SESSION 1: EXTREME WEATHER EVENTS

Understanding how exposure to novel climatic conditions shapes biodiversity responses to environmental change

Newbold, T. Centre for Biodiversity & Environment Research UCL., Outhwaite, C. Centre for Biodiversity & Environment Research UCL.

Understanding of the ecological impacts of climate change is generally based on long-term average climatic conditions, often average annual temperature or annual total precipitation. There is a growing recognition that the emergence of more frequent and longer-lasting extreme climatic conditions is important in determining changes in biodiversity. I will present recent work from my research group showing that responses of species to environmental changes (both climate change and land-use change) are shaped by exposure to climatic conditions not experienced by these species before the onset of rapid anthropogenic climate change. These results have important implications for understanding future changes in biodiversity, as novel climatic conditions occur more often.

Observing health of trees in the urban area of Milton-Keynes through remote sensing data using google earth engine

Khan, R. The Open University., Maseyk, K. The Open University., Wheeler, P. The Open University.

Trees in urban environments are more than just an accessory to complement the beauty of the surroundings. They also provide several ‘ecosystem services’ to society through their ecological function. For example. an increasingly important ecosystem service is their role in combating rising temperatures through both their shading and evaporative cooling. Urban areas tend to be warmer than surrounding rural areas (‘urban heat island’ effect’) and therefore increasing temperatures are more pronounced in urban areas. In this research, satellite datasets of Era-5 and Sentinel-2 will be used to identify heatwaves in Milton-Keynes from previous records. Since the heatwaves are seen mostly in summer and spring, the time series plot and regression model will be generated for the tree’s health during these seasons from 2016 to 2020 with cloud cover percentage keeping below 40 for the built-up areas in the wards of the study area.

Modelling the impact of temperature variability on pest-parasitoid population dynamics

Edwards, S. University of Reading., Walters, R. Centre for Environmental and Climate Science Lund University., Girling, R. School of Agriculture Policy and Development University of Reading., Bishop, J. School of Agriculture Policy and Development University of Reading.

Predictive models that incorporate differences in response to environmental change among traits, species and trophic levels have the potential to yield important insights over single species models. Mechanistic models commonly assume constant temperatures over time. This is problematic because temperature variability is projected to increase with climate change. We demonstrate the potential effects of temperature variability in pest-parasitoid systems on emergent properties of total pest abundance, pest population peak size and the

number of population cycles throughout a growing season. We use an established population-dynamics model parameterised with temperature-dependent behavioural, physiological and functional response traits, using standardised data from a collated database of values. We use Jensen's Inequality to incorporate responses to temperature variability. We present results for a range of conceptual temperature scenarios and for future climatic predictions using outputs from the CMIP5 ensemble of global climate models under two emissions scenarios.

Experimental heat waves disrupt bumble bee foraging through direct heat effects and reduced nectar production

Hemberger, J. University of California Davis., Rosenberger, N. University of California Davis., Williams, N. University of California Davis.

Heat waves are an increasingly common extreme weather event across the globe and are projected to increase in frequency and severity in the coming decades. Of ecological processes, plant-pollinator mutualisms are especially vulnerable due to interacting effects of extreme heat on ectothermic insect pollinator foraging behavior and their forage plants. We designed an experiment to parse the impact of extreme heat on bumble bee foraging mediated directly through air temperature and indirectly through changes in plant rewards. Temperatures simulating a moderately severe heat wave negatively impacted foraging bumble bees via direct stress that reduced the proportion of successful foraging bouts, foraging bout duration, and plant and flower visitation, and indirect stress through reduced nectar production that limited foraging bout duration. Our results provide a mechanistic link between climate, plants, and pollinators while outlining potential risks facing both wild and managed plant-pollinator interactions under future climate scenarios.

The effect of projected imminent increases in extreme drought on two key Scottish habitats, ombrotrophic wetlands and temperate rainforest

Kirkpatrick Baird, F. NatureScot., Stubbs Partridge, J. NatureScot., Spray, D. NatureScot., Hall, J. NatureScot.

Climate-driven changes in extreme weather events include increased drought risk in temperate climates, which may be less resilient to water scarcity than already-arid habitats. Scotland provides an example of an oceanic climate in which drought risk is understudied, but could have substantial ecological impacts, particularly in occurrence with other extreme weather events. We modelled and mapped changes to extreme drought risk in Scotland in the near future (2021-2040) and considered potential impacts of these changes on two key oceanic habitats, ombrotrophic wetlands and temperate rainforest. We found increases in the likelihood of both the number and length of extreme drought events throughout the country, with the most severe effects occurring in autumn. These changes could have significant implications for both ombrotrophic wetlands and temperate rainforest (both of which host species that rely on wet climates for key life stages), particularly in interaction with other climate-driven changes and anthropogenic pressures.

SESSION 2: SHIFTING CLIMATES SHAPING ECOLOGY

Combining field observations with ecosystem and climate models to study the responses of a Norwegian deep-sea fjord community to climate change

Gallo, N. University of Bergen and Bjerknes Centre for Climate Research., Salvanes, A. University of Bergen and Bjerknes Centre for Climate Research., Gao, S. Institute of Marine

Research and Bjerknes Centre for Climate Research., Skogen, M. Institute of Marine Research and Bjerknes Centre for Climate Research., Darelius, E. University of Bergen and Bjerknes Centre for Climate Research., Myksvoll, M. Institute of Marine Research and Bjerknes Centre for Climate Research.

Western Norwegian fjords are iconic and economically important marine ecosystems that are experiencing climate-related deep-water warming and reduced basin water circulation, leading to deoxygenation and acidification. A new strategic project at the Bjerknes Centre for Climate Research uses Masfjord, a well-studied fjord ecosystem near Bergen, to examine ecological responses to recent and future climate-related changes. One focal area is on combining analysis of new and existing field observations with numerical model simulations using the NORWECOM.E2E ecosystem model and downscaled climate model projections to examine how climate change may alter the fjord's carrying capacity and identify changes in deep sea biodiversity and species composition. However, there are challenges to linking ecological datasets with ecosystem and climate models, including differences in scale, species resolution, and temporal resolution. In this presentation, I will share preliminary time-series results and our approach to combining field-based and modelling approaches to examine ecological responses to climate change.

Forecasting ungulate populations dynamics with a coupled herbivore-dynamic global vegetation model

Stratmann, T. Goethe University Frankfurt Senckenberg Biodiversity and Climate Research Center., Forrest, M. Senckenberg Biodiversity and Climate Research Center., Mueller, T. Goethe University Frankfurt Senckenberg Biodiversity and Climate Research Center., Hickler, T. Goethe University Frankfurt Senckenberg Biodiversity and Climate Research Center.

Predicting effects of climate change on herbivore population dynamics will require realistic simulations of vegetation dynamics but also herbivore physiology. We used a physiological model of herbivores coupled with a dynamic global vegetation model to predict changes in the population dynamics of Mongolian gazelles (*Procapra gutturosa*) in the Eastern Steppe of Mongolia. We simulated population dynamics to 2100 under different climate change scenarios (ISIMIP3b: 5 GCMs, high and low joint SSP/RCP scenarios). Gazelle abundances generally showed large increases that were linked to warmer winter temperatures, which reduced thermoregulation costs, but also large increases in forage quantity driven by longer growing seasons and increases in atmospheric CO_2 concentrations and nitrogen deposition. Simultaneously, warming temperatures and increased nitrogen deposition increased nitrogen fertilization and narrowed C:N ratios, improving forage quality. These potential positive effects of climate change in temperate steppe environments have not yet been considered for the conservation of large herbivores.

