure vegetation structure. The presence of soil-inhabiting cryptic groups (e.g. fungi and other microorganisms) will be analyzed by extracting environmental DNA. In southern Switzerland, we have established the first plots recently and successfully tested the laser scanner in dense palm thickets (Fig. 1 and 2). Part of the vegetation sampling was carried out, and a pilot experiment was conducted using artificial caterpillars to record how non-native palms affect the presence of hunting birds (Fig. 3).

In the next months, we will continue the data collection in Switzerland and in autumn 2018, respectively winter 2019, fieldwork will begin in Brazil, California, Mexico, and Hawaii.

TROPHIC REWILDING IN A DANISH NATIONAL PARK

MOLS, DENMARK

The Natural History Museum Aarhus initiated a trophic rewilding project in 2016 by introducing 13 Exmoor horses and 13 Galloway cattle on 120 hectares at the Mols Laboratory, one of the most biodiverse and varied landscapes in Mols Bjerge National Park and a biodiversity hot spot for Denmark (Fig. 1). The large herbivores were introduced as wild populations with no supplementary feeding or other relief from humans, except minerals and water. Regulation of the populations only occurs by culling individuals that fall below a set of welfare thresholds based on their body condition. By spring 2018, the two populations have grown to 46 individuals in total. In 2017, an exclosure experiment was set up jointly by BIOCHANGE researchers and Natural History Museum Aarhus to investigate and monitor how biodiversity dynamics are affected by rewilding with large herbivores. The experiment compares rewilding to four different alternative scenarios: (1) mowing, (2) only summer grazing (the typical grazing management approach in Denmark), (3) only winter grazing (to assess the specific role of having large herbivores in the system in the stressful winter period, where they may forage on less ideal food sourecs, such as woody plant parts), and (4) leaving the area to free succession without the impacts by large herbivores. The ecosystem is expected to be affected especially by direct feeding and trampling effects on the vegetation by the cattle and horses, but also by their dispersal of nutrients and propagules via their movement and defecation activities. For arthropods, a range of direct and indirect effects are expected as changes in vegetation composition, vegetation structure, resources and abiotic environments can have dramatic impacts on invertebrate communities.

Horse and cattle movement and behavior are following over extensive periods of the year to quantify their use of the rewilding area. This is partly based on field-based direct observation, partly using GPS-collars on a subset of individuals.

The plot-based experimental setup contains 22 randomly assigned blocks in the area with each having 4 treatment plots and 1 control plot, sized 5 × 9 meters. The treatments include 1 permanent exclosure, 1 permanent exclosure with mowing, 1 summer exclosure (1. May to 1. November ±14 days) and 1 winter exclosure (1. November to 1. May ±14 days). Data retrieved from each plot is a combination of traditional field-based methods and novel remote sensing techniques. For the vegetation, modified Raunkiær circles in different sizes (Fig. 2) was applied to record species richness, and cover, accompanied by additional environmental measurements as e.g. slope, aspect, and soil analyses. Arthropod sampling is conducted three times a year on each plot, including pitfall and pan traps (Fig. 2). These standard measurements are assisted by modern remote sensing data where camera traps will be recording arthropods, their interactions, activity and abundance on a very fine temporal and spatial resolution, providing data not achievable with any existing trapping method.

Several drone campaigns have been conducted across the area to set a baseline for future vegetation monitoring. The drones have been equipped with basic RGB cameras and the most advanced multispectral and LiDAR sensors, which potentially will provide new perspectives in the way we monitor vegetation.

Figure 1. Horses at the Mols Laboratory.
Photo: Oskar L.P. Hansen, BIOCHANGE

Figure 2. Schematic representation (not to scale) of our experimental rewilding block design consisting of one control plot (no treatment), and four sub-plots where four alternative rewilding scenarios will be tested: In permanent exclosures (black solid line): (1) mowing and (2) free succession (no herbivory from large animals); In seasonal exclosures (dotted line): (3) summer grazing only, and (4) winter grazing only. Green concentric circles denotes plot sizes used for vegetation sampling across scales. Blue rectangles indicate areas where arthropod traps are positioned within each sub-plot.
Drawing by Simon Schowanek, BIOCHANGE

SEARCHING FOR ROCK SHELTER SITES TO TEST THE HUMAN IMPACTS OF THE LATE PLEISTOCENE LAACHER SEE ERUPTION

NORTHERN HESSIA, GERMANY

The field campaign in the Federal State of Hesse in Central Germany aims to find new Final Palaeolithic sites, which show archaeological strata and tephra of the Laacher See volcanic eruption c. 13,000 years ago (Fig. 1). The goal is to investigate the influence of the cataclysmic event on human lifeways in the medial zone of the eruption. Since to date only few open-air sites are known in this area, a legacy database of potential rock shelter locations formed the basis for predictive modelling. The legacy database contained more than 700 entries, which were evaluated regarding their archaeological potential based on the model (Fig. 2). Using the predictions, two surveys were conducted in November 2017 and March 2018 during which 80 different locations were visited. Among these, several potential sites were identified, three of which were selected for fieldwork in summer 2018.

Figure 1. Distribution of tephra of the Laacher See volcanic eruption. Map: Florian Rudolf Sauer

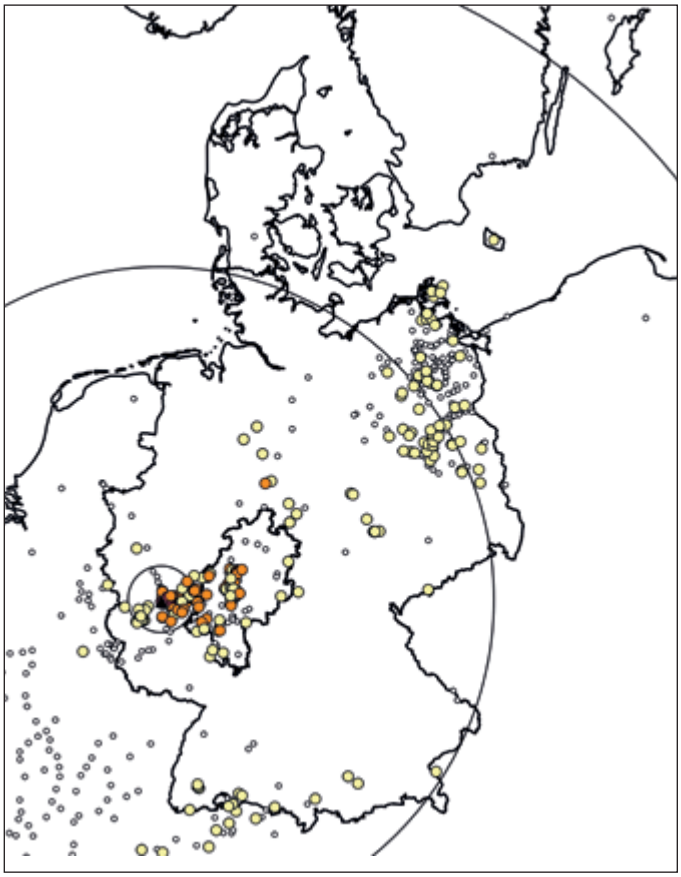


Figure 2. A: Predictions on the rock shelter database of the Federal State of Hesse combined with the distance to the next known tephra outcrop. B: Sites selected for fieldworks (1: Alraft 1 & 2, 2: Wetterstein, 3: Baumbach). Map: Florian Rudolf Sauer

