BIOdiversity and Economics for CONservation – BIOECON

www.bioecon-network.org

XXIII ANNUAL BIOECON CONFERENCE ON:

"Biodiversity, Finance and Economy"

4th - 6th September 2022
University of Exeter
United Kingdom

Endorsed by EAERE and CMCC

Hosted by the LEEP Institute, Department of Economics, University of Exeter Business School

With support from:
Dragon Capital, Cambridge University Land Economy, German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, the University of Exeter Business School, Land Environment, Econonomics and Policy Institute and the Dragon Capital Chair in Biodiversity Economics.
Founding Partners of the BIOECON Network:
United Nations Environment Programme(UN Environment), The Graduate Institute of International and Development Studies (IHEID)

Keynote Speakers

Dr Eyal Frank
University of Chicago

Dr Rachael Garrett
ETH Zurich & The University of Cambridge

UNIVERSITY OF EXETER | BUSINESS SCHOOL

LAND, ENVIRONMENT, ECONOMICS AND POLICY INSTITUTE

iDiv

UNIVERSITY OF CAMBRIDGE

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THE GRADUATE INSTITUTE GENEVA

CENTRE FOR INTERNATIONAL ENVIRONMENTAL STUDIES

EAERE
European Association of Environmental and Resource Economists

cmcc
Centro Euro-Mediterraneo sui Cambiamenti Climatici

Contents

AGENDA

Saturday 3rd September

1730-2200	Beaver Excursion	Bus from Holland Hall

Sunday 4th September

1000-1600	Dartmoor excursion	Bus from Holland Hall
1900 onwards	Drinks Reception	Old Firehouse

Monday 5th September

0900-0915	Welcome Address	Henderson (zoom)
0915-1030	Plenary: Eyal Frank	Henderson (zoom)
1030-1100	Coffee	XFi Atrium
1100-1300	Parallel Session 1	Various (pg 9)
1300-1400	Lunch	XFi Atrium
1400-1600	Parallel Session 2	Various (pg 10)
1600-1630	Coffee	XFi Atrium
1630-1800	Panel Session 1: Measuring Biodiversity for Policy Purposes	Henderson (zoom)
1800-2000	BIOECON Committee Meeting (invite only)	LEEP Offices
2000-onwards	Dinner	Holland Hall

Tuesday 6th September

0900-1030	Panel Session 2: Natural Capital and Ecosystem Services Finance Solutions	Henderson (zoom)
1030-1100	Coffee	XFi Atrium
1100-1300	Parallel session 3	Various (pg 11)
1300-1400	Lunch	XFi Atrium
1400-1515	Plenary: Rachael Garrett	Henderson (zoom)
1515-1545	Coffee	XFi Atrium
1545-1715	Parallel session 4	Various (pg 12)
1715-1730	Closing Remarks	Henderson (zoom)

Welcome to BIOECON XXIII

Dear Friends,

On behalf of the whole BIOECON Committee and organising team it is our pleasure to welcome you to the 23rd edition of BIOECON. We're delighted to welcome such a large and enthusiastic audience to The LEEP Institute here in Exeter.

We'd first like to thank all of you for being involved and travelling from far and wide to be here. Second, we're extremely grateful to our numerous sponsors and the University of Exeter Business School for facilitating this conference.

We hope that you have a thoroughly enjoyable time and come back to visit us in the future.

On behalf of the whole team, have a great time everyone!