Integrating climate and genomic data to model ecological responses of bats to global change

Razgour, O. University of Exeter.

Climate change will produce a range of new selection pressures forcing many species to move in search of suitable conditions or adapt. Whether organisms can respond to these threats depends on their adaptive capacity or phenotypic plasticity, their dispersal ability, and the rate and magnitude of change. Research carried out in my group combines genomic tools with ecological research, climatic data and modelling approaches to assess and predict how climate and land-use changes affect biodiversity. We focus on bats as important ecosystem components and potential indicators of the state of the environment and other

biodiversity. This talk will demonstrate how we can integrate climate and genomic data through identifying local climatic adaptations and modelling their impacts on future range suitability, range shift potential and population vulnerability to climate change.

Roaming from sea to shore: modelling the vulnerability of seabirds to climate change using both marine and terrestrial information

Hakkinen, H. Institute of Zoology Zoological Society of London.

Seabirds are one of the most threatened of all bird groups, and are particularly vulnerable to the effects of climate change. Understanding and predicting how and where seabird species are vulnerable is key to conservation planning. However, seabirds present a challenge for conventional habitat suitability and species distribution models (SDMs), as they are dependent on conditions both in the terrestrial and marine realm. Each individual realm matters, but the spatial arrangement and proximity of suitable terrestrial and marine habitat is also key to species' long-term survival, which conventional SDMs do not incorporate. In this talk I will present the model framework we developed to include both marine and terrestrial information, and assess how habitat suitability across Europe may change for breeding seabirds under a range of emission scenarios. Our approach provides a repeatable and transparent method to combine information from multiple ecological realms in a single SDM framework.

Tracking ecosystem heterogenity changes from space under current climate change

Rocchini, D. Alma Mater Studiorum University of Bologna.

Ecosystem heterogeneity has been widely recognized as a key ecological indicator of several ecological functions, diversity patterns and change, metapopulation dynamics, population connectivity or gene flow. In this study, I will present a new R package - -rasterdiv - to estimate heterogeneity changes under current climate change, by calculating indices based on remotely sensed data. I will provide ecological applications at the landscape and global scales to demonstrate its power in revealing potentially hidden heterogeneity patterns.

Microclimate-driven trends in spring-emergence phenology in a temperate reptile *(Vipera berus*): evidence for a potential 'climate trap'?

Turner, R. UK Centre for Ecology and Hydrology., Maclean, I. University of Exeter.

Climate change will increase the exposure of organisms to higher temperatures, but can also alter species phenology and susceptibility to conditions at the onset of breeding cycles. We examined the risk of a 'climate trap' – a climatically-driven desynchronisation of the cues that determine life-cycle events and fitness later in the season in a hibernating reptile, the European adder (*Vipera berus*). Using a mechanistic microclimate model, we derived spring-emergence trends from historical adder observations in Cornwall, UK, and related trends to the likelihood of ground frost exposure. We found that adders advanced their phenology towards earlier emergence and, contradicting the expected effects of macrowarming, that some populations experienced increased exposure to ground frost. The mechanism underpinning this 'climate trap' was related to rate at which frost risk diminishes relative to phenological advancement. We emphasise the need to consider exposure to changing microclimatic conditions when forecasting biological impacts of climate change.

Vegetation canopy structure, photosynthesis and the global carbon cycle.

Quaife, T. University of Reading.

Photosynthesis schemes in Earth System Models have undergone numerous advances in recent decades. Improving understanding of this process is critical, as it is the dominant mechanism by which the land surface removes carbon from the atmosphere. However, one fundamental aspect that has not changed greatly since the 1980s is the assumption that the canopy is structured as a random media. This stems from the need for computational efficiency, as it permits construction of analytical solutions to the radiative transfer problem. Recent studies have highlighted this as a significant uncertainty and have shown differing impacts on modelled global photosynthesis, varying not just in magnitude of the predicted carbon flux but also in the sign of the effect. An important question, then, is to ask what level of complexity in the vegetation canopy should be included to sufficiently capture terrestrial carbon dynamics. This presentation explores some current work to address that question.

What the flux: how marine plankton influence ocean carbon sequestration and feedbacks in Earth System Models

Cavan, E. Imperial College London., Henson, S. National Oceanography Centre.

The transfer of biological carbon from the upper to the deep ocean by particulate export flux is the starting point for the long-term storage of photosynthetically-fixed carbon. Export flux and subsequent carbon sequestration reduce atmospheric CO2 levels by ~ 200 ppm relative to a world without export flux. I present a recently published synthesis showing that despite its importance for forecasting ocean carbon cycling, Earth System Models disagree on the projected response of the global export flux to climate change, with estimates ranging from -41% to +1.8%. Our synthesis prioritises the ecological processes most important to include in modern-day estimates (particle fragmentation and zooplankton vertical migration) and future projections (phytoplankton and particle size spectra, and temperature-dependent remineralization) of export. I will also show how considering the timescale of ocean carbon sequestration by marine life can highlight key areas globally for zooplankton-mediated carbon sequestration and could improve forecasting.

More than species number games – connecting biodiversity and earth system models using species area relationships

Karger, D. Swiss Federal Research Institute WSL., Zimmermann, N. Swiss Federal Research Institute WSL.

Earth system models (ESMs) provide estimates of the distribution and dynamics of major terrestrial habitats. Although they are highly complex in estimating climatic processes, a biodiversity component has so far been elusive. ESMs only use a simple characterization of plant functional groups that does not allow a distinction of individual species or biodiversity-related processes. However, in the context of global change, precise estimates of these biodiversity related processes is highly relevant for mitigation and conservation planning. One key problem is that biodiversity predictions are not only sensitive to the environment, but also heavily scale dependent. Here we present a new approach of estimating changes in global biodiversity from ESMs using well-known species area relationships (SARs) for terrestrial plant species. We show how changes in species richness

can be estimated from ESMs using output scaling, and how climate variability has already globally influenced biodiversity over the last decades.

Are peatlands robust to climate change?

Belyea, L. Queen Mary University of London.

Peatlands store one-third of all soil carbon, most in regions of rapid climate change. Persistence of this vast carbon store depends on feedbacks regulating water-table depth. This regulatory feedback network reduces the sensitivity of peatland properties to climate drivers. But how can we quantify sensitivity? And under what conditions does robustness fail?
I define and quantify peatland robustness by analysing time series from long-term monitoring. Definition is conditional on the system property, type of perturbation and time scale. Water-table depth, for example, is robust to seasonal and interannual variations in rainfall. Peatland robustness to common events conflicts with fragility to uncommon droughts and floods. The robust-yet-fragile nature of peatlands makes forecasting their response to climate change challenging.

Phenology v. hydrology: net loss of carbon to the atmosphere as drought shifts the balance of emission and uptake in the Okavango Delta, Botswana.

Helfter, C. UK Centre for Ecology & Hydrology., Gondwe, M. Okavango Research Institute University of Botswana., Murray-Hudson, M. Okavango Research Institute University of Botswana., Makati, A. Okavango Research Institute University of Botswana., Lunt, M. School of GeoSciences University of Edinburgh., Palmer, P. School of GeoSciences University of Edinburgh., Skiba, U. UK Centre for Ecology& Hydrology.