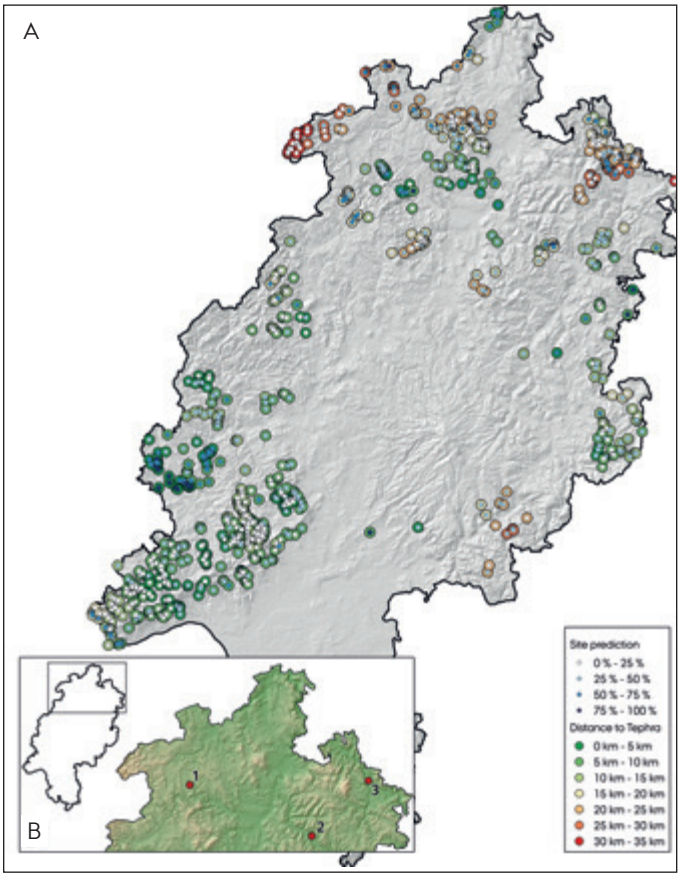


Figure 3. Alraft 1, 'Im Rollborn', Waldeck-Frankenberg District.

Photo: Florian Rudolf Sauer, BIOCHANGE

Figure 4. Alraft 2, 'Im Schladenbläche', Waldeck-Frankenberg District.

Photo: Florian Rudolf Sauer, BIOCHANGE

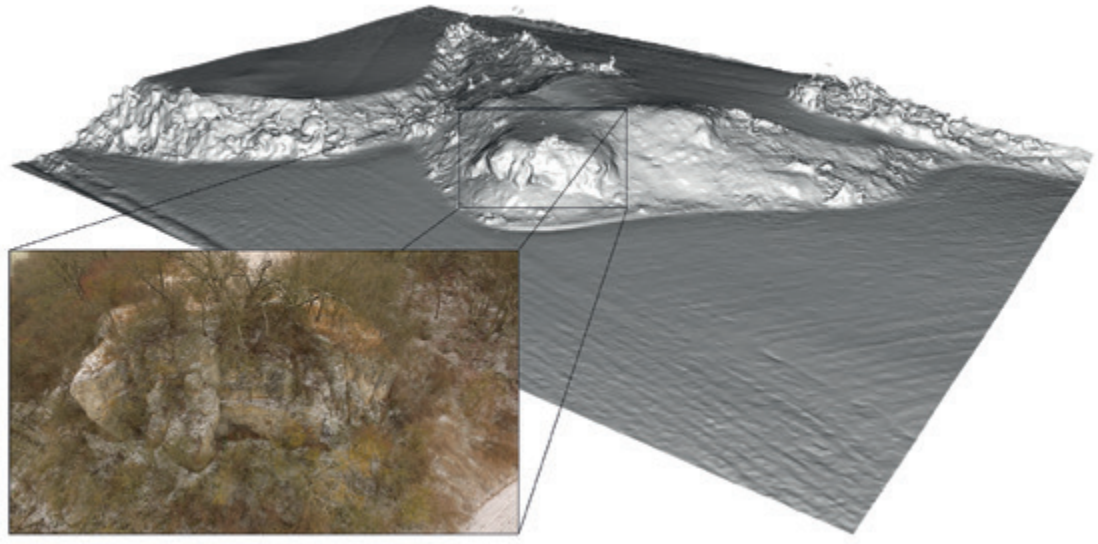
Figure 5. Bettenroder Berg IX, Lower Saxony.

Photo: Florian Rudolf Sauer, BIOCHANGE

Figure 6. Wetterstein, Werra-Meißner District.
Photo: Florian Rudolf Sauer, BIOCHANGE

Fieldwork will commence between 15 July and 15 September 2018 in Alraft, Wetterstein and Baumbach. The sites of Alraft 1 (Fig. 2B1; Fig. 3) and 2 are rock shelters in a row of limestone escarpments at the banks of the Werbe Creek. The overhang situations and caves are almost entirely filled with sediments. They show a comparable morphological makeup to the Final Palaeolithic site of Bettenroder Berg in Lower Saxony (Fig. 5). The large limestone rock needle of Wetterstein covers an area of c. 50 m² and provides a substantial sediment mound (Fig. 2B3; Fig. 6). The overhang faces south and opens towards the floodplains of the Werra river, which flows past the Wetterstein about ten meters below. This situation is typical for Final Palaeolithic sites and can also be found at the third location of Baumbach in the Fulda valley (Fig. 2B2; Fig. 7). Here, two small rock shelters are situated very close to the floodplains and offer large sediment mounds in front of the features. During the fieldwork campaign, keyhole excavations of two square meters will be conducted at all four locations.

Figure 7. Baumbach, 'In der Lache', Hersfeld-Rotenburg District. Aerial 3D-model and close-up aerial photo.
Photo: Florian Rudolf Sauer, BIOCHANGE



DEVELOPING A REFERENCE DATABASE OF PROXIMAL LAACHER SEE TEPHRA COMPOSITIONS FOR FUTURE FIELD CAMPAIGNS

LAACHER SEE, GERMANY

The c. 13,000 before present Plinian eruption of Laacher See (Fig. 1) produced a thick pyroclastic sequence in proximal areas and a widespread tephra layer across much of Europe. The products from different eruptive stages show diverse dispersal patterns due to changing eruptive mechanisms and environmental conditions and a distinct compositional variation. This allows linking distal Laacher See Tephra (LST) to the respective eruptive phase based on glass compositions. While early geochemical data are still being used as reference, recent studies reveal a much more complex dispersal of the different phases and also discrepancies in distinguishing mid to late-stage compositions.