Best wishes,

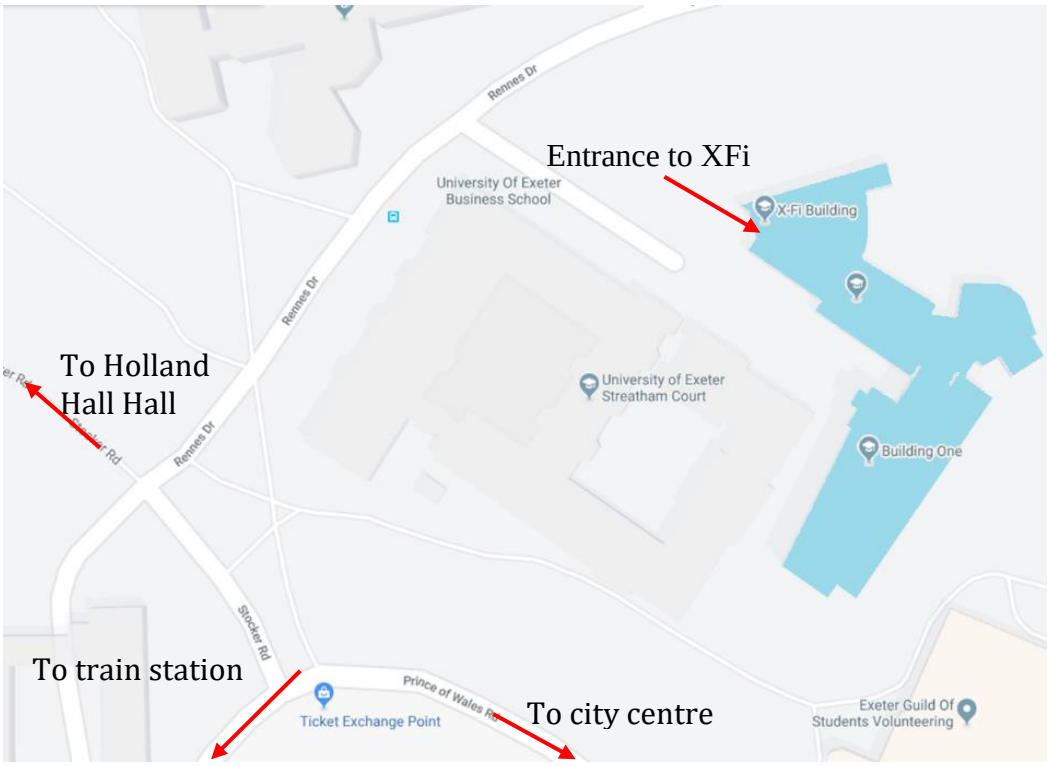
The Local Organising Committee,

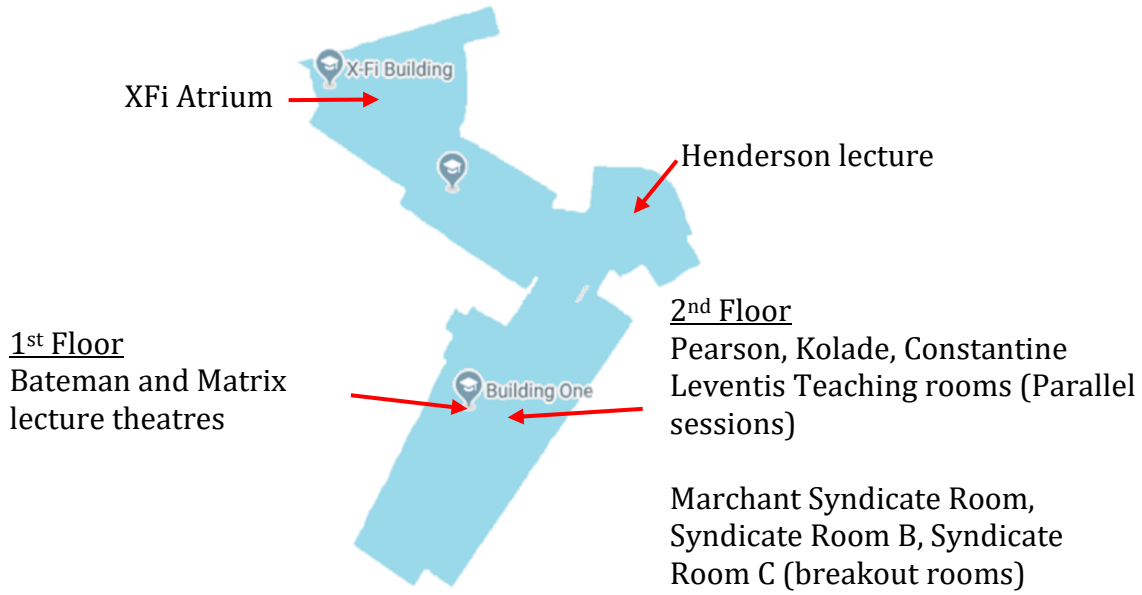
Ben Groom

Wei Xin

Ben Balmford

Map


Entrance to XFi
University Of Exeter Business School
X-Fi Building
Rennes Dr
To Holland Hall Hall
University of Exeter Streatham Court
Building One
Stocker Rd
To train station
Ticket Exchange Point
Prince of Wales Rd
To city centre
Exeter Guild Of Students Volunteering


XFi Atrium
X-Fi Building
Henderson lecture
1st Floor
Bateman and Matrix lecture theatres
Building One
2nd Floor
Pearson, Kolade, Constantine Leventis Teaching rooms (Parallel sessions)
Marchant Syndicate Room, Syndicate Room B, Syndicate Room C (breakout rooms)

Plenary talks

Henderson Lecture Theatre

Plenary 1: Eyal Frank – "The Role of Quasi-Experimental Evidence in Justifying and Prioritizing Biodiversity Financing", *Monday 5th 0915-1030*
Zoom link:
https://Universityofexeter.zoom.us/j/94853105386?pwd=TE0wdDl4U0hJZDgyLzIyaHJHREhjUT09

Eyal Frank, *The University of Chicago*
Eyal is an Assistant Professor at the University of Chicago Harris School of Public Policy. As an environmental economist, he works at the intersection of ecology and economics. His areas of research present a causal inference challenge as manipulating ecosystems and species at large scales is often infeasible. In his work, Frank draws natural experiments from ecology and policy, and uses econometric techniques to estimate different pieces of the puzzle regarding the social cost of biodiversity losses.

Abstract
The efforts for closing the financing gap for biodiversity can benefit from recent evidence on the role that biodiversity has on human well-being. In this talk, I will review how quasi-experimental variation in ecosystems has been used in the applied economics literature, and what are some of the key opportunities to advance our understanding of biodiversity economics.

Plenary 2: Rachael Garrett – "Are efforts to conserve forests and biodiversity through supply chain policies working? And for whom?", *Tuesday 6th 1400-1515*
Zoom link:
https://Universityofexeter.zoom.us/j/94853105386?pwd=TE0wdDl4U0hJZDgyLzIyaHJHREhjUT09

Rachael Garrett, *ETH Zurich & The University of Cambridge*
Rachael is an Assistant Professor of Environmental Policy at ETH Zurich in the Department of Humanities, Social, and Political Sciences and the Dept. of Environmental Systems Science, and is the University of Cambridge's Moran Professor of Conservation and Development from 1st October. She has interdisciplinary training in economics, geography, history, systems thinking, environmental science, and policy analysis and use a wide range of research methods and designs, including statistical models and case studies.

Abstract
In this talk I will give an overview of recent efforts to halt tropical deforestation through supply chain policies including their adoption, coverage, additionally, and effectiveness, drawing on the broad literature as well as my own group's ongoing research across Brazil, Indonesia, Ghana, and Ivory Coast. I will then dive deeper into some of the challenges that these forest-focused supply chain policies have encountered, including equity impacts on more marginalised farmers, spillovers to non-targeted actors and regions, and legitimacy within producer nations. I propose alternative policy approaches that can complement and eventually replace supply chain-centric efforts for agriculture-forest frontier governance. I will conclude by pointing to major research needs related to forest conservation policy in the tropics.

Panel Sessions

Henderson Lecture Theatre

Panel Session 1: Measuring Biodiversity for Policy Purposes

Organized by: Alex Bush (Lancaster), Katherine Simpson and Nick Hanley (Glasgow)

Zoom link:

https://Universityofexeter.zoom.us/j/94853105386?pwd=TE0wdDl4U0hJZDgyLzIyaHJHREhjUT09

Overview:

Initiatives such as Biodiversity Net Gain (BNG) are leading to an expansion of regulated markets in biodiversity credits; whilst in the UK, the development of new agri-environment schemes will incentivize landowners to increase conservation actions for a monetary reward. In both cases, the policy designer needs to decide on how best to measure changes in biodiversity. How biodiversity change is measured – the choice of metric – will impact on how markets in biodiversity perform, and on the emergence of sufficient conservation actions to achieve national targets for recovery.

Brett Day *The University of Exeter*

Brett is an environmental economist working in the field of ecosystem services, the particular focus of his research being the development of methods and knowledge for the support of environmental decision-making.

Alex Bush *The University of Lancaster*

Alex is lecturer of environmental remote sensing at Lancaster University, specialising in ecological modelling for monitoring, managing and conserving biodiversity at macroecologcial scales.

Bob Smith *The University of Kent*

Bob's work as a conservation scientist has mainly focused on identifying priority areas for conservation and designing protected area networks.

Sophus zu Ermgassen *The University of Kent*

Sophus is an ecological economist based at the University of Kent and the University of Copenhagen working on exploring the financial mechanisms that can deliver nature restoration across Europe.

Nicholas Henley *The University of Glasgow*

Nicholas is an environmental economist who mainly works on the application of economic methods (including behavioural economics) to biodiversity conservation, invasive species, and measures of sustainability.

Katherine Simpson *The University of Glasgow*

Katherine is an environmental economist with an interest in the application of economic techniques to conservation and environmental management.