We report on three years of continuous monitoring of carbon dioxide (CO_2) and methane (CH_4) emissions in two contrasting wetland areas of the Okavango Delta, Botswana: a perennial swamp and a seasonal floodplain. We show that phenology is the overarching control of net CH_4 emissions to the atmosphere in the permanent swamp, and we find that vegetative processes modulate net CH_4 emissions at sub-daily to inter-annual timescales. Both ecosystems were sensitive to drought, which switched these sinks of atmospheric CO_2 into sources due to a weakening of the vegetative sink. CH_4 emissions decreased by a factor of 4 in the seasonal swamp during drought, which had however negligible impact on CH_4 emissions in the perennial swamp. Our study demonstrates that complex and divergent processes coexist within the same landscape, and that meteorological anomalies can significantly perturb the balance of the individual terms of the GHG budget and their respective controls.

SESSION 4: FROM RESEARCH TO OPERATIONS

Developing an early-warning system to forecast crop pest migration at high spatiotemporal resolution.

Dobson, R. University of Leeds., Cheke, R. University of Greenwich., Jennings, S. University of Leeds., Willis, S. Durham University., Challinor, A. University of Leeds., Dallimer, M. University of Leeds.

Early-warning systems that forecast migratory crop pest movements can advance

management by enabling preventative action. Using novel modelling techniques and state-of-the-art remote sensing data, we show that short-term weather conditions and dynamic crop distributions drive the occurrence of the crop pest bird, the red-billed quelea (*Quelea quelea*). Quelea pose a serious threat to food security in sub-Saharan Africa, with large flocks consuming staple small-grain cereals. The irregular, nomadic movements of this avian pest present a challenge to control operations, resulting in delayed and inefficient action. By applying identified drivers of occurrence, the inter- and intra-annual variation in quelea distribution and abundance can be projected accurately at high spatiotemporal resolution. These preliminary findings could help to develop an early-warning system for quelea - a vital forecasting tool for protecting farmers' livelihoods and food security across Africa. Furthermore, the methods developed could be applied for ecological forecasting in many other systems.

Atmospheric dispersion model forecasts of desert locust swarm movement during the 2019-2022 upsurge

Thurston, W. Met Office., Coward, K. Met Office., Millington, S. Met Office., Hort, M. Met Office., Cressman, K. Food and Agriculture Organization of the United Nations.

The 2019-2022 outbreak of desert locusts (Schistocerca gregaria) across East Africa, the Arabian Peninsula and the Indian subcontinent is the largest experienced in decades. Swarms of desert locust can contain up to 80 billion individuals, each capable of eating 2 grams of vegetation per day, and therefore pose an acute threat to livelihood in regions of the world that are already under severe food stress. Furthermore, with the capability of travelling over 100 km in one day, swarms can quickly traverse national boundaries. Predictions of the likely movement of swarms are therefore crucial to successful surveillance and control operations. Here we present the bespoke configuration of the Met Office's atmospheric dispersion model, NAME, used to provide operational forecasts of desert locust swarm movement, in order to support the UN Food and Agriculture Organisation (FAO) in coordinating in-country surveillance and control.

Lessons learnt from a decade of developing climate services for drought management in Africa

Black, E. University of Reading., Boult, V. University of Reading., Maidment, R. University of Reading.

Under global climate change, the frequency and severity of floods and droughts are projected to increase. Early warning of such events can mitigate their impact on fragile ecosystems. Nowhere is this truer than in Africa. TAMSAT-ALERT is a novel, lightweight forecasting approach that enables African agricultural organisations to produce their own drought risk assessments. This presentation will reflect on our experience of developing TAMSAT-ALERT, focusing on how the lessons we have learnt can be applied to climate services for ecological systems.

**Tropical Applications of Meteorology using SATellite data - Agricultural Early waRning sysTem (TAMSAT-ALERT)*

Forecast-based action for conservation: combining meteorological forecasting and humanitarian innovation to protect biodiversity from extreme weather

Boult, V. University of Reading.

Extreme weather events pose an immediate threat to biodiversity, but existing conservation

strategies have limitations. Advances in meteorological forecasting and innovation in the humanitarian sector provide a possible solution – Forecast-based Action (FbA) – with potential to revolutionise conservation's approach to extreme weather.
The growth of ecological forecasting demonstrates huge potential to anticipate conservation outcomes, but a lack of operational examples suggests a new approach is needed to translate forecasts into action. FbA provides such a framework and here, I draw on experience from the humanitarian sector to suggest how FbA could work in conservation. I address likely challenges in realising FbA for conservation – including establishing a financing mechanism, allocating funds to actions, and decision-making under uncertainty – provide a theoretical example, and discuss what FbA means for conservation research, practice and governance.

The utility and challenges of forecasting mast-seeding of trees

Pesendorfer, M. Institute of Forest Ecology University of Natural Resources and Life Sciences Vienna., Gratzer, G. Institute of Forest Ecology University of Natural Resources and Life Sciences Vienna., Oberklammer, I. Institute of Forest Ecology University of Natural Resources and Life Sciences Vienna.

Synchronized annual variation in seed production, termed mast-seeding, is an important driver of forest ecosystem dynamics and management. As a bottom-up driver of recruitment dynamics and trophic chains, masting not only affects the efficacy of forestry operations, but also influences the success of habitat restoration, species conservation, and predator control efforts, and even predicts the incidence of zoonotic diseases transmitted to humans by ticks. As classic ecological time-series correlated with preceding weather, masting should have high intrinsic predictability, and, fueled by the recent publication of a global reproduction time-series database, we expect rapid advances in mast forecasts. However, due to the complex mechanisms that link weather to reproduction and potential non-linearity of climate change effects, several challenges lay ahead. We discuss the current and potential future applications of mast forecasts and highlight next steps towards short- and long-term prediction of seed production in trees.

Future risk for Southern Ocean ecosystem services under climate change

Cavanagh, R. British Antarctic Survey., Hill, S. British Antarctic Survey., Melbourne-Thomas, J. CSIRO., Trathan, P. British Antarctic Survey., Bracegirdle, T. British Antarctic Survey., Constable, A. University of Tasmania., Barnes, D. British Antarctic Survey., Halfter, S. University of Tasmania., Hughes, K. British Antarctic Survey., Hollyman, P. British Antarctic Survey., Johnston, N. British Antarctic Survey., Meredith, M. British Antarctic Survey., Muelbert, M. Universidade Federal de Sao Paulo., Murphy, E. British Antarctic Survey., Trebilco, R. CSIRO., Turner, J. British Antarctic Survey., Watters, G. NOAA., Grant, S. British Antarctic Survey.

Utilising United Nations' Intergovernmental Panel on Climate Change (IPCC) outputs, including from the Coupled Model Intercomparison Project (CMIP), we evaluate climate-related risks to Southern Ocean ecosystems and services. Relationships between physical variables and ecological processes underpin our approach, and findings indicate that most ecosystem services face intermediate to high risk from climate change. The Antarctic krill fishery faces high risk, but the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), which manages this fishery, has progressed little in developing a coherent response to the rapid pace of climate change affecting the region. Given the urgency for climate-responsive options within CCAMLR's ecosystem approach to management, we use our risk assessment to make recommendations. We acknowledge challenges including uncertainty, and mismatch between spatial and temporal scales of

climate projections and ecological processes, advocating further engagement between climate scientists, ecologists, and policymakers to integrate climate-focused actions into ecosystem management.

Farmer-led agroecological scenarios for biodiversity with climate change

Bohan, D. INRAE., Richter, A. Thünen Institut of Biodiversity., Bane, M. UK CEH., Therond, O. INRAE., Pocock, M. UK CEH.

The increasing pace of climate change is an existential threat to farming continuity and biodiversity. Agricultural innovation is currently too slow. A farmer-led narrative would answer the agronomic and socio-economic problems farmers have for the continuity of farming and to meet societies' environmental needs, thereby being more acceptable and adopted more rapidly.