As part of the 'Apocalypse then' project, we will be investigating several medial and distal sites in Germany in an archaeological and sedimentological context over the next few months. Geochemical analysis of the occurring LST will provide a better understanding of the impacts of the various eruptive stages on different regions and their timeframe. The April field campaign aimed at collecting new reference samples (Fig. 2) for our upcoming field investigations that will allow a more consistent correlation with the proximal sequence. A series of pumice samples was collected from proximal locations south and east of the volcano that will be geochemically analysed

Figure 1. The Laacher See basin with its surrounding crater rim and scoria cones seen from the northeast.

Photo: Anke Verena Zernack, BIOCHANGE

for their major and trace element compositions using electron microprobe and ICPMS methods, respectively. Samples for the southern LST sequence were obtained at Wingertsberg, where nearly the entire succession is exposed in a famous 50-m thick tephra wall (Fig. 3). The eastern depositional fan was sampled at several localities in the Neuwied Basin since none comprised the complete sequence due to active mining, partial refilling or erosion. In addition, the field campaign also allowed revisiting proximal sites that will be included in the publication of a recent study on the dynamics of the unstable, ash-flow producing middle stage of the eruption.

Figure 2. Pumice clast from the Middle Laacher See phase with large blue Hauyne crystal, a sulphur-rich mineral found in phonolite eruptives.
Photo: Anke Verena Zernack, BIOCHANGE

Figure 3. Upper part of the Laacher See Tephra sequence at Wingertsberg, consisting of a series of pyroclastic breccias and surge deposits.
Photo: Anke Verena Zernack, BIOCHANGE

RESEARCH TRAINING AND EDUCATION

RESEARCH TRAINING

In collaboration with Section for Ecoinformatics and Biodiversity (ECOINF), Department of Bioscience and Graduate School of Science and Technology (GSST), BIOCHANGE offers advanced research training for the current PhD students, aimed at those at the center, but open to and attended by students also from Aarhus University more broadly, as well as from other universities from Denmark and beyond. Three PhD courses have been conducted since the inauguration of the center in Megafauna ecosystem ecology, Remote sensing, and LiDAR technology in ecology. Moreover, BIOCHANGE and ECOINF host weekly journal clubs for all postdocs and PhD students in the group as well as periodical discussion groups on specific research topics and methodological workshops organized by BIOCHANGE and/or ECOINF postdocs.

All PhD students are offered to participate in international workshops and conferences and are on exchanges abroad at international institutions during their PhD program in accordance with the rules and regulations of the Graduate Schools. All PhD students are involved as teaching assistants in BSc and MSc courses at Aarhus University, or do other outreach work in special cases.

PHD COURSES

PhD course on Megafauna ecosystem ecology

The focus was on the future leaders of science last fall when MegaPast2Future hosted an engaging 1-week course on all aspects of megafauna ecosystem ecology. The PhD course was led by Carlsberg Semper Arden Postdoctoral Fellows Matt Davis and Andreas Schweiger with the help of Professor Jens-Christian Svenning. However, students had the opportunity to interact with a wide range of megafauna researchers including special guest lecturers Drs. Timo Conradi and Robert Buitenwerf and invited lecturer Professor Christopher Sandom (University of Sussex). The eleven course participants included a diverse mix of PhD and masters students and hailed from fieldwork, institutions, and homelands on five different continents. Over the very busy week, they discussed key papers, participated in lectures, collaborated on capstone projects, and started lifelong friendships and collaborations. The course commenced with a tour of Aarhus University Natural History Museum's 'Back to the Ice Age' exhibit so that students could see preshistoric megafauna 'in the flesh' but the highlight for many was the full day field trip to investigate several active megafaunal rewilding sites in Jutland. The long trudge through bogs at Lille Vildmose was rewarded with an amazing, up close view of a rewilded moose feeding on cattails. Although they have spread back around the world from Aarhus, the students are still regularly collaborating, preparing their capstone project manuscripts for publication in scientific journals. The course took place in October 2017 at Aarhus University.

Photo: Jens-Christian Svenning, BIOCHANGE

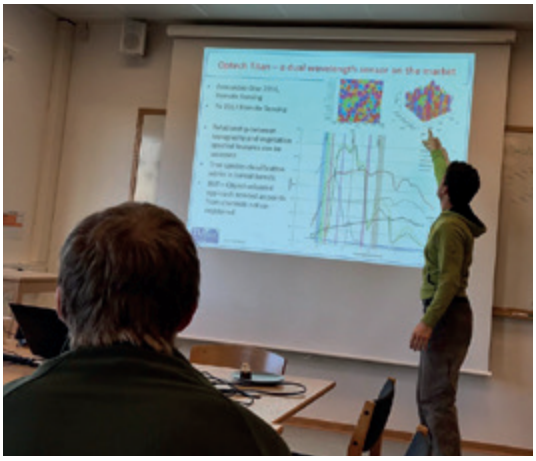


Photo: Michael Munk, BIOCHANGE

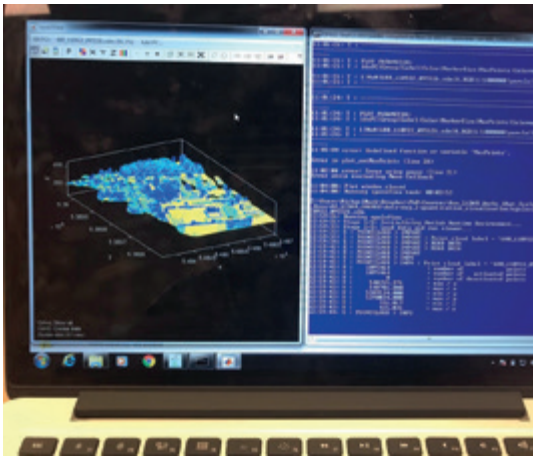


Photo: Michael Munk, BIOCHANGE

PhD course on High-resolution satellite and drone-based remote sensing in Environmental Sciences

The objective of the course was to give the participants the tools and insight needed to get started with using high-resolution remote sensing data to answer questions of relevance for environmental sciences. Specifically, the course introduced the students to: (1) image processing in the ENVI software, (2) pixel-based classification methods in ENVI, (3) image segmentation and object-based classification approaches in the eCognition software, (4) change detection techniques, (5) Unmanned aerial image processing and data handling methods, and (6) data download and handling in Google Earth Engine. The course alternated between lectures, where the students were introduced to the different methods, and exercises, where the students applied the methods to various image data sets. BIOCHANGE Alumni postdoc Gary Richard Watmough and Urs A. Treier led the course with the help from Signe Normand and Peder Klith Bøcher. The course took place in November 2017 at Aarhus University.

PhD course on Why use LiDAR in Ecology?

The objective of the course was to give the participants the tools and insight needed to get started with analyses of LiDAR data of relevance for answering their ecological questions. Topics covered was: the physical basis and functioning of LiDAR systems; basic processing tasks for terrain and vegetation modelling; LiDAR-based extraction of biophysical parameters; LiDAR-based classification of terrain and vegetation; fusion of LiDAR with optical imagery; Case studies of LiDAR for Ecology; State of the Art in LiDAR systems and applications. The course alternated between lectures, where the students were introduced to the different methods, and exercises, where the students applied the methods to various image data sets. Hands-on practicals was delivered using the OPALS software package. Postdoc Andras Zlinsky led the course with help from Signe Normand and Urs A. Treier. The course took place in December 2017 at Aarhus University.