Panel Session 2: Natural Capital and Ecosystem Services Finance Solutions: Investing in Nature to support the SDG agenda.

Organized by: Andrew Seidl (Colorado State) & Paulo A.L.D. Nunes (FAO)

Zoom link:
https://Universityofexeter.zoom.us/j/94853105386?pwd=TE0wdDl4U0hJZDgyLzIyaHJHREhjUT09

Overview:

Natural capital and ecosystem services is the direct focus of two Sustainable Development Goals: Life Below Water (SDG 14) and Life on Land (SDG 15) and contributes to many other goals. To be sure, part of our challenge is in measurement. But mobilizing new resources, redirecting subsidies harmful to biodiversity, and improving program and policy delivery toward biodiversity positive outcomes requires us to measure better across all sectors and sources of investment to manage better.

In this context, this Policy Session provides a forum to highlight recent advances and opportunities in meeting the global biodiversity and ecosystem services finance challenge for a prosperous future. The panelists include international and national public and private sector initiatives, academic researchers and implementing organizations are developing, testing and adapting finance tools to bridge the local, national and global investment gap.

Moderator

Andrew Seidl *Colorado State University/UNDP-BIOFIN*

Andy's work focuses on natural resource-based economic development. He employs economic approaches to help decision makers identify, quantify and capture the wealth of nature.

Panelists

Emily McKenzie *Taskforce on Nature-related Financial Disclosures*

Emily McKenzie is the Technical Director at the Taskforce on Nature-related Financial Disclosures (TNFD). She has worked for 20 years integrating nature in policy, finance, economics and decision-making.

Katia Karousakis *OECD*

Katia Karousakis works in the Environment Directorate at the Organisation for Economic Co-operation and Development (OECD), where she leads the Biodiversity, Land Use and Ecosystems (BLUE) programme.

Onno van den Heuvel *UNDP-BIOFIN*

Onno is the Global Manager for BIOFIN – based at UNDP's Istanbul Regional Hub. He leads the BIOFIN team, responsible for all global and national activities, programme development, resource mobilisation and partnerships.

Fiona Elizabeth Stewart *World Bank*

Fiona Stewart works for the World Bank's Global Capital Markets, Non-bank Financial Institutions group, which provides policy advice on pension reform to governments around the world.

Closing Remarks

Paulo ALD Nunes *UN-FAO*

Paulo A.L.D. Nunes is an economist who devotes his passion, energy and talent to the new and unmet needs of society in moving towards the eradication of poverty, end of hunger and all forms of malnutrition.

Parallel session overviews

Parallel Session 1

Monday 5th September 1100-1300

Session 1a: Biodiversity and Finance – Bateman Lecture Theatre **Zoom:** https://Universityofexeter.zoom.us/j/92048723413?pwd=Q1FtbmpzNHRYNlduYXVJYjlQV0lZUT09	
Speaker	**Title**
Matthew Agarwala (Chair)	Nature Loss and Sovereign Credit Ratings
*Lewis Grant**	The mechanics of biodiversity in ESG ratings
Wei Xin	Biodiversity confusion
Session 1b: Climate Change – Impacts – Matrix Lecture Theatre **Zoom:** https://Universityofexeter.zoom.us/j/92092464743?pwd=akZmREZySStnSXpWV2Fub0c0dVZzZz09	
Speaker	**Title**
Bernardo Bastien-Olvera	Climate change impacts on terrestrial ecosystems and its consequences for human well-being and macro-economic growth.
Irmelin S Helgesen	Welfare implications of climate change for reindeer herding Saami in northern Sweden and Norway - a bioeconomic model
Leanne Cass	Weather shocks and international trade
David Maddison (Chair)	Another Look at the Impact of Climate Change on Mexican Agriculture
Session 1c: Deforestation – Pearson Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/92846214883?pwd=eCtZUnVhOERCNGZUQnFPc0dVcWlTdz09	
Speaker	**Title**
*Julia Naime**	Will peer punishment protect tropical forests? Multi-country experimental evidence
Michael Tanner	Deforestation, Institutions, and Property Rights: Evidence from land titling to indigenous peoples and local communities in Ecuador
Gabriela Demarchi	Using publicly available remote sensing products to evaluate REDD+ projects in Brazil
Sabrina Eisenbarth (Chair)	How do Global Conservation Interventions Interact With Local Social Structures?
Session 1d: Wildlife Management – Kolade Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/96377119363?pwd=a04rVEt2M3RPYmZtc2FjbzF4TlV3UT09	
Speaker	**Title**
Robbert-Jan Schaap	Regulating demand: Tourism and the conservation of marine resources
Takahiro Kubo	Spillover Impacts of Wildlife Trade Bans on Demand for Non-banned Threatened Species: Evidence from Synthetic Difference-in-Differences
*Adrian Lopes**	An Organized Crime Model of Illicit Trade in Pangolin Scales and Elephant Ivory
Timo Goeschl (Chair)	Subsidizing Compliance: A Multi-Unit Price List Mechanism for Legal Fishing Nets at Lake Victoria
Session 1e: Resource Management – Constantine-Leventis Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/98229037557?pwd=RCtkbXMzUFVzSml5em1Cckpkbm1UUT09	
Speaker	**Title**
Claudia Kelsall	A Tractable Model of Renewable Resource Management with Insurance
Pierre Courtois	The private management of plant epidemics: Infection levels and social inefficiencies
*Nicolas Quérou**	Common-pool resource management and risk
Martin Quaas (Chair)	Love of Variety and the Long-Term Welfare Effects of Trade in Open-access Renewable Resources