We wanted to develop novel rotations for farmers to continue to farm profitably with CC, while assuring biodiversity and ES. We detail a tool for farmers to innovate rotations, by translating CC scenarios into metrics that have higher operational value for farmers. Importantly, because farmers only propose sequences of crops that make agronomic sense, the farmer-led rotations are farmer-acceptable and can be treated as scenarios of future rotations that allow exploration of CC adaptation. EAE scores of each rotational scenario level can then be validated and demonstrated to farmers, via Citizen Science or Agricultural Living Labs.

SESSION 5: BIODIVERSITY CHANGE SCENARIOS & TARGETS

Climate change and the reorganization of animal communities

Araújo, M. CSIC., González del Pliego, P. University of Évora., Trujillo, J. CSIC., Mendoza, M. CSIC.

Climate controls the amount of energy for plants and these determine the amount of resources for animals. When climate changes so should the trophic structure of animal communities. Using a novel approach we model the global distribution of bird and mammal trophic communities and investigate how they might change under 21st century climate change. We show that trophic communities are expected to undergo profound changes, chiefly in the tropics and across high-latitude regions. This process could cause losses of trophic guilds across key biodiversity areas, such as the Eastern Arc Mountains and tropical Andes. We show that projected changes across animal communities could lead to the emergence of vacant niches, a process that has likely exacerbated past invasions by alien species. We argue that building on the collective properties of functional (trophic) groups, could help constraint some of the uncertainties that are propagated when combining hundreds of individual species models.

Climate genomics of Antarctic toothfish

Caccavo, J. Laboratoire des sciences du climat et de l'environnement | Laboratoire d'océanographie et du climat., Frémont, P. Genoscope., Jaillon, O. Genoscope., D'Ovidio, F. Laboratoire d'océanographie et du climat: expérimentation et approches numériques., Gehlen, M. Laboratoire des sciences du climat et de l'environnement.

Estimating the ecological impact of climate change is an unprecedented challenge that

drives the emergence of novel cross-disciplinary studies. Recently, the potential for genomics to address climate change impacts on species has come to the fore. This burgeoning field, which we refer to as climate genomics, is spurred on by the use of genomics to understand how climate change impacts species, populations, and ecosystems. We present approaches, considerations, and reciprocal benefits of climate genomics to molecular ecologists and climate scientists by focussing on the example of a recently funded study of Antarctic toothfish (*Dissostichus mawsoni*). One of the largest of the Southern Ocean fishes, Antarctic toothfish contribute to a 500-million USD fishery. Their life history is tied to sea ice extent, putting them at risk for climate change impacts. This study showcases the use of climate genomics to understand current and future impacts of climate change on Antarctic toothfish distributions.

A new set of UK future scenarios linking climate change with multiple environmental drivers

Bullock, J. UK Centre for Ecology & Hydrology.

Creation of reliable climate change projections is the focus of much research, but their usefulness is constrained by the lack of reliable coupling to other environmental drivers. To address this gap, we are producing spatially-explicit projections for the UK of how key environmental variables – comprising climate, socio-economics, land use, and pollution – are predicted to change in concert under alternative scenarios over this century. This implements the IPCC approach of combining climate change projections (RCPs) with the Shared Socioeconomic Pathways (SSPs). We have developed: 1) SSPs for the UK economy, demography, society, technology and institutions; 2) RCPs by downscaling and interpolating UKCP18. Using plausible RCP+SSP combinations, we have developed projections of land use change, which differ greatly under alternative scenarios. These combined scenarios are being used to project pollution and, ultimately, impacts on biodiversity. Together, these linked projections are a rich resource for ecological researchers to explore plausible futures.

Climate and nature scenarios in Scotland from 2030 to 2100 and beyond

Bassett, D. NatureScot., Mitchell, C. NatureScot.

Envisaging what a changing climate means for ecosystems in Scotland between 2030 and 2100 is vital to protecting and restoring nature. We examine this through low and high emission pathways. The low emission results in 1.5-2°C average global temperature rise between 2040-2060 which then stabilises to 2100, the high emission reaches 1.5-2°C for 2040-2060 and then 3-4°C for 2080-2100. We also examine 2100-2300 given that many ecosystems we are concerned with, such as peatlands and woodlands, persist for decades or centuries. Providing a clear understanding of what we know about climate change in the abstract, and translating this into ecosystem impacts and changes will help us to make better decisions for nature, climate and people. Enabling us to frame what land and sea management needs to look like in the future, and how we manage risks, if biodiversity is to flourish and provide the services we need.

Indicators of climate change impact on biodiversity and resilience in Scotland

O'Brien, D. NatureScot., Foster, S. NatureScot., Brooker, R. James Hutton Institute., Genney, D. NatureScot., Ogden, R. University of Edinburgh., Pakeman, R. James Hutton Institute., Thompson, D. NatureScot.

Monitoring and the production of indictors are essential if we are to track the interaction of the twin biodiversity and climate change crises. We use indicators to help us understand

current impacts. In Scotland, we have indicators that focus on climate change effects (e.g. summer temperature and bryophytes) and those which show climate impacts as part of a wider set of pressures (e.g. butterfly abundance and occupancy). We also use indicators that tell us about how resilient our species and ecosystems are. These indicators are used to inform government policy and all are made publically available. We are looking to develop new indicators to guide our response to climate change and give us the evidence we need to ensure mitigation is effective.

POSTER PRESENTATIONS

P1: Assessing the effect of extreme weather events on biodiversity using climate change metrics

González-Trujillo, J. Museo de Ciencias Naturales de Madrid., Roman-Cuesta, R. Wageningen University. GAIA Building., Araújo, M. Museo de Ciencias Naturales de Madrid.

Different metrics describe different facets of climate change. Understanding these differences is critical for climate change impact studies, chiefly on ecosystems and biodiversity. We develop a typology of climate change metrics to help navigate the plethora of metrics available. We focus on metrics describing extreme weather events and classify them in two groups: range-based metrics help identify regions more exposed to extreme events within a given time period; event-based metrics help identify exposure to episodic events or the cumulative effect of compound events - a combination of multiple events. We use the proposed classification together with a number of climate change metrics to explore extreme weather events in the Caribbean region over the last 80 years, and describe what trends and possible consequences for biodiversity.

P2: Extraordinary droughts trigger holm oak mortality in the Iberian Peninsula

Gea-Izquierdo, G. INIA-CSIC.

Increase in abiotic and biotic stress under global change threatens forests and challenges understanding of tree mortality. *Phytophthora cinnamomi (*PHYCI) is a lethal pathogen for many forest species. Dynamics of biotic agents and their hosts are influenced by climatic variability. A warming trend since the 1980s coincided with *Quercus ilex* mortality attributed to PHYCI. Tree mortality and latency of pathogens can be expressed at variable time spans and explained by abiotic factors. Growth of dead trees declined after two-year extraordinary droughts and for 30 years before tree death. Tree growth was highly sensitive to water stress. Live and dead trees expressed different sensitivity to moisture availability. Primary productivity was higher in live stands with less atmospheric demand for water. Tree death was a slow multiannual process as expressed by radial growth declines. Regardless of the causal agent or mechanism, dead *Q. ilex* trees exhibited negative drought and land-use legacies.

P3: Future climate change effects of reoccurring heatwaves and elevated temperature fluctuations towards chemically stressed freshwater ecosystems

Hermann, M. Wageningen University and Research., Peeters, E. Wageningen University and Research., Van den Brink, P. Wageningen University and Research.