JOURNAL CLUB

BIOCHANGE hosts a weekly journal club jointly with ECOINF, which is open to all PhD students and postdocs in the two groups. The journal club is led by center director Jens-Christian Svenning jointly with 1-2 early-career scientists (this year: BIOCHANGE PhD students, Simon Schowanek and Emilio Berti). In the journal club, the attendants discuss scientific papers that all help select. The aim of the journal club is to create an active and stimulating environment in which ideas and methods are discussed as well to improve communication skills and critical sense towards scientific works and to broadening the attendants' perspective on ecological and socio-ecological topics beyond their specific field of study. In the journal club we aim to create interactive discussions about the articles from different points of view of all the participants. The group discusses the scientific value of the paper, methodological procedures, work impact on its specific field, and implication for the projects of the group.

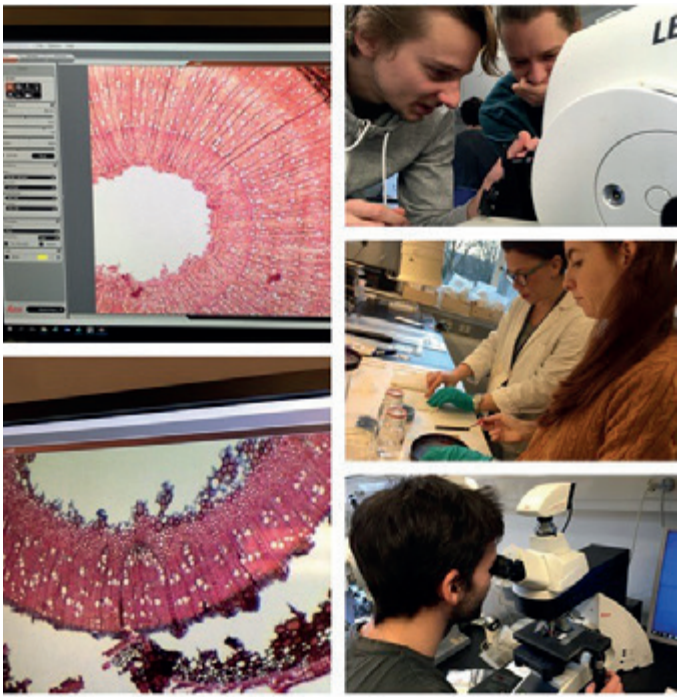
METHOD WORKSHOPS

- Tree-Thinking: an introduction to phylogenies for ecologists, April 2018, hosted by BIOCHANGE postdoc, Matt Davis and Associate Professor Wolf Eiserhardt from ECOINF.
- Lab methods for studying wood anatomy, December 2017, hosted by BIOCHANGE alumni postdoc, Angela Prendin and alumni PhD student, Sigrid Schøler Nielsen.

DISCUSSION GROUPS

- Remote sensing
- Socio-ecological systems

Photo: Michael Munk, BIOCHANGE



Photos: Bob Muscarella

EDUCATIONAL ACTIVITIES

The senior members of BIOCHANGE are responsible and involved in the teaching of several BSc and MSc courses and in the supervision of project- BSc and MSc students.

Photo: Urs A. Treier, BIOCHANGE

Photo: Anne Blach Overgaard, BIOCHANGE

BSc AND MSc COURSES

- Biogeography & Macroecology
  (Aarhus University, 10 ECTS)
- Danish Flora and Vegetation
  (Aarhus University, 10 ECTS)
- Geographic Information Systems (GIS)
  (Aarhus University, 5 ECTS)
- Statistical and Geospatial Modelling
  (Aarhus University, 10 ECTS)
- Geospatial Ecology
  (Sino-Danish Center for Education and Research (SDC), jointly with Graduate University of Chinese Academy of Sciences (GUCAS), 3.75 ECTS)
- Cultural-Historical Overview/World Archaeology
  (Aarhus University, 10 ECTS)
- Prehistoric archaeology 1: Stone Age
  (Aarhus University, 10 ECTS)
- Natural science in archaeology 1
  (Aarhus University, 15 ECTS)
- Natural science in archaeology 2
  (Aarhus University, 10 ECTS)
- Archaeological data analysis
  (Aarhus University, 20 ECTS)

BSc AND MSc PROJECTS

The projects are supervised by BIOCHANGE senior core members, some in collaboration with senior scientist at Section for Ecoinformatics and Biodiversity (ECOINF) or early-career scientists at BIOCHANGE. Hereunder, we provide examples of some of the projects supervised in BIOCHANGE in 2017-2018.

Maria Juul Nørmark
(BSc project)

Supervisors: Jens Christian Svenning and Peder Klith Bøcher in collaboration with Aarhus city

This rewilding study investigates differences in habitat selection between konik horses, Galloway cattle and water buffalos in two seasons, in Geding-Kasted moor, north of Aarhus. The behavior of all three species are observed in the field from February to May and compared between morning, noon and evening. The study aims to determine if water buffalos contribute different space use and behavior to the rewilding compared to horses and cattle. The project is ongoing, and no conclusions can be drawn yet.

Matilde Skjoldager
(BSc project)

Supervisor: Signe Normand

Knautia arvensis is a keystone species in grassland habitats and act as host plant for a variety of insects. It is an important plant for the biodiversity of the Danish grassland habitats. The study investigated the effect of different environmental parameters on the presence and frequency of *K. arvensis* in Mols Bjerge, and found that the presence of *K. arvensis* is correlated with vegetation height and the availability of light and moisture.

Julie Balslev Pristed
(BSc project)

Supervisor: Signe Normand and Urs A. Treier

It remains a key issue in ecological studies if remote sensing can be used as a nondestructive technique for estimating plant biomass from ground cover and vegetation height. Data was collected data to mimic airborne LiDAR and photogrammetry technology derivatives. Cover and height were found to significantly describe biomass: (R^2 = 0.435) for grasses and (R^2 = 0.292) for herbs.

Lea Bach Sloth
(BSc project)

Supervisor: Jens-Christian Svenning

The goal for this study was to investigate the habitat selection and behavior of Exmoor ponies and Galloway cows at the rewilding project at the Mols Laboratory. The results showed that the Exmoor ponies and the Galloway cows used different habitats for ecological important behaviors such as grazing and resting, thus the study concluded that it is important to have both types of grazers for rewilding projects to increase the biodiversity of flora and fauna.

Nana Bouvin Christiansen
(Biological project)

Supervisors: Signe Normand and Angela Luisa Prendin

Climate is changing rapidly in the Arctic. The aim of the study is to detect the main limiting growing factors of the most Northern growing shrub, Salix arctica, living under extreme conditions. Samples were collected close to Station Nord in Greenland and the analysis is based on dendro-chronology and -anatomy. This is analyzed to test if changes in summer temperature or winter precipitation is detectable in different anatomical traits.