***** Denotes speaker presenting virtually

Parallel Session 2

Monday 5th September 1400-1600

Session 2a: Experiments for Resource Management – Bateman Lecture Theatre **Zoom:** https://Universityofexeter.zoom.us/j/92048723413?pwd=Q1FtbmpzNHRYNlduYXVJYjlQV0lZUT09	
Speaker	**Title**
Peter King	Willingness to pay for the colours, sounds, smells and ecological processes of forest biodiversity.
Katherine Simpson	Comparing ecological and economic outcomes under a payment for results compared to a payment for actions agri-environment scheme
Tobias Börger	Equity preferences and abatement cost sharing in international environmental agreements
Esther Schuch (Chair)	Managing tipping point dynamics: Experimental evidence on the role of fairness, inequality aversion, and framing
Session 2b: Climate Change – policy – Matrix Lecture Theatre **Zoom:** https://Universityofexeter.zoom.us/j/92092464743?pwd=akZmREZySStnSXpWV2Fub0c0dVZzZz09	
Speaker	**Title**
Ben Groom	The Social Cost of Carbon with Intragenerational Inequality under Economic Uncertainty
*Aino Assmuth**	Climate economics of boreal deforestation: the case of Finland
Moritz Drupp (Chair)	Relative Price Changes of Ecosystem Services: Evidence from Germany
Session 2c: Conservation and Development in the 21st Century Brazilian Amazon: Providing Evidence for Improved Governance – Pearson Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/92846214883?pwd=eCtZUnVhOERCNGZUQnFPc0dVcWlTdz09	
Speaker	**Title**
*André Sant'anna**	Land Grabbing and Deforestation in the Brazilian Amazon
Erich Gimenes	An agri-environmental scheme to reduce agricultural fires: a study of the case of the Brazilian Amazon
*Paula Pereda**	Land organization effects on the economic incentives to deforestation
Thiago Morello (Chair)	The effect of fire-induced forest-degradation on rain-fed water supply: a causal inference analysis of the case of the Brazilian Amazon
Session 2d: Valuation - Choice Experiments – Kolade Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/96377119363?pwd=a04rVEt2M3RPYmZtc2FjbzF4TlV3UT09	
Speaker	**Title**
Maria Loureiro	Environmental and cultural ecosystem services valuation in post-fire risk assessments
*Valeria Toledo**	Valuing ecosystem services and disservices of blue/green infrastructure. Evidence from a choice experiment in Vietnam
Bartosz Bartkowski	Between complexity and unfamiliarity: preferences for soil-based ecosystem services
Marc Conte (Chair)	The Value of Species: Understanding Income Effects to Inform Integration of Natural Capital Into Climate Policy
Session 2e: Sustainable Agriculture – Constantine-Leventis Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/98229037557?pwd=RCtkbXMzUFVzSml5em1Cckpkbm1UUT09	
Speaker	**Title**
Germán Sánchez	Farmland economic value and the sustainability of a bird community: A trade-off quantification of the Lleida Plain
Lea Nicita	What is the Value of Agrobiodiversity?
*Jenni Miettinen**	Strip harvesting in drained boreal peatlands when climate impacts and water quality matter
Salvatore Di Falco (Chair)	Learning about Sustainability: Experimental Evidence from Ethiopia

***** Denotes speaker presenting virtually

Parallel Session 3

Tuesday 6th September 1100-1300

Session 3a: Offsets – Bateman Lecture Theatre **Zoom:** https://Universityofexeter.zoom.us/j/92048723413?pwd=Q1FtbmpzNHRYNlduYXVJYjlQV0lZUT09	
Speaker	**Title**
Luc Doyen	When profitability meets conservation objectives through biodiversity offsets
Sophus zu Ermgassen	Evaluating the impact of one of the world's oldest biodiversity offsetting systems on native vegetation
Jussi Lintunen	Mechanisms for Additional Forest Management Carbon Sequestration
Frank Venmans (Chair)	The social value of offsets
Session 3b: Planning Resource Management – Matrix Lecture Theatre **Zoom:** https://Universityofexeter.zoom.us/j/92092464743?pwd=akZmREZySStnSXpWV2Fub0c0dVZzZz09	
Speaker	**Title**
Mette Termansen	Integrated environmental-economic modelling for cross sectoral water policy evaluation
*Itsaso Lopetegui**	An efficient portfolio approach towards ecosystem-based fisheries governance in EU
Amelie Luhede	The value of monitoring information for water quality management
Ian Bateman (Chair)	How to make decisions! Markets, scenarios and natural capital approaches to land use policy
Session 3c: Tipping Points and Regime Shifts – Pearson Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/92846214883?pwd=eCtZUnVhOERCNGZUQnFPc0dVcWlTdz09	
Speaker	**Title**
Michael Stecher (on behalf of Stefan Baumgärtner)	With limited power comes limited responsibility: a novel dynamic measure of causation and its implications
Daniele Rinaldo	Scenes from a Monopoly: Quickest Detection of Ecological Regimes
Frikk Nesje	Early warning of tipping points improve management but may encourage risk taking
Michael Stecher (Chair)	Catastrophic shifts in the Western Baltic Sea - who's responsible?
Session 3d: Valuation - Revealed Preferences – Kolade Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/96377119363?pwd=a04rVEt2M3RPYmZtc2FjbzF4TlV3UT09	
Speaker	**Title**
Yacouba Kassouri	Well-being and the Environment: A two-step approach to value multiple, spatially-heterogeneous public goods
Maria Teresa González Valencia	The Near-miss Effect of Forest Fires: Evidence from Western Australia
Yacov Tsur	Freshwater Ecosystem Services within a Dynamic Water Economy Framework
Allan Beltran (Chair)	The Disamenity Impact of Anaerobic Digestion
Session 3e: Environmental Market Design – Constantine-Leventis Teaching Room **Zoom:** https://Universityofexeter.zoom.us/j/98229037557?pwd=RCtkbXMzUFVzSml5em1Cckpkbm1UUT09	
Speaker	**Title**
Frank Wätzold	Flexibility of policy instruments for cost-effective biodiversity conservation under climate change: land purchase versus conservation contracts
Martin Drechsler	Improving models of coordination incentives for biodiversity conservation by fitting a multi-agent simulation model to a lab experiment
Zhaoyang Liu	Spatially coordinated conservation auctions: a framed field experiment
David Simpson (Chair)	Allocating 'nonuse rights' for natural resources: when do markets improve efficiency?

* Denotes speaker presenting virtually

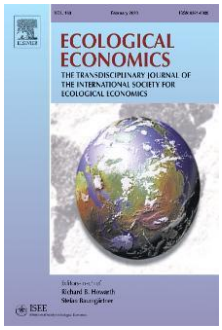
Parallel Session 4

Tuesday 6th September 1545-1715

Session 4a: Energy – Bateman Lecture Theatre **Zoom:** https://Universityofexeter.zoom.us/j/92048723413?pwd=Q1FtbmpzNHRYNlduYXVJYjlQV0lZUT09	
Speaker	**Title**
Charlotte Geiger	Wind power development in Germany: Spatial planning instruments and exeternality trade-offs
Paul Lehmann (Chair)	The opportunity cost of binary land-use restrictions for renewable energy deployment
Session 4b: Blue biodiversity - supporting sustainable development, marine conservation and restoration – Matrix Lecture Theatre **Zoom:** https://Universityofexeter.zoom.us/j/92092464743?pwd=akZmREZySStnSXpWV2Fub0c0dVZzZz09	
Speaker	**Title**
Carlo Fezzi	The economic value of coral reef restoration in the face of climate change
Luke Brander	Turtle Economic Value: Estimating the non-use value of marine turtles in the Asia-Pacific region
Tiziana Luisetti (Chair)	Blue carbon: an opportunity for a 'new normal' sustainable economic growth

***** Denotes speaker presenting virtually

The programme of events is subject to change and in the event that changes are made, these will be communicated on the day.