Temperature alterations in consequence of global climate change (GCC) will affect aquatic

ecosystems. In future, higher mean temperatures and more severe and frequent weather extremes (e.g. heatwaves) are expected. Their impacts are, yet, unknown due to complex stressor interactions with other stressors like chemicals. While the majority of multiple stressor experiments consider single species responses, only few investigate populations or communities. Additionally, daily temperature fluctuations, thus natural variability, are rarely applied in experiments. Our goal was to study effects of GCC-scenarios on zooplankton-dominated freshwater ecosystems under chemical stress. Temperature variability and extremes were operated by the Transportable temperature and heatwave control device (TENTACLE). Results revealed a significant decline in macro- and micro-zooplankton species abundance towards all stressors. Community analyses presented rotifers having highest tolerance compared to copepods, while cladocerans presented lowest tolerance towards combined stress. Other multiple stressor effects were bidirectional, positive and negative, depending on trophic level and endpoint.

P4: High inter-annual variation stresses marmots: associated changes in health markers after an extreme weather event

Jebb, A. University of Aberdeen., Mackay, M. University of Aberdeen., Blumstein, D. University of Los Angeles California., Bize, P. University of Aberdeen., Martin, J. University of Ottawa.

Long-term individual based studies can provide insights into species responses to rare ecological disturbances. As body mass is a proxy of energy reserves in wild animals, studies often focus on effects of ecological disturbances on body mass changes. Although such disturbances are expected to additionally alter the internal health of organisms, we still know little about the consequential effects on health markers, such as measures of oxidative stress, and whether internal and external markers exhibit complementary changes. From 2018-2019, a population of yellow-bellied marmots (Marmota flaviventer) were subjected to an ecological disturbance when a harsh winter occurred that surpassed decadal averages in weather conditions. We quantified the health status of individuals within these years by assaying their body mass (g) along with markers of oxidative stress. Overall, this study describes an ecological disturbance associated with declines in both external and internal health markers that were buffered by life-stage or elevation.

P5: How does climate variability influence wetland flooding and waterbird habitat in human-made wetlands of Central India?

Bhojwani, S. University of Minnesota., Galatowitsch, S. University of Minnesota., Karwan, D. University of Minnesota., Krishnaswamy, J. Indian Institute for Human Settlements.

Patterns of wetland flooding can act as a strong habitat filter for aquatic communities. Human-induced climate change places constraints on waterbirds by altering the availability of suitable habitat. However, the strength of constraints on waterbird habitat can vary with local climate, regional land use, and water use. Our study investigates the influence of climate variability on waterbird community structure in ancient human-made wetland systems of Central India - situated within the context of the Indian Summer Monsoon. Using satellite-derived climate products and image classification, we present a time-series analysis for the relationship of precipitation, Land Surface Temperature and Evapotranspiration with the timing and duration of wetland flooding. Using 3 seasons of data, we also present the relationship between flooding variables and the probability of use by waterbird communities using an occupancy modeling framework. These results provide a foundational understanding of wetland vulnerability and habitat suitability to inform regional conservation planning.

P6: The effect of the 2018 European heat wave on the demography of a short-lived perennial plant, Plantago lanceolata

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Extreme climate events are projected to become more frequent, and we currently lack a conclusive understanding of how herbaceous plant species will respond to them. We examine the effect of the 2018 European heat wave on the demography of *Plantago lanceolata*, a short-lived herbaceous perennial. We use demographic data from PlantPopNet, a worldwide spatially distributed data collection effort. We perform a preliminary analysis on a subset of PlantPopNet data which includes European sites that experienced extreme conditions in 2018 and 2019. We link population growth rates and the underlying demographic rates to a drought index: the site-specific standardized precipitation evapotranspiration index. We find that drought negatively impacted the population growth, survival, and biomass growth of *P. lanceolata*. However, the effects of drought are relatively small, suggesting that short-lived perennial plants like *P. lanceolata* might be able to persist in the presence of short-term extreme drought events.

P7: Where will the forests go: predicting the potential future forest cover of an ancient land

Ekberzade, B. Istanbul Technical University - Eurasia Institute for Earth Sciences., Şen, O. Istanbul Technical University - Eurasia Institute for Earth Sciences., Yetemen, O. Istanbul Technical University - Eurasia Institute for Earth Sciences.

The study aims to predict the potential future forest cover for Anatolia, a peninsula situated in the Eastern Mediterranean Basin, a historic land bridge between Southeast Europe and Southwest Asia with diverse terrestrial ecosystems hosting uniquely adapted species due to topographic heterogeneity and climatic variability. To forecast the potential future distribution of its forests (assuming zero anthropogenic interference), a dynamic regional to global vegetation model, *LPJ-GUESS* was used, forced with *ERA5-Land* reanalysis data at 9 km horizontal resolution for the historical simulation (1982 – 2014) and different model contributions to *CMIP6* for the future phase (2015-2100) reflecting RCP8.5 scenario. Our preliminary findings show little change to the forest cover for the peninsula for the simulation period, but a significant shift in forest composition in favor of the Mediterranean type pine taxa, indicating a potential future expansion of the Mediterranean type climate within the peninsula, with an increase in risk of forest fires.

P8: Accidental associations between species distributions and climate: how much are we (un)certain?

Barták, V. Department of Spatial Sciences Czech University of Life Sciences Prague.

For reliable predictions of the future species distribution dynamics, species distribution models are often used to estimate the species-climate functional relationships from observed data. It has been demonstrated that such observed relationships may not

necessarily reflect real causal associations, but may simply arise as an accidental consequence of strong spatial autocorrelation in both species and environmental data. Naturally, projecting such accidental relationships outside the original space-time domain may lead to completely misleading predictions, whose level of uncertainty will be unknown. This contribution aims at quantifying the uncertainty in model predictions related to this issue by simulating both species and environmental data with known levels of autocorrelation, as well as suggesting some guidelines on how to deal with the problem in practical modeling.

P9: Arctic terns and the changing Atlantic Ocean wind regime

Skyllas, N. University of Groningen., Loonen, M. University of Groningen., Bintanja, R. Royal Netherlands Meteorological Institute (KNMI).

We study wind conditions along the flyways of two Arctic tern populations over the Atlantic Ocean, and assess potential effects of climate change by integrating bird tracking and wind data. The exploitation of favourable winds differs between populations and seasons, with birds either drifting with the general wind patterns (Svalbard population, wind support =s2.47 ± 3.38 m/s), or (partly) compensating for the effect of crosswinds (Netherlands population, wind support = 0.65± 4.10 m/s). By the end of the current century, changes in wind conditions along the flight-paths are projected to influence the shape of the flyways as per our least-cost-path analysis. Finally, we examine the robustness of our projections by using multiple CMIP6 climate models to evaluate intermodel and interannual uncertainties. This study highlights the contribution of wind patterns in shaping bird migratory flyways and shows the significance of migration timing, in particular for the highly-variable mid-latitude climate.

P10: Climate change poses a risk to anti-malarial plants in Samburu, Kenya

Gafna, D. Karlsruhe Institute of Technology Germany., Obando, J. Kenyatta University Nairobi Kenya., Kalwij, J. Karlsruhe Institute of Technology Germany., Dolos, K. Karlsruhe Institute of Technology Germany., Schmidtlein, S. Karlsruhe Institute of Technology Germany.

Anti-malarial plants are commonly used as the only source of treatment against malaria in many parts of East Africa. However, population of these plant species are on a rapid decline. To efficiently conserve the anti-malarial plant species, we need to understand the current and future intersection of their distributions and that of malaria itself. Here, we simulated the current overlap in the distributions of anti-malarial plants and malaria vectors in Samburu, Kenya. We further assessed the impact of climate change on anti-malarial plants and malaria vectors and reported the future overlaps in their distributions. Results show that some regions are characterized by huge losses while others gained slightly. Future patterns of anti-malarial plants and malaria affected areas show that the later will increase while the former will lose a considerable amount of suitable habitat. Therefore, we argue that geographically targeted conservation strategies should be undertaken in the fight against malaria.