Jonas Brunbjerg Lauridsen
(MSc project)

Supervisors: Jens-Christian Svenning and Peder Klith Bøcher

The purpose of this project is to detect potential areas in Denmark, where moose (*Alces alces*) could live. Moose was chosen as as a focus, because it is native to Denmark, but absent due to prehistoric extirpation, and could contribute important ecological functions to wetland areas if reintroduced. Potentially suitable areas detected using GIS-based modelling include Rold Skov, Blåvand area, Thy area and Almindingen in Bornholm. The model was built in ArcMap using data of forest distribution and urban zones in Denmark.

Laura Balslev
(MSc project)

Supervisor: Signe Normand and Urs A. Treier

The project investigated the effect of historical human activities on the arctic vegetation and the spatial scale at which these effects are detectable. Field work was conducted at Anavik, a norse settlement in West Greenland, and changes in plant species composition, C:N ratio, isotopic ratio and shrub ring-width with distance from the settlement were analyzed. The results show that legacies are still evident today, c. 500 years after cessation, in a radius of c. 200 m from the center of the settlement.

Line Bøgelund Bang
(MSc project)

Supervisors: Jens-Christian Svenning and Maya Pasgaard

Iconic wildlife as lions and elephants live side by side with local communities in Maasai Mara, the Kenyan part of the famous Mara-Serengeti ecosystem with its massive wildebeest and zebra migrations. Wildlife populations in the area is under pressure, and future persistence of the ecosystem depends on the continuation of societal support for human-wildlife coexistence. Despite many conflicts between wildlife and humans, this survey shows that women in the Maasai Mara have a positive attitude towards wildlife and feel like the benefits (especially from ecotourism) of living amongst wildlife are greater than the costs.

Katrine Hvid Andersen (MSc project)

Supervisors: Anders S. Barfod and Signe Normand

The aim of the project is to investigate the effect of different afforestation methods on tree mortality and growth rates in the early stages of forest development. The project is based on an experimental forest near Mariendal beach, south of Aarhus. The forest was established in 2014 to test how the afforestation method affect growth and mortality as the forest development and the forest associated biodiversity, and thus contribute to developing best practices for creating biodiverse and natural forest. The afforestation project is developed in collaboration with Aarhus City and Jens-Christian Svenning.

Lars Christian Aage (MSc project)

Supervisors: Signe Normand and Anders Barfod

The project aims to address how the hydrology and grazing megafauna affect the diversity and dominance ratio of bryophytes in the rewilding area in Geding-Kasted moor, where konik horses, Galloway cattle and water buffalos affect the local environment and vegetation. The project uses ultra-high resolution digital surface models and vegetation surveys to investigate the correlation between varying topography created by the animals, and bryophyte diversity and dominance, and if this is mediated by a direct or indirect effect by competition from higher plants.

Other students

- Julie Drud (BSc)
  Supervisors: Jens-Christian Svenning and Robert Buitenwerf
- Line Guld (MSc)
  Supervisors: Jens-Christian Svenning and Peder Klith Bøcher
- Thomas Elsborg (BSc)
  Supervisors: Signe Normand and Urs A. Treier
- Elisabeth B. Slæggerup (BSc)
  Supervisor: Signe Normand and Urs A. Treier
- Mette Møller Christensen (BSc)
  Supervisors: Jens-Mogens Olesen and Signe Normand
- Mette Bundgaard Larsen (BSc)
  Supervisor: Signe Normand

COMMUNICATION AND OUTREACH

COMMUNICATION AND OUTREACH

INVITED TALKS

August 2017
Signe Normand: Billedanalyse som værktøj til naturovervågning – potentiale & perspektiver. Miljøstyrelsen, Copenhagen, Denmark.

September 2017
Jens-Christian Svenning: Broad-scale, long-term perspectives on megafauna ecology and trophic rewilding in a changing world. Calpe annual conference, Gibraltar Museum, Gibraltar.

October 2017
Alejandro Ordonez Gloria: History supplements current environment in driving functional diversity patterns. The Geological Society of America (GSA) 129th Annual Meeting, Seattle, Washington, USA.

Jens-Christian Svenning: Trophic rewilding – background, South American context, and open questions. Instituto de Botánica del Nordeste, CONICET, Corrientes Argentina.

November 2017
Felix Riede: Shocks and hazards in deep history. Capturing vulnerability and resilience using archaeological sources. Antwerp University, Belgium.

December 2017
Signe Normand: Understanding vegetation dynamics using UAS-based remote sensing. Meeting on New Opportunities in Satellite & Airborne remote sensing: Hydrological and Environmental Applications. DTU Environment, Lyngby, Denmark.

Jens-Christian Svenning: Long-term biodiversity-climate disequilibria – a macroecological perspective. Bolin Centre for Climate Research, Stockholm University, Sweden.

Jens-Christian Svenning: Broad-scale, long-term perspectives on trophic rewilding. Ecology Across Borders, Joint Annual Meeting of the British Ecological Society (BES), Gesellschaft für Ökologie (GfÖ) and NecoV, in association with European Ecological Federation (EEF), Ghent, Belgium.

January 2018
Alejandro Ordonez Gloria: The rising novelty in ecosystems and climates: looking to the past to understand a no-analogue future. Conference: 'Do species move, adapt or die?', University of Plymouth, Plymouth, UK.

Signe Normand: Investigations from Northeast Greenland in a Greenlandic and biome-wide context. Villum Research Station Annual Meeting. Roskilde, Denmark.

Jens-Christian Svenning: Trophic rewilding – background, implementation, link to societal dynamics, and open questions. Rewilding in a Changing Europe conference, Bangor, UK.

March 2018
Felix Riede: Palaeo|environmental Humanities – from deep time to the future. RUC, Denmark.

Jens-Christian Svenning: Paleoclimate supplements contemporary environment in driving plant functional diversity and vegetation-related ecosystem structure across broad spatial scales. IBS, Evora, Portugal.

April 2018
Signe Normand: Vegetation dynamics in a changing world: insight from cells to satellites. Annual meeting of the specialist group for macroecology of the Ecological Society of Germany, Austria and Switzerland, Birmensdorf, Switzerland.

Jens-Christian Svenning: Long-term biodiversity-climate disequilibria – a macroecological perspective. Inner Mongolia University, Hohhot, China.

Jens-Christian Svenning: Biodiversity Dynamics in a Changing World. Institute of Botany, Chinese Academy of Sciences, Beijing, China.

May 2018
Jens-Christian Svenning: Broad-scale, long-term perspectives on rewilding. University of Sussex, Brighton, UK.

Jens-Christian Svenning: Broad-scale, long-term perspectives on rewilding. Knepp Estate, UK.

Jens-Christian Svenning: Trophic rewilding – background, opportunities and challenges for megafauna-based restoration in the Anthropocene. Department of Systematic and Evolutionary Botany, University of Zurich, Switzerland.

Jens-Christian Svenning: Paleoclimate supplements contemporary environment in driving plant functional diversity and vegetation-related ecosystem structure across broad spatial scales. University of Zurich & ETH Zurich, Switzerland.