Ecological Economics

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https://www.journals.elsevier.com/ecological-economics

Ecological Economics invites contributions for a **special issue on Biodiversity and Finance: Risk, Disclosure and Double Materiality;** guest edited by Ben Groom (University of Exeter, LSE Grantham), Mark Freeman (University of York) and Matthew Agarwala (University of Cambridge) .

Topic

This special issue will investigate the way in which material nature-based risks are reflected in financial assets including sovereign debt, and the impact of investments and corporate activities on nature, biodiversity and ecosystem service. The special issue will evaluate the extent to which these dual aspects of nature-based risks, the double materiality, can be adequately reflected and whether mechanisms such as disclosure (e.g. via the Taskforce for Nature Related Financial disclosures (TNFD) or Taskforce for Climate Related Financial Disclosures (TCFD)), ESG and other ratings, can influence the allocation of capital to lessen the effect of economic activity on nature and biodiversity and induce sustainability. We invite empirical, theoretical and think-piece papers on all aspects concerning biodiversity and the financial sector ranging from the perceptions and demands of individual investors, the role of asset managers, the metrics with which nature based risks are measured, the implications for portfolio management and the legality of focusing on ESG criteria rather than the more narrow fiduciary duties of companies and asset managers of maximizing financial returns for shareholders and investors.

Timeline

The special issue is **open for submission** starting from 1st October 2022. The **deadline for submissions** is 31th December 2022. Submissions must be made through the journal's online submission platform Editorial Manager https://www.editorialmanager.com/ecolec/default1.aspx. We aim for publishing accepted publications from September 2023.

Preparing contributions

Contributions to the special issue may be Analysis, Survey, Commentary, or Book Review, as described in the **Guide for Authors** (https://www.elsevier.com/journals/ecological-economics/0921-8009/guide-for-authors). All contributions to a special issue must be prepared according to the journal's **Guide for Authors**.

Review process

All contributions will go through the **normal peer-review process** and are expected to at least meet, if not exceed, the usual quality standards of articles published in *Ecological Economics*. This includes the possibility that a given contribution will not be published if it is found to be not suitable.

Publication format

Special issues are published as **virtual special issues**. Each paper is published as soon as the proof is corrected in the next available regular issue, with an imprint indicating that it is part of a special issue. Simultaneously all special-issue articles are gathered together in an online-only grouping for the special issue itself. On ScienceDirect, the special issue is set up under the heading Article Collections and filled with special-issue-articles one by one, as they are published. The special issue becomes visible to end-users once the first article is

linked to the special issue, rather than waiting for all papers to be finalised before it can be compiled. **Examples** of previously published special issues can be found at https://www.sciencedirect.com/journal/ecological-economics/special-issues.

Contact

For questions, contact any of the Guest Editors:

Ben Groom: b.d.groom@exeter.ac.uk
Mark Freeman: mark.freeman@york.ac.uk
Matthew Agarwala: mka30@cam.ac.uk

Instructions for speakers, chairs and attendees

Speakers

- The sessions are designed for 22-minute talks, plus 5 minutes for questions
- There is an additional 3 minutes per talk for switching between speakers
- In-person speakers: please arrive at the meeting room **15 minutes** early, and have your presentation in either **ppt or pdf** format on a **USB stick**. Please ensure that you are correctly sharing your slides on the zoom meeting (as you would for any other virtual talk) so that the online participants can see your slides
- Virtual speakers: please arrive into the zoom link **15 minutes** early, and please check that you can **properly share your screen** and that **your audio is working** ahead of the session starting (as you would for any other virtual talk)
- There are **no** discussants

Chairs

- Please ensure that speakers keep to time – there will be "5 mins to go" and "1 min to go" signs; for virtual speakers, please either let them know in the chat box, or by putting the sign in front of the camera in the room
- The Zoom meetings will be setup for you in advance of your arrival into the room
- Please check that any in-person speakers have their slides loaded and are able to share them with the virtual participants
- Please check that any virtual speakers are able to share their screen and that you can hear their audio
- Please monitor the zoom meeting and let participants in before the talks start, and, if there are late comers, between the talks
- Please then chair the Q+A session – ensuring that the Zoom link if monitored for people with raised hands, or questions in the chat box
- If your session is in either the Matrix or Bateman lecture theatres, please ensure that questions are asked into the microphones on the desks (and that the participant asking the question has unmuted their mic)

Attendees

- Please save your questions for the end of each talk
- If you are in person in a session in either Henderson, Matrix or Bateman lecture theatres, please speak into a microphone (in the Henderson these will be brought to you; in the Matrix and Bateman, these are on the desks, please just ensure that you unmute it for your question)
- If you are attending virtually:
    - Please stay on mute unless invited to unmute
    - Please have your camera turned on if you are able to
    - Please raise your hand if you would like to ask a question (you can write it in the "everyone" chat box instead if you would prefer, but if possible, use the raise hand function and then ask aloud)
- Breakout rooms are available on the second floor of Building One (the Syndicate Rooms)

Key Information

Contact details for the duration of the conference:
b.balmford@exeter.ac.uk
+44 (0)7510 108 627

Arrival:
If you have accommodation booked please head to Holland Hall where you will be able to check in between 1500 and 2300.
If you do not have accommodation booked, please meet at: Holland Hall for the excursions; The Old Firehouse for the drinks reception; and the XFi Atrium for the conference itself.
You'll be able to collect your welcome pack at the drinks reception on Sunday evening or from the XFi atrium on Monday morning.

Accommodation:
For those who have pre-registered for accommodation, this will be located on campus at the below address:
Holland Hall, Clydesdale Road, University of Exeter, Exeter, EX4 4SA
Tel: +44 (0)1392 722330
Please note if using a Sat Nav device then enter the postcode EX4 4QR to lead you to the Streatham Campus and then follow the campus signage to Holland Hall / Mardon Hall.
For further information and directions visit:
https://www.exeter.ac.uk/eventexeter/accommodation/
Bookings include a cafeteria-style **breakfast served between 07.30– 09.00**
On the day of arrival, please make your way to the Reception within the building. **Keys can be collected between 15.00 and 23.00**. Reception is open until 23.00. If you are due to arrive after this time, please let us know by contacting b.balmford@exeter.ac.uk and upon arrival, you will need to call Estate Patrol on +44 (0)1392 723999 who will then be able to let you into your room.
On the day of departure, **all rooms must be vacated by 10.00** and all keys returned to reception.
Please note all bedrooms at Holland Hall are **non-smoking**.

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In the event that you need to bring any luggage into the conference venue we are able to store this onsite, but please be advised that items are left at your own risk and the University is unable to accept any liability in the event of any damage/loss.