P11: Climate-driven range shifts in cool-adapted moths

Hordley, L. Butterfly Conservation., Fox, R. Butterfly Conservation., Suggitt, A. Northumbria University., Bourn, N. Butterfly Conservation.

Distributions of species adapted to cooler climates are expected to shift northwards and to higher elevation in response to climate change. However, species' may shift their

distribution in multiple directions to maintain their climatic niche, but evidence of multidirectional shifts is lacking for many species. Here, we analysed species' distribution shifts for 75 cool-adapted moths in Great Britain using citizen science occurrence records from the National Moth Recording Scheme over a 40-year period. We find that warm margins have retreated northwards (although not to higher elevation) but shifts in species' range centroids are oriented towards the north-west on average and are more closely correlated with the directional changes in total precipitation than average temperature. Species' local extinction risk is highest in the warmest parts of species' ranges but diminishes as precipitation increases. Our results indicate that cool-adapted moths are responding to climate change, and partly driven by responses to precipitation.

P12: Energy-mediated responses to climate-change induced modifications to prey size and distribution in marine top predator movements and population dynamics

Gallagher, C. University of Potsdam., Chimienti, M. Centre d'Etudes Biologiques de Chizé., Grimm, V. Helmholtz Centre for Environmental Research – UFZ., Nabe-Nielsen, J. Aarhus University.

Alterations in marine conditions with climate change may decrease fish size and alter their spatial distributions, ultimately impacting predator species which rely on these communities. To investigate the impacts of these climate-driven changes in prey structure on predator population dynamics, we applied an agent-based model parameterized for harbor porpoises (*Phocoena phocoena*) which represents animal energetics and movements in high detail. Decreased prey size and aggregation led to altered movements, with more time spent in transit behavior, and reduced reproductive success and survival. Impacts caused population decline and, in some cases, total population collapse - indicating climate-induced changes in prey structure may threaten predator populations. We demonstrate how simulation models with realistic movements and process-based energetics can be used to investigate the population consequences of shifting food availability and provide a mechanistic explanation for how changes in prey structure can impact energetics, behavior, and ultimately viability of predator populations.

P13: Exploring the effects of CO_2 elevation on seedlings' growth of Acacia senegal in the era of changes; experimental study

Attaelmanan, A. University of Khartoum., Siddig, A. University of Khartoum.

This study is conducted in light of increasing elevated carbon dioxide (eCO_2). Many studies showed that eCO_2 causes increased photosynthesis in plants and growth. Acacia senegal tree is an important species in drylands of Sudan. We investigated its response to eCO_2. Seven days old seedlings were assigned to eCO_2 (600-800 ppm) or ambient (≥400 ppm) under different irrigations and soil types. Seedling height and number of leaves were measured weekly and then biomass and soil properties were measured. The eCO_2 showed significant increase in tap-root length. However, the irrigation showed significant increase in seedling's height, number of leaves, root length and seedling's dry weight. Soil treatment showed effects on stem height, leaf number, seedling's dry weight, leaves and root N% and soil C%. This indicates the importance of soil moisture, physical and chemical properties that reflects adaptation of the species to its dry land.

P14: Fern and Lycophyte niche displacement under predicted climate change in Honduras

Reyes Chavez, J. Edge Hill University., Pie, M. Edge Hill University., Batke, S. Edge Hill University., Dallimore, T. Edge Hill University.

Ferns are excellent model organisms to investigate the effect of climate change on species niches, due to their high sensitivity to changes in temperature and precipitation. We analysed a newly developed database of herbarium fern records (n=11,791), and used ordination models to compare the climatic niche of all Honduran fern taxa under present and future climates. We found that species were distributed throughout most of the available climatic space. Under RCP2.6 and RCP8.5 projections 128 to 391 taxa (of 713) will have their average niche positions outside of the predicted available climatic space by the years 2049-2099. Particularly affected will be species that grow in low temperature and high precipitation areas. In general. Considering that ferns are sensitive to changes in climate, if tested in the future, they could be used as a proxy for other Honduran plant taxa.

P15: Forecasting apex predator distribution at the regional level: seabirds in the Drake Passage, Southern Ocean

Cargill, C. University of St Andrews., Heinrich, S. University of St Andrews., Boehme, L. University of St Andrews.

Anthropogenic climate change underlies observed and predicted fluctuations in the occurrence and magnitude of marine primary production at high latitudes. The ability to explore corresponding scenarios of spatio-temporal variation in the distribution of apex predators - at the regional scale - is an important prerequisite for informing best practice in species conservation and management of polar marine areas. We demonstrate that platform of opportunity (i.e., cruise ship) surveys comprise a useful data source with which to calibrate species distribution models and forecast patterns of summer at-sea distribution for six marine birds with differing ecological and behavioural characteristics. Focusing on the Drake Passage in the Southern Ocean, select environmental covariates were used within a two-step hurdle model approach to generate distribution maps for the present day and the end of the century, the latter assuming IPCC Representative Concentration Pathway 8.5. Expected trends included range contractions and poleward shifts in environmental suitability.

P16: Global warming generates predictable extinction patterns of marine benthic invertebrates following a simple model of occupancy loss

Reddin, C. Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science., Aberhan, M. Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science., Raja, N. Geozentrum Nordbayern Germany., Kocsis, A. Geozentrum Nordbayern Germany.

Anthropogenic global warming is expected to raise extinction risk and both warm- and cold-water organisms may be threatened. Extinction trends are observable in the fossil record but need correcting for sampling biases and regional climate variation. Here, we relate extinction risk of ancient marine animals directly to seawater temperature estimates sourced from paleoclimate models. We compare these patterns to simulated extinctions generated by simple geometric loss of thermal habitat. During times of rapid global warming, extinction trends deviate significantly from their usual form, imperilling marine invertebrates with preferences for habitats warmer than ~21°C and increasingly for habitats cooler than ~11°C. This bimodal latitudinal distribution of extinctions is congruent with simulated results, suggesting the spherical geometry of the globe alongside the temperature-latitude relationship causes an uneven loss of thermal habitat. Modern range shifts already indicate this mechanism. Following IPCC projections, cold-water habitats and their endemic species face annihilation within centuries.

P17: KrigR — A tool for downloading and statistically downscaling climate reanalysis data

Kusch, E. Aarhus University., Davy, R. Nansen Environmental Research Centre.

Novel climate reanalysis products like ERA5(-Land) provide more accurate environmental information at higher temporal resolution than traditional climate data products used in ecological applications. Furthermore, they provide uncertainty metrics useful for assessing data quality.
The KrigR R-package reduces barriers for users to (a) download ERA5(-Land) data (b) aggregate these data to desired temporal resolutions and metrics, (c) acquire topographical co-variates, and (d) statistically downscale spatial data using co-variates via kriging which allows for integration of data uncertainty with interpolation uncertainty for improved data reliability indicators.
The KrigR workflow allows highly flexible data product creation for unparalleled aligning of data set specifications with research objectives. Climate products obtained through KrigR offer great potential for quantification of exposure to extreme events due to their combinations of high spatial and temporal resolutions. Lastly, KrigR can incorporate third-party data which enables generation of high-resolution, bias-corrected climate projection data allowing for ecological forecasting at high-resolution.