INVITED POPULAR SCIENCE TALKS

October 2017
Jens-Christian Svenning: Rewilding – koncept, baggrund og implementering. Danmarks Naturfredningsforening Århus' årsmøde, Aarhus, Denmark.

Anne Blach Overgaard: Klima, Biodiversitet & Økoinformatik. Studiepraktik, Aarhus University, Denmark.

Sigrid Schøler Nielsen: Hvorfor bliver Grønland grønnere? Risskov sognegård, Aarhus, Denmark.

November 2017
Anne Blach Overgaard: Klimaets betydning for biodiversiteten. Skelager Kirke, Aarhus, Denmark.

Kristine Engemann Jensen: Har grønne områder og naturen betydning for vores mentale sundhed? Ellevang Kirke, Aarhus, Denmark.

December 2017
Jens-Christian Svenning: Rewilding med store vilde dyr i den danske natur – baggrund, status, potentiale & udfordringer/ Vejen til endnu vildere natur. Naturhistorisk Forening for Nordsjælland, Hillerød

January 2018
Signe Normand: Vegetationsforandringer i Arktis. Biologilærerdag, Aarhus Universitet, Denmark.

May 2018
Signe Normand: Biodiversitet. Frederiksbjergskole, Aarhus, Denmark.

MEDIA | DEBATES | NEWS

Below is a selection of examples of media appearances, partitioning in debates and news stories by BIOCHANGE senior core members.

August 2017

Jens-Christian Svenning: Ufatteligt flot: Se USA's nationalparker fra rummet. Videnskab.dk. 4 August 2017

Jens-Christian Svenning: Her er Danmarks nye rovdyr. Nordjyske Stiftstidende. 11 August 2017

Jens-Christian Svenning: Gråsælen er kommet til Danmark – men er det godt eller skidt? TV2 Nyhederne. 28 August 2017

Jens-Christian Svenning: Øer er evolutionens laboratorium. Videnskab.dk. 31 August 2017

September 2017

Jens-Christian Svenning: Naturen uden os. Nordjyske Stiftstidende. 8 September 2017

October 2017

Jens-Christian Svenning: Utroligt: 'Uddødt' kæmpeinsekt genopstår på klippeø. Videnskab.dk. 5 October 2017

Felix Riede: Eske Willerslev løfter dynen over 35.000 år gamle sexvaner. Videnskab.dk. 7 October 2017

Felix Riede: Matematikere afslører endelig, hvorfor neandertalerne uddøde. Videnskab.dk. 31 October 2017

November 2017

Jens-Christian Svenning: Big data – når virkeligheden fungerer som eksperiment (press release). Scitech.au.dk. 9 November 2017

Jens-Christian Svenning: Megafaunaens betydning for Jordens økosystem. Videnskab/Lidenskab. 16 November 2017

Jens-Christian Svenning *et al.*: Topforskere: Her er fakta i debatten om bier (Bruun, H.H., Ejrnæs, R., Rahbek, C., Svenning, J.-C., Hansen, M.D.D., Strandberg, B. & Geldmann, J. 2017). Altinget.dk. 17 Novemebr 2017

December 2017

Jens-Christian Svenning: Få de store dyr tilbage i naturen. Frederiksborg Amts Avis. 4 December 2017

Jens-Christian Svenning: Palmegrænsen. Weekendavisen. 15 December 2017

January 2018

Jens-Christian Svenning: Skindet bedrager! Zebraer er meget mere forskellige end antaget. Videnskab.dk. 22 January 2018

Felix Riede: Rekordgamle fund afslører: Mennesker forlod Afrika længe før troet. Videnskab.dk. 25 January 2018

Jens-Christian Svenning: Ulven kommer – men hvilke dyr er ellers på vej til landet? TV2Oj.dk. 23 January 2018

Jens-Christian Svenning: Geoengineering kan smadre klodens biodiversitet. Videnskab.dk. 23 January 2018

February 2018

Jens-Christian Svenning: Geo-Engineering (podcast). NOVA. 2 February 2018

Felix Riede: Verdens ældste hulemalerier blev skabt af neandertalere. Videnskab.dk. 22 February 2018

March 2018

Alejandro Ordonez Gloria: Første eksperiment i ægte koralrev: Sådan påvirker CO_2-udledning om 100 år. Videnskab.dk. 15 March 2018

April 2018

Signe Normand and Jens-Christian Svenning: Increase of plant species on mountain tops is accelerating with global warming (press release). Scitech.au.dk. 4 April 2018

Signe Normand og Jens-Christian Svenning: Blomstrende bjergtoppe: Antallet af plantearter vokser hastigt på tinderne. DR.dk. 4 April 2018

Jens-Christian Svenning: Nyt studie: Om 200 år er koen det største pattedyr på land. Videnskab.dk. 19 April 2018

Jens-Christian Svenning: Pressede nyttedyr. Weekendavisen. 20 April 2018

May 2018

Jens-Christian Svenning: In today's dung beetles, echoes of a lost world – and hints of a new one. Anthropocenemagazine.org. 9 May 2018

Jens-Christian Svenning: Nyt studie: Klimaet er på farlig kurs for verdens dyr og planter. Videnskab.dk. 17 May 2018

Jens-Christian Svenning: Spørg Aarhus Universitet (debate). Naturmødet, Hirtshals, Denmark. 25 May 2018

Jens-Christian Svenning: Hvor vilde skal vi være? Videnskabelig debat om rewilding (debate). Naturmødet, Hirtshals, Denmark. 25 May 2018

Jens-Christian Svenning: Hvad vil vi med vores fælles natur? En faglig og visionær snak om fremtidens forvaltning af vores fælles statsejede natur (debate). Naturmødet, Hirtshals, Denmark. 26 May 2018

Jens-Christian Svenning: Spontane processer og rewilding (debate). Naturmødet, Hirtshals, Denmark. 26 May 2018

Jens-Christian Svenning: Bringing Back the Mammoth (debate). Bloom festival om natur og videnskab, Denmark. 27 May 2018

Jens-Christian Svenning: Mennesket er dyrenes konge (debate). Bloom festival om natur og videnskab, Denmark. 27 May 2018

OTHER OUTREACH ACTIVITIES

Signe Normand and five biology students taught almost 90 primary school students at a school in the center of Aarhus about biodiversity. Together they documented the diversity of plants and arthropods and helped the students expanding the ecospace (i.e. available environments conditions and resources) of the area by planting almost 600 native plants and building insects hotels. The plants were sponsored by Nordea Fonden as part of KribleKrable (http://natur-vejleder.dk/projekter/krible-krable/ansoeg-minibiotop-2018/)

Photo: Urs A. Treier, BIOCHANGE

EVENTS AND VISITORS

INAUGURATION OF CENTER FOR BIODIVERSITY DYNAMICS IN A CHANGING WORLD

BIOCHANGE was inaugurated on 9 November 2018 at a formal event held at the Main Hall at Aarhus University, where two VILLUM Investigator grants at Aarhus University were celebrated. Center director Jens-Christian Svenning and Professor Bjørk Hammer (Department of Physics and Astronomy) both recipients of the prestigious VILLUM Investigator grants from VILLUM FONDEN, co-hosted the event. More than 160 guests attended the inauguration. The day included a session of formal speeches and talks by the Chair of VILLUM FONDEN, Jens Kann-Rasmussen, Rector at Aarhus University, Brian Bech Nielsen, Professor Jens-Christian Svenning, Professor Bjørk Hammer, and Professor Nils Ole Bubandt (Department of Anthropology), which was subsequently followed by a reception.