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Parallel session paper abstracts
Monday 5th September 1100-1300

Session 1a - *Biodiversity and Finance*

Matthew Agarwala, Matt Burke, Patrycja Klusak, Moritz Kraemer, Ulrich Volz
University of Cambridge

Nature Loss and Sovereign Credit Ratings

Biodiversity loss, decline of ecosystem services, and overall environmental degradation can hit economies through multiple channels. The combined macroeconomic consequences can impact sovereign creditworthiness. Yet, the methodologies published and applied by leading credit rating agencies (CRAs) do not explicitly incorporate biodiversity and nature-related risks. Omitting them may ultimately undermine market stability. As environmental pressures intensify, the gap between the information conveyed by ratings and real-world risk exposure may grow. A consistent approach to integrating nature- and biodiversityrelated risks into debt markets is long overdue. This report models the effect of nature loss on credit ratings, default probabilities, and the cost of borrowing. The results have implications for stakeholders including credit rating agencies, investors, and sovereigns themselves.

Lewis Grant, Ben Groom, Wei Xin, Chendi Zhang
The Federated Hermes

The Mechanics of Biodiversity in ESG

Analysts and investors who want to avoid biodiversity and other nature-based risks or engage in environmental conservation use ESG as a key resource to evaluate portfolios. However, past research shows evidence that ESG does not appear to achieve its purpose. Biodiversity has historically been underrepresented within investment decisions making and although attention toward this crucial topic is increasing, it is unclear how the construction of ESG metrics and approaches to ESG integration are suited to delivering positive biodiversity outcomes. In this paper we consider how biodiversity is reflected in ESG metrics and how screening for or tilting towards ESG or Environmental ratings affects portfolio alignment with biodiversity issues and metrics. We show that there are unanticipated outcomes for biodiversity ratings of such investment strategies, casting doubt on whether the investment industry's adoption of ESG metrics within capital allocations will have desirable effects on nature-based risk management or outcomes for biodiversity.

Wei Xin, Lewis Grant, Ben Groom, Chendi Zhang
University of Exeter

Biodiversity Confusion

Biodiversity has been shown to be an important aspect of natural capital, an important cultural ecosystem service, and underpins the supporting and provisioning of ecosystem services. This close connection between the economy and nature means that economic activity impacts biodiversity and natural capital, but is also exposed to nature-based risks. As a result, the so-called ``double-materiality'' of biodiversity risks and impacts have little effect on decisions in the financial sector. In this paper, we examine the extent to which risks and impacts associated with biodiversity are reflected in financial markets via one of the chief disclosure mechanisms for environmental risks: ESG ratings. We find that biodiversity performance in ESG data is hardly associated with firms' characteristics, stock future returns, and firms' operating performance. Neither do other financial participants including institutional investors and sell-side analysts take biodiversity performance into account in their professional activities. Our findings suggest that the biodiversity component of E in ESG is unlikely to achieve much in terms of shifting capital away from harmful activities, or insulating companies from natural capital risks.

Session 1b - ***Climate Change-Impacts***

Bastien-Olvera B. A., Conte M., Emmerling J., Tavoni M., Dong X., Briceno T., Batker D., and F. C. Moore
University of California Davis

Climate change impacts on terrestrial ecosystems and its consequences for human well-being and macro-economic growth.

Ecosystems contribute to human well-being through economic and non-economic benefits. As climate change influences ecosystems distribution throughout the world, these benefits will change. However, the degree and even the direction of the impact will depend on how ecosystems will shift and to what extent countries rely on them for their economic and non-economic activities. In this work, we simulate country-level economic and ecosystem services growth using reduced-form form macro-economic models with natural capital as a productive asset. We estimate climate change damages to natural capital through a random forest algorithm that combines outputs from a dynamic terrestrial ecosystem model, and ecosystem services valuation database, and the World Bank inclusive wealth accounts.

Our results show that the mean global flow of ecosystem services could be reduced by 32% in 2100 under the SSP2-4.5 (~2.6°C), and the mean global GDP could decrease by 1.5% in 2100, having larger effects on African countries (-5%) and dampening as country-level wealth increases. Limiting temperature below 2°C could cut GDP and ecosystem services damages at least by half and reduce economic inequality among countries.

Irmelin S Helgesen
Norwegian University of Science and Technology

Welfare implications of climate change for reindeer herding Saami in northern Sweden and Norway - a bioeconomic model

The Arctic is warming three times faster than the global average. It is predicted that rising temperatures could reduce the snow-covered season and increase plant productivity in the spring, fall and summer. While this may increase carrying capacity and growth of semi-domesticated reindeer, rising temperatures could also lead to an increase in rain-on-snow events during winter. Rain-on-snow creates hard ice layers in the snow, making it difficult for the reindeer to reach the lichen and negatively affecting reindeer body mass, survival and reproductive success. In this paper we create a stage-structured bioeconomic model of reindeer herding that incorporates the contrary effects of climate change on reindeer growth, reproduction, and survival. The model is calibrated using historical data on reindeer numbers and weight, in combination with climate data. The model will be used to simulate the effects of different climate change scenarios in Norway and Sweden, while comparing current harvesting levels to optimal harvesting.

Leanne Cass
London School of Economics and Political Science

Weather shocks and international trade

Previous research provides ample evidence that on their own international trade and weather shocks can be important drivers of economic growth, but we know relatively little about how these two factors might interact. This paper brings together recent developments from the international trade and climate change economics literatures to investigate the differential impact of weather shocks on exports relative to domestic sales. In contrast to previous empirical papers that study the impact of weather shocks on international trade, I use an empirical approach that includesdomestic trade flows and controls robustly for multilateral resistance parameters.

I find that agricultural exports are particularly sensitive to weather shocks relative to domestic

market sales, especially in hot and rainy countries. Strong institutions may be an important mitigating factor for this impact of precipitation shocks on agricultural exports. Economists usually conceptualize the macroeconomic damages of climate change as productivity impacts, but these results provide some evidence that weather and potentially climate change can be an additional barrier to trade, implying that the full economic damages of these shocks entail not only productivity impacts on the farm, but also disruptions along the supply chain once goods leave the farm. Given the close link between exports and economic development and welfare, these findings have economic significance.

David Maddison, Saul Basurto-Hernandez and Anindya Banerjee
University of Birmingham

Another Look at the Impact of Climate Change on Mexican Agriculture

This paper uses the Ricardian technique to investigate the impacts of climate change on agriculture in Mexico. Whereas previous studies for Mexico based their estimates on municipal-level data or on an unrepresentative sample of farms, we use farm-level data which is representative for the entire country. This paper further improves on the literature by using the NEGLOG transformation to overcome the problem of negative net revenues and latent class analysis (LCA) to endogenously allocate farms into different classes. Significant empirical support is found for both the NEGLOG transformation and the use of LCA. More specifically, the analysis points to the importance of gender discrimination and indigenous status as determinants of the effect of climate on agricultural productivity (as well as confirming the expected importance of education and farm-size).