P18: Large herbivore and plant functional composition as drivers of drought resilience in savannas

Irob, K. Freie Universiät Berlin., Blaum, N. University of Potsdam., Uiseb, K. Ministry of Environment and Tourism Namibia., Hauptfleisch, M. Namibia University of Science and Technology., Tietjen, B. Freie Universität Berlin.

The state of a savannah largely depends on how resilient it is to stress. Unfavourable climatic conditions, such as prolonged droughts, combined with overgrazing, can favour a shift towards a particular condition.
In this study, we used the ecohydrological, spatially explicit savannah model EcoHyD to assess the effects of droughts on vegetation dynamics and the ability of the system to recover from these droughts (resilience) in a Namibian rangeland under different land use types (grazer, mixed-feeders, browsers). We also investigated whether plant diversity has a stabilising effect on vegetation during drought periods.
In general, resilience increased with a higher browser fraction and greater plant functional diversity. The longer the drought lasted, the more likely was the system to enter a shrub-encroached state.
We concluded that a higher browser proportion and greater plant diversity served as a buffer against adverse climatic conditions and contributed to the maintenance of important ecological functions.

P19: Long-term contrasting effects of temperature and biodiversity on the stability of natural aquatic food webs

Zhao, Q. Namur University., De laender, F. Namur University.

Climate change and biodiversity changes occur in concert, but their long-term joint effects on the stability of natural food webs are unknown. Here, we study this question using 11 aquatic food webs from three continents, in which population dynamics and temperature have been monitored for 10 to 30 years. We analysed the time-varying species interactions and stability in these food webs, and found that warmer temperature decreased local stability, while greater biodiversity increased it. The effect of temperature was about 40%

greater than that of biodiversity. Changes in the standard deviation and mean of species interactions, self-regulation, and the correlation of species interactions explain these results, supporting theoretical findings. Our results suggest that, in nature, warmer temperature and biodiversity can have contrasting effects on stability, and that these effects can be explained by theory on species interactions.

P20: Modelling continental-scale responses of European bats to climate and land-use change

Fialas, P. University of Exeter., Amorim, F. CIBIO-InBIO., Santini, L. Sapienza University., Novella-Fernandez, R. Technische Universität München., Marquez, F. Porto University., Rebelo, H. CIBIO-InBIO Porto University., Russo, D. University of Naples Federico II., Razgour, O. University of Exeter.

Climate change is a key and growing threat to biodiversity, influencing the geographic distribution of many species. However, less is known about the impact of climate change on functional diversity. Through our international collaborative network, we gathered location records and functional trait data for 37 European bat species. We used ensemble species distribution modelling, combining climatic and land cover data, to study changes in range suitability and patterns of functional diversity in European bats under climate change. Our models predict range shifts, with most species losing ranges from the southerner areas and gaining upwards in northern latitudes; however, predictions are species-dependant. .Patterns of species diversity and community composition are predicted to change in response to climate and land-use change. Our results will be used to inform the development of a cross-European monitoring network to better understand bat responses to climate change at the continental scale.

P21: Predicting seasonal-priority conservation hotspots for avian biodiversity using species distribution modeling in the Drylands of Nigeria

Magaji, A. Yusuf Maitama Sule University Kano Nigeria., Badamasi, M. Bayero University Kano Nigeria., Usman, H. Bayero University Kano Nigeria., Rabiu, S. Bayero University Kano Nigeria.

Seasonal variability of weather for the dryland Nigeria is increasing and estimating the distribution of avian species response to these changes is critical for informing ecological planning. These variabilities could alter distributions of species across the drylands through changes in weather, or through climate-induced changes on forest cover. Our objective was to determine the relative impacts of environmental variables on the abundance of the avian species' habitat in the drylands of Kano, Nigeria. We examine the potential spatial distribution of avian species seasonal changes by assessing WorldClim data, DEM and NDVI relationship over space. We constructed an ensemble of three models to predict avian population habitat with R using the biomod2 package. Our models for avian abundance show a southward increasing trend with latitude and wetness. Wetter habitat attracts more birds than drier locations. The change maps between wet and dry season predicted models indicate hotspots for conservation.

P22: Seawater influx elicits a compositional and functional change in plant associated microbial communities.

Browett, L. Manchester Metropolitan University., Ruiz-Lopez, S. Manchester Metropolitan University., Mossman, H. Manchester Metropolitan University., Dean, A. Manchester Metropolitan University., Rivett, D. Manchester Metropolitan University.

Extreme weather resulting in the encroachment of seawater onto coastal soils is predicted to increase with climate change. Understanding the response of microbial communities to inundation will allow us to predict the implications of these surges. We experimentally simulated flooding events, and subsequent recovery, of soil mesocosms taken from a naturally occurring saltmarsh-pasture gradient. Environmental parameters (pH, ICP-OES, conductivity), Microbial community composition (16S rRNA) and ecosystem functions (degrative enzymes) were measured. Significant changes were observed in all environmental parameters; however, these did not align with changes in enzyme activity. The results also indicated that there was a convergence in the enzymic profiles between the saltmarsh and pasture sites with increased flooding duration. When the microbial composition was included in the analysis, there were no universal change, rather site-specific changes were observed. This study suggests a disconnect between changes in environmental parameters and the functioning of microbial communities under stressful conditions.

P23: Carbon stock and sequestration changes under traditional grazing management practices in semiarid pastoral ecosystem of Eastern Ethiopia

Gebremedhn, H. Haramaya University., Zewdu Kelkay, T. Bahrdar University., Tesfay, Y. Mekelle University., Tuffa, S. Oromia Agricultural Research Institute Addis Ababa Ethiopia., Dejene, S. Haramaya University Ethiopia., Anthony, E. 5 Regional Universities Forum for Capacity Building in Agriculture (RUFORUM).

In this study, we have measured carbon stocks and sequestrations in a case study of a semi-arid pastoral ecosystem under traditional grazing management practices. Data were collected from three traditional rangeland management practices of communal open grazing areas, private enclosure areas that are used for forage reservation in the dry season, and communally bush-dominated rangelands (Bay in the local name) that used for browser animals. The woody, herbs, and Soil organic carbon (SOC) pools were showed a significant difference (($P < 0.05$) among the management categories. We found 349, 349, 177 tons of CO_2 ha^{-1} sequestration potentials for the open browsing, enclosure, and open communal grazing areas respectively. This revealed that rangelands have the potential to form a chief component in the mitigation of global warming and ecosystem services. Moreover, modest change of grazing rangelands by pastoral land use contributes positively to the global carbon cycle for climate change mitigations.

P24: Contemporary and end of century plankton biogeography at genomic scale: bridging ecology and biogeochemistry

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The impact of climate change on the ecology of marine plankton and its feedback on climate remain an unresolved issue. We present environmental niches defined at the genomic scale for plankton communities collected during the Tara Oceans expedition. The spatial extrapolation of these niches portrays ocean partitionings south of 60°N into *climato-genomic* provinces. These provinces are characterized by the presence of signature genomes. We describe how these provinces will be reorganized by 2090 under the RCP8.5 scenario. This reorganization encompasses compositional shifts among phototrophs, copepods and diazotrophs that suggest impacts on the nitrogen and carbon cycles in agreement with current model predictions. Finally, we link provinces to estimates of carbon export fluxes and project their decrease on average by 4% in response to biogeographical

restructuring. This study paves the way towards the integration of biogeochemistry and genomic ecology to improve projections of climate change impacts on marine ecosystems.

P25: Process-guidance improves predictive performance of neural networks for carbon turnover in forest ecosystems

Moser, N. University of Jyväskylä., Wesselkamp, M. University of Freiburg., Dormann, C. University of Freiburg.