A. Chair Jens Kann-Rasmussen from VILLUM FONDEN speaks at the VILLUM Investigator and center inauguration 9 November 2017.
Photo: Lars Kruse, AU

B. Jens-Christian Svenning lectures on Biodiversity Dynamics in a Changing World.
Photo: Lars Kruse, AU

C. Jens-Christian Svenning's lecture on Biodiversity Dynamics in a Changing World.
Photo: Lars Kruse, AU

D. Bjørk Hammer on Machine Learning in Atomistic Structure Determination.
Photo: Lars Kruse, AU

E. Nils Ole Bubandt on Biodiversity and technology in the Anthropocene.
Photo: Lars Kruse, AU

F. Inauguration reception – Aarhus University's main Hall.
Photo: Dennis Pedersen

G. Inauguration reception. Felix Riede, Jens-Christian Svenning & Jens Kann-Rasmussen (VILLUM FONDEN).
Photo: Dennis Pedersen

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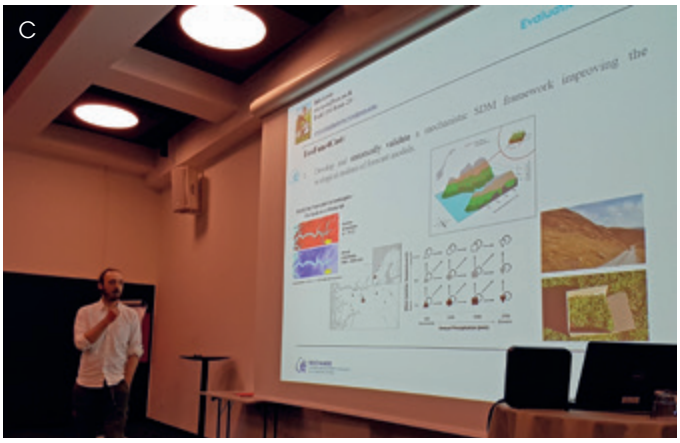
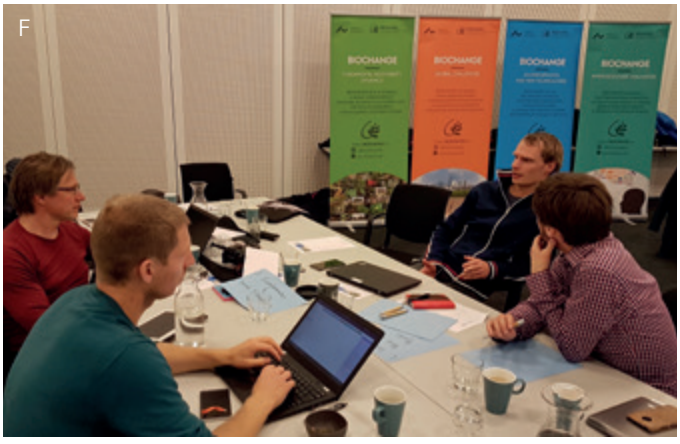
KICK-OFF SEMINAR

4 April 2018, BIOCHANGE members, guests and associates met at Scandic hotel down town Aarhus to meet and greet, discuss scientific subjects, and introduce the current research conducted in the center. The activities during the day were a mix of speed-talks by all PhD students and postdocs, longer presentations by the senior core members, scientific speed-dating, group discussions and brainstorm sessions. The day was finalised by a final recap of the day. Notably the group discussions focussed on the four themes of BIOCHANGE, which resulted in a neat database of ideas and suggestions for future research projects, seminars, workshops and PhD courses. Below, some impressions from the seminar:



A. Presentation by center director Jens-Christian Svenning
B. Speed-talk by postdoc Robert J. Lewis
C. A concentrated audience
D. Scientific speed-dating
E. Scientific speed-dating
F. Group discussions
G. Group discussions
H. Senior core members discussing future collaborations
Photos: Anne Blach Overgaard, BIOCHANGE



BIOSCIENCE ALUMNI DAY

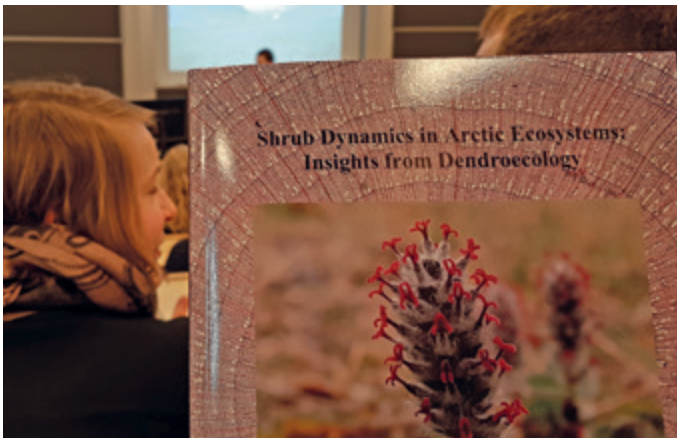
5 April 2018, BIOCHANGE were present with two stands at the annual Bioscience alumni day at the Main Hall, Aarhus University. Signe Normand, Urs A. Treier and Bjarke Madsen represented the UAS4Ecology Drone Lab, and Jens-Christian Svenning, Peder Klith Bøcher, Michael Munk and Anne Blach Overgaard a stand presenting the research taking place in BIOCHANGE with emphasis on the newest technologies and data, we use in the current research projects.

A. Anne Blach Overgaard introduces how terrestrial 3D laser scanning is implemented in the research projects of BIOCHANGE.
B. Peder Klith Bøcher and Jens-Christian Svenning interacting with visitors at the BIOCHANGE stand.
C. Urs A. Treier and Peder Klith Bøcher at the UAS4 ECOLOGY stand.
D. Impressions of the many Bioscience alumni visiting the many stands at the event including the two BIOCHANGE stands.

Photos: Lars Kruse, AU

PHD DEFENSES

BIOCHANGE has already celebrated two successful PhD defenses.



On 1 February 2018, BIOCHANGE Alumni PhD student Sigrid Schøler Nielsen, supervised by senior core member Signe Normand and Anders S. Barfod from ECOINF, defended her thesis: Shrub dynamics in Arctic Ecosystems: Insights from dendroecology. Members of the assessment committee consisted of Professor Bente Jessen Graae (Norwegian University of Science and Technology), Professor Hans Henrik Bruun (University of Copenhagen), and Chair Volker Loeschcke (Aarhus University).