Session 1c - *Deforestation*

Julia Naime and Arild Angelsen
Center for International Forestry Research (CIFOR)

Will peer punishment protect tropical forests? Multi-country experimental evidence

This paper examines patters and impacts of peer punishment in a framed field experiment on forest conversion, in situations with homogeneous and heterogenous agents. The experiment included 720 forest users in Brazil, Indonesia and Peru. Our first research question is to examine the relationship between first order (the appropriation problem of a common pool resource) and second order (peer punishment) cooperation. A small share (18.2%) of the participants behaved as self-interested payoff maximisers, while the largest group (26.1%) cooperates in both the appropriation and enforcement stages. The remaining participants do not behave consistently across the first and second-order cooperation dilemmas, and we discuss possible motivations. Second, we examine punishment effectiveness: does it change the optimal strategy, and does it lead to more cooperation in forest protection? We find stark differences across country sites: in Indonesia, the probability of receiving punishments is roughly twice that in the Brazilian and Peruvian sites. Receiving prosocial punishment, defined as the punishment of free riders, effectively increases cooperation, while receiving antisocial punishment reduce cooperation. The effect of agent heterogeneity on peer punishment is small, while important inter-site variation is observed.

Michael Tanner, Leonie Ratzke
University of Hamburg

Deforestation, Institutions, and Property Rights: Evidence from land titling to indigenous peoples and local communities in Ecuador

Deforestation is a matter of pressing global concern, contributing to declining ecosystem services, biodiversity loss, and ultimately climate change through growing emissions. We evaluate the effect of assigning property rights to local and indigenous peoples in coastal Ecuador on deforestation and the role external institutions play in policy effectiveness. Informed by a theoretical model, we develop an instrumental variable approach and a regression discontinuity design to 1) evaluate changes in forest coverage for the first 12 years of policy adoption, and 2) evaluate the effect of the presence of non-governmental organizations (NGOs) on policy permanence. We find that assigning property rights to local and indigenous peoples significantly decreases mangrove deforestation and that the presence of NGOs funded by foreign aid significantly increases the probability of policy adoption and permanence. We assess the positive development implications of the policy concerning fisheries provisioning for local communities and the role of international aid in achieving environmental outcomes. We calculate that the policy prevented additional emission of more than 1.55 million tCO2 and estimate the additional fisheries attributable to assigning property rights. Our work highlights the importance of local and indigenous peoples and civil society as actors for sustainable land stewardship in future climate policy.

Gabriela Demarchi, Julie Subervie, Thibault Catry, Isabelle Tritsch
French National Research Institute for Agriculture, Food and the Environment (INRAE), Center for Environmental Economics, Montpellier (CEE-M)

Using publicly available remote sensing products to evaluate REDD+ projects in Brazil

Ensuring the perpetuity and improvement of REDD+ initiatives requires rigorous impact evaluation of their effectiveness in curbing deforestation. Today, a number of global and regional remote sensing (RS) products that detect changes in forest cover are publicly available. In this study, we assess the suitability of using these datasets to evaluate the impact of local REDD+ projects targeting smallholders in the Brazilian Amazon. Firstly, we reconstruct the forest loss of 21,492 farms located in the Transamazonian region for the period 2008 to 2018, using data from two RS products: Global Forest Change (GFC) and the Amazon Deforestation Monitoring Project (PRODES). Secondly, we evaluate the consistency between these two data sources and find that the deforestation estimates at the farm level vary considerably

between datasets. Despite this difference, using micro-econometric techniques that use pre-treatment outcomes to construct counter-factual patterns of REDD+ program participants, we find that an average of about two (2) hectares of forest were saved on each of the 350 participating farms during the first years of the program, regardless of the data-source used. Moreover, we find that deforestation decreased on plots surrounding participating farms, suggesting that the program had a positive spillover effect on neighboring farms. Finally, we show that participants returned to the businessas- usual pattern at the end of the program; however, the environmental gain generated during the four years of the program was not offset by any "catch-up" behavior. By calculating the monetary gain of the delayed carbon dioxide emissions, we find that the program's benefits were ultimately greater than its costs.

Sabrina Eisenbarth, Miguel A. Fonseca and Alexander Pfaff
University of Exeter

How do Global Conservation Interventions Interact With Local Social Structures?

Conservation increasingly is incentivized via external payments to groups that vary in their internal capacities to overcome free-riding and provide local public goods. We generate such variation in lab experiments with 1010 participants, using partial (as opposed to full or zero) information on other's contributions to the local public good. This setup yields contributions levels that remain steady (norms) yet vary considerably across groups. For this varied 'societal-scape', we consider two interventions to support local public goods provision: temporary economic incentives (as per most real-life PES programs), a forum where attendees share all their contribution information (like village councils seen globally) and the combination of the two. Both interventions have impact on average contributions: the forum raises contributions by 18% and a collective incentive for contributions over baseline raises contributions by 11%. More importantly, we study whether the effect of our interventions depends on pre-existing informal (low, medium and high) contribution norms. We find that both interventions raise contributions for each norm. However, once incentives end, only high contribution norm groups contribute above their pre-incentive levels. For groups with low contribution norms, there is descriptive evidence that the information-sharing forum raises the effectiveness of incentives both during implementation and after incentives end.

Session 1d - ***Wildlife Management***

Robbert-Jan Schaap, Michael Tanner, Cesar Viteri-Mejia, and Jorge Ramírez-González
University of Hamburg

Regulating demand: Tourism and the conservation of marine resources

Ecotourism is put forward as a sustainable alternative to natural resource exploitation for coastal communities. Ideally, tourism acts as a substitute economic activity for resource exploitation, reducing harvesting effort. However, tourism can increase demand for natural resources, such as locally caught fish. Subsequent increases in resource prices can motivate resource users to increase harvesting effort. We exploit a negative shock on tourism exogenous to environmental quality, to estimate the causal effect of ecotourism on natural resource exploitation in the Galapagos Islands. We find that tourism has a positive effect on fishers revenue by substantially increasing resource prices. Total fishing effort is unaffected by the presence of tourists, however tourism shifts effort to higher value species. This has a negative effect on environmental quality as the higher value species are more susceptible to over fishing. Our results suggest that conservation goals could be negatively impacted by ecotourism.