Forests form the largest terrestrial carbon pool with processes sequestrating immense amounts of carbon between the atmo-, bio- and pedosphere. Therefore, a fundamental understanding of forest ecosystems is crucial for climate change projections. However, revealing unknown processes is challenging as most of the ecosystem processes cannot be recorded in high resolution and on large spatial scales. As a result, fundamental forest ecosystem processes remain poorly understood and represented in modelling frameworks. We integrate mechanistic process knowledge with deep neural networks. These process-guided neural networks outperform the mechanistic model and a data-driven neural network in predicting site-specific and general forest carbon turnover. Further, the models show the potential to uncover unknown processes and complement forest ecosystem knowledge. Our results indicate that the combined methods are highly useful under sparse data conditions. As data is sparse in most ecological study systems we see high potential of applying our models beyond forest ecosystems.

P26: The potential for plant translocations as bioassays of climate change

Dalrymple, S. Liverpool John Moores University., Branwood, H. Liverpool John Moores University., Thomas, N. Liverpool John Moores University., Bellis, J. Liverpool John Moores University.

Anthropogenic climate warming is undisputed and yet, there is much that is unknown regarding biological impacts of changing temperature and precipitation. The use of existing plant translocations to offset past declines and future population losses in conservation and forestry have the potential to become bioassays of spatially-variable impacts of climate change. Collectively, these existing plant translocations could be harnessed to develop a global monitoring array reporting biologically-meaningful responses to climate change across populations, species and biomes. From a dataset of many hundreds of examples of plant translocations, we identify the opportunities for harnessing existing translocations to inform our understanding of climate change impacts on biological diversity. We conclude with recommendations for constructing a robust system of data collection and collation that has relevance for practice and policy.

P27: Integrating meteorological and epidemiological models for crop disease early warnings: complementing expert surveys with online media scraping

Smith, J. University of Cambridge., Faisal, A. CIMMYT., Krupnik, T. CIMMYT., Thurston, W. Met Office., Hodson, D. CIMMYT., Millington, S. Met Office., Mona, T. University of Cambridge., Salam, M. CIMMYT., Faisal, M. CIMMYT., Gilligan, C. University of Cambridge.

It is vital to improve food system resilience as food security is increasingly pressured by climate change, growing populations and globalisation. In Bangladesh and Nepal, wheat is amongst the top three staple crops but yield is frequently reduced by outbreaks of fungal rust diseases. A wheat rust early warning system has been established, comprising near real-time surveillance, disease risk forecasts and advisory dissemination. However, rust infections can be transmitted hundreds of kilometres by meteorologically-driven aerial

dispersal. Without surveillance from wheat growing areas in neighbouring countries, these crucial dynamics are missed. In response, we test algorithms to automatically generate 'virtual observations' from online media reports as a proxy for infections across the broader South Asian landscape. Our results indicate clear advantages in wheat disease forecasts for Nepal and Bangladesh. The results also highlight the importance of long-distance dispersal and the benefits of using innovative techniques to identify proxy wheat rust infections.

P28: Promoting adaptation to changing coasts– cross border climate change adaptation project

Burgess-Gamble, L. Environment Agency.

PACCo has two arms – the Lower Otter Restoration Project at Budleigh Salterton, Devon, and the Basse Saâne: 2050 project at Quiberville, Normandy.

The €26m twin projects are both managed realignments – returning the floodplains to how they were 200-plus years ago, before land at both sites was reclaimed for agricultural use – designed to adapt to the changing climate.

The work will result in 100ha of mudflats and saltmarshes being created across the two sites. These will improve biodiversity, offering new habitats for a variety of wading birds, and act as carbon sinks.

As part of the PACCo project, a "how to" guide will be developed setting out all of the aspects of the two schemes, in order for other bodies in coastal regions to assess whether a similar managed realignment scheme might be suitable for their areas.

P29: Tackling trade-offs between climate and nature

Mitchell, C. NatureScot.

Burning fossil fuels and intensified land use change short-circuits the carbon cycle and has created the climate-nature crisis. Life on Earth is carbon-based. On land, life in soils regulates the global carbon cycle and other key biogeochemical cycles. The stronger our disruption to these and ocean cycles, the greater the problems for nature and people. Healthy soils are essential to a healthy climate-nature system.

Furthermore, floods, fires, drought, pests, disease and pandemics will impact nature more severely the more degraded it is. More diverse nature builds resilience to these events and makes them less likely by correcting disruptions to biogeochemical cycles.
All uses of the land and sea must *simultaneously* reduce emissions for a 1.5°C goal, adapt to a 2.7°C 'post-COP-26' world, and enhance the state of nature. I discuss this framework to evaluate supposedly competing actions for climate and nature.

P30: EcoservR for predicting change in ecosystem service provision

Dowdall, L. Liverpool John Moores University., Angers-Blondin, S. Liverpool John Moores University., Bentley, L. Liverpool John Moores University.

With Biodiversity Net Gain now mandated in the UK and Environmental Net Gain soon to follow, predicting how changes in habitats affect ecosystem services is becoming more important. EcoservR is a tool that uses spatially explicit and nationally available data to build a habitat map from which ecosystem service supply and demand can be predicted.

This habitat map can be edited to reflect different scenarios such as habitat loss, nature-based solutions or other landscape changes to predict impacts on ecosystem services such as air quality, flood mitigation, carbon storage and sequestration, etc. EcoservR can help identify pinch points and opportunities at site to landscape scale and can work alongside other tools to understand future impacts of climate-induced changes or inform strategic nature-based solutions.

P31: Modelling species responses to changing climate and habitat alteration, using spatio-temporal models in INLA

Wiethase, J. University of York., Mostert, P. Norwegian University of Science and Technology., Beale, C. University of York.

Climate change and alteration of intact habitat are some of the biggest pressures that species are facing today. Knowing how individual species are responding to these pressures is a crucial prerequisite for conservation efforts: highlighting vulnerable species, but also potential indicators of intact habitat. Previous work has identified range shifts as a key response to changing environmental conditions across taxa, but noted unexplained species-level variation in the responses.

Here, we present a cutting edge modelling technique to address these questions. We use data integration, to combine species observations from different data sources, and apply INLA and SPDE algorithms in a spatio-temporal model, to estimate and compare species ranges at different time periods. We show how this model can be applied, using 40 years of bird observations from Atlas and citizen science data for Tanzanian savannahs, a biome of ecological and economic importance experiencing high levels of recent change.

P32: Megaherbivores promote riparian habitat heterogeneity in ephemeral rivers

Farren, W. ZSL Institute of Zoology., Cowlishaw, G. University of Reading., Black, E. University of Reading., Pettorelli, N. ZSL Institute of Zoology.

The ephemeral rivers of Namibia are of vital importance to the survival of wildlife that utilise them and for people dependent on the ecosystem services they yield. Historically megafauna, terrestrial vertebrates weighing over 1000kg, have been present within all of Namibia's ephemeral river catchments, but are now thought to be locally extinct in many. Here we examine how megaherbivore presence influences habitat heterogeneity in ephemeral rivers. This was done by comparing Normalized Difference Vegetation Index (NDVI) Coefficient of Variation from Sentinel-2 images taken from Namibian ephemeral rivers within known megafauna ranges, as well as comparison of tree height Coefficient of Variation derived from Global Ecosystem Dynamics Investigation (GEDI) lidar data. We also consider the influence of local climate, anthropogenic pressure and input from proximate tributaries. Using an information-theoretic modelling approach we observed an increase in habitat heterogeneity driven by elephant presence and tributary input.