On 8 March 2018, BIOCHANGE Alumni PhD student Shuqing Teng, supervised by Jens-Christian Svenning defended his thesis: Coevolution of people, agriculture and the environment in Eastern China over the past two millennia. Members of the assessment committee consisted of Professor Richard Corlett (Chinese Academy of Sciences), Professor Peter Verburg (Vrije Universiteit, Amsterdam), and Chair Signe Normand (Aarhus University).

Photos: Anne Blach Overgaard, BIOCHANGE

BIOCHANGE VISITORS

Junia Machado, Presidente do Santuário de Elefantes Brasil, Brazil (7 – 9 August 2017).

Søren Faurby, Assistant Professor, University of Gothenburg (7 – 8 September 2017).

Roberto Manuel Salas, Research assistant, National University of the Northeast, Corrientes, Argentina (10 – 24 September 2017).

Vincent Pellissier, Alumni postdoc, Aarhus University, Denmark (9 – 15 October 2017).

Irena Simova, Postdoc, Center for Theoretical Study, Charles University, Prague, Czech Republic (9 – 13 October 2017).

Judith Slagt, Project manager, Regelink Ecologie & Landschap, Holland (8 – 10 November 2017).

Alexander Zizka, PhD student, Gothenburg University, Sweden (28 – 29 November 2017).

Hanna Tuomisto, PhD, University of Turku, Finland (17 – 19 January 2018).

Bente Jessen Graae, Professor, Norwegian University of Science and Technology (1 February 2018).

Hans Henrik Bruun, Professor, University of Copenhagen (1 February 2018).

James Speed, Associate Professor, Norwegian University of Science and Technology (31 January – 1 February 2018).

María Genoveva Gatti, Professor, National University of Misiones & Researcher, Subtropical Biology Institute (CONICET-UNaM), Argentina (5 – 6 February 2018).

Gustavo Andres Zurita, Professor, National University of Misiones & Researcher, Subtropical Biology Institute (CONICET-UNaM), Argentina (5 – 6 February 2018).

Richard Corlett, Professor, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Science, China (7 – 8 March 2018).

Peter Verburg, Professor, Vrije University, Holland (8 March 2018).

Luisa Genes, MSc, Federal University of Rio de Janeiro, Brazil (7 – 11 May 2018).

Caroline Dracxler, PhD, Natural History Museum, Paris, France (14 – 18 May 2018).

Guillermo Fandos, Research Associate, Complutense University of Madrid, Spain (15 – 18 May 2018).

Adriane Esquivel Muelbert, Research Fellow, University of Leeds, UK (28 – 29 May 2018).

John (Jack) Williams, Professor, University of Wisconsin-Madison in Madison, Wisconsin, USA (29 May – 28 June 2018).

Brody Sandel, Assistant Professor, Santa Clara University, USA (18 – 22 June 2018).

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IN A CHANGING WORLD

Contact information:

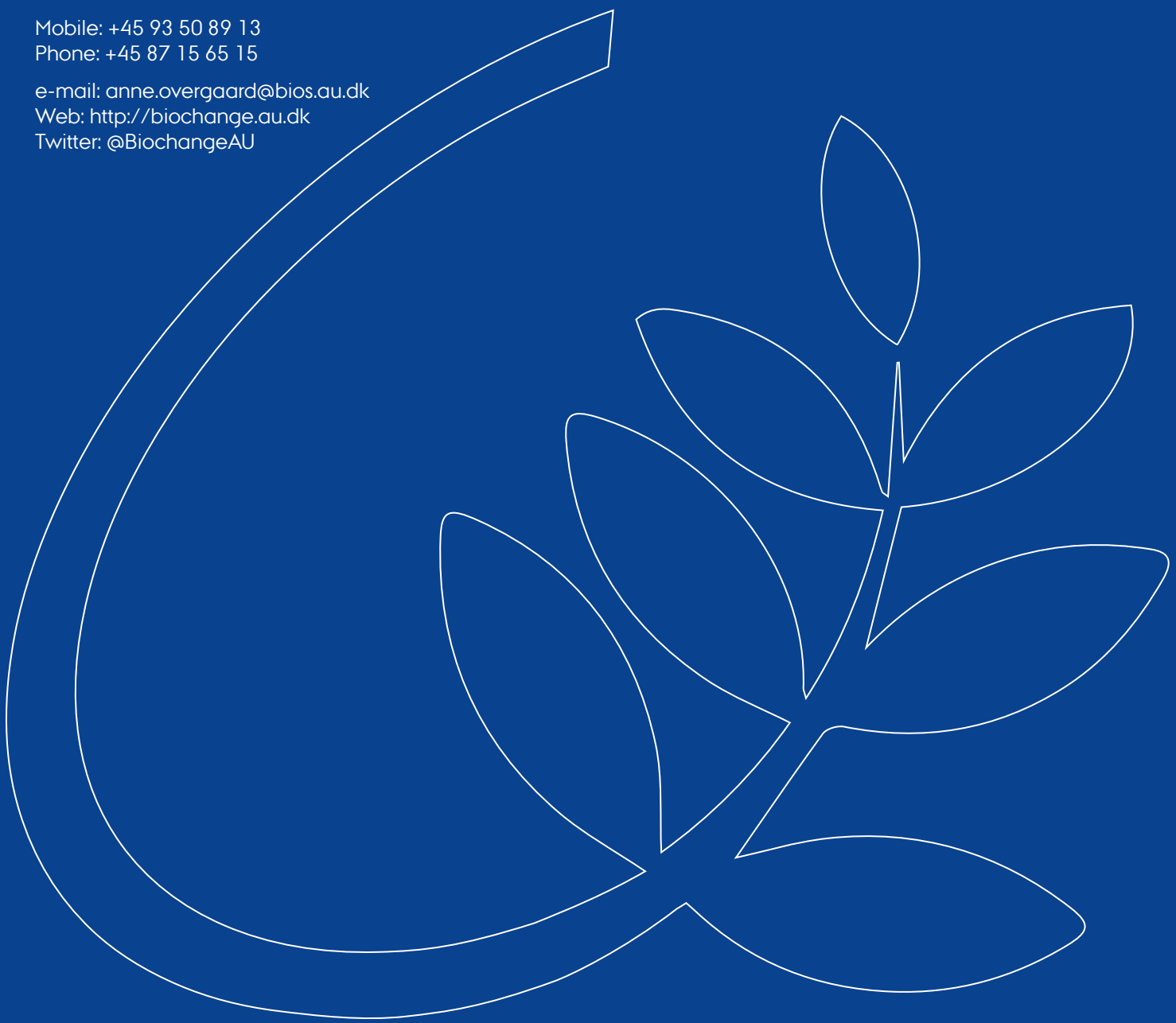
Anne Blach Overgaard, PhD
Center Manager

BIOCHANGE – Center for Biodiversity Dynamics
in a Changing World

Department of Bioscience
Aarhus University
Ny Munkegade 116
DK-8000 Aarhus C
Denmark

Mobile: +45 93 50 89 13
Phone: +45 87 15 65 15

e-mail: anne.overgaard@bios.au.dk
Web: http://biochange.au.dk
Twitter: @BiochangeAU



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