Takahiro Kubo, Taro Mieno, Shinya Uryu, Saeko Terada, Diogo Veríssimo
National Institute for Environmental Studies, Tsukuba, Japan

Spillover Impacts of Wildlife Trade Bans on Demand for Non-banned Threatened Species: Evidence from Synthetic Difference-in-Differences

Regulations on the use of natural resources might have unintended spillover impacts beyond the policy targets. Banning commercial wildlife trade is an approach to protect species from overexploitation; however, most studies have focused on the trades of policy targeted banned species, which might have overlooked side effects of trade bans on unregulated threatened species. This study explores whether trade ban regulations on three threatened species (i.e., giant water bugs Kirkaldyia deyrolli, Tokyo salamanders Hynobius tokyoensis and golden venus chub Hemigrammocypris neglectus) have spillover impacts on the demand for non-banned species considered as substitutes. We draw on a 10-year online auction dataset and the recently developed causal inference approach—synthetic difference-in-differences—to analyze the trade ban regulation implemented in February 2020 in Japan, one of the largest wildlife trade countries. The results show that bans on the giant water bugs and Tokyo salamanders led to an increase in the trade of non-banned species, whereas there was no such evidence concerning the golden venus chub. The findings suggest that policy evaluations ignoring spillover effects might overstate the benefits of the trade ban policy in conservation. Our findings raise concerns about the unintended consequences caused by trade ban regulations and restate the importance of further efforts of consumer research, monitoring and enforcement beyond the species targeted by policies, while minimizing the costs by applying modern technologies and enhancing international cooperation.

Adrian A. Lopes
American University of Sharjah

An Organized Crime Model of Illicit Trade in Pangolin Scales and Elephant Ivory

Recent patterns in endangered species trafficking have witnessed a shift towards multiple animal derivative products in overseas shipments. Organized crime syndicates smuggle mixed contraband via shipping companies that use their licenses and sea routes to screen illegal products with legitimate exports. Port seizures have revealed that pangolin scales and elephant ivory are shipped together and disguised using scrap plastics, wood products, or frozen meat items. Pangolin scales are used in traditional eastern medicine and possessing carved ivory continues to be associated with societal status in East Asia. Illicit trade threatens the longevity of such species. I develop a model of an organized crime manager who plans for contraband shipments based on an expected net return. The model numerically yields a number of planned shipments for variations in the content of scales and ivory, and a contraband-contingent probability of detection by port authorities. Planned shipments

are influenced by detection probabilities and the increasing content of one contraband type at the expense of the other– suggesting a range of substitutability between contraband types. A dynamic population model of pangolins and elephants is coupled with the syndicate manager's model to depict and discuss probable extinction scenarios and the realized returns of the syndicate.

Timo Goeschl, Florian Diekert, Tillmann Eymess, Santiago Gómez-Cardona, and Joseph Luomba
Heidelberg University

Subsidizing Compliance: A Multi-Unit Price List Mechanism for Legal Fishing Nets at Lake Victoria

Like many common-pool resources, the Lake Victoria fisheries are characterized by poor compliance with production input regulations that are intended to reduce overexploitation. To explore the use of input subsidies to increase compliance, we determine the subsidy level required to induce demand for legal fishing nets, thereby 15 compensating fishermen for loss of productivity net of enforcement risk. Our study additionally tests the subsidy-enhancing effect of a norm-nudge. A new multiple price list mechanism for eliciting revealed willingness to pay for multiple units of a production input is developed, adapted to the demands of a challenging eld setting, and implemented with 462 fishermen at 20 landings sites on the Tanzanian 20 lakeshore. Consistent with the high prevalence of illegal fishing gear at our sites, we find a zero median demand for legal net panels at local market prices. The subsidy required to shift median demand to at least one legal net panel is a 21% discount. Norm-nudging generates no policy-relevant enhancement of the subsidy.

Session 1e - *Resource Management*

C. Kelsall, M. F. Quaas and N. Querou
University of Leipzig and German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany

A Tractable Model of Renewable Resource Management with Insurance

We study optimal management of a renewable resource with stochastic and spatial dynamics. We contribute to the literature by developing a tractable model of formal income insurance and explore the potential for insurance to aid sustainable management of natural resources. We find that formal insurance can act as a substitute for self-insurance by mitigating risk, leading to more conservative resource use. We also determine conditions under which resource managers would buy insurance, finding that full insurance is only bought when the market is fair. Using an example with constant absolute risk averse preferences, we also show that as the magnitude of risk, or degree of risk aversion increases, the more beneficial insurance can be.

Pierre Courtois, César Martinez, Gaël Thébaud, and Mabel Tidball
CEE-M, Univ. Montpellier, CNRS, INRAe, Institut Agro, Montpellier, France

The private management of plant epidemics: Infection levels and social ineffciencies

Plant epidemics spread across landscapes. Control is often implemented at the private property level, and, in the absence of public intervention, landowners choose their level of efforts based on costs and benefits. Depending on infection levels, connectivity, and spread, control of an epidemic in private properties can be mutually reinforcing or offsetting. The order of this relationship is critical when it comes to addressing social inefficiencies due to private management. In this paper, we consider a simple finite-horizon game where two landowners decide whether or not to control an epidemic in their property. We characterize the game and its outcomes according to initial epidemic conditions and focus on those likely to produce social inefficiencies. Two results are drawn. First, we show that depending on the initial infection levels, a broad range of games may arise, including games with multiple pure strategy equilibria, games without pure strategy equilibria, and games with coordination and anti-coordination patterns. While the literature either assimilates the epidemic game to a game with strategic complements (i.e., a weakest link game) or a game with strategic substitutes (i.e., a free-riding problem), our simple model shows that depending on the state of the epidemic, the nature of strategic interactions may change. Second, we characterize the epidemic conditions for which private management produces social ine_ciencies. These two results allow us to present policy recommendations to reduce the social ine_ciency of private management depending on the state of the epidemic.

Nicolas Quérou and Can Askan Mavi
CEE-M, Univ. Montpellier, CNRS, INRAe, Institut Agro, Montpellier, France

Common pool resource management and risk perceptions

Motivated by recent discussions about the issue of risk perceptions for climate change related events, we introduce a non-cooperative game setting where agents manage a common pool resource under a potential risk, and agents exhibit different risk perceptions. We first highlight that risk and risk perceptions have qualitatively different impacts on optimal decisions. Then, focusing on the effect of the polarization level and other population features, we show that the type of perception (overestimation versus underestimation) and the resource quality level before and after the occurrence of the shift have first-order importance on the qualitative nature of behavioral adjustments and on the pattern of resource conservation. When there are non-uniform perceptions within the population, the intra-group structure of the population qualitatively affects the degree of resource conservation. Moreover, science-based agents (choosing extraction levels based on the probability estimate making consensus within the scientific community) may react in non-monotone ways to changes in the polarization level when faced with agents exhibiting different types of perception. The size of the science-based agents' sub-population does not qualitatively affect how an increase in the polarization level impacts individual behavioral adjustments, even though it affects the magnitude of this change. Finally, it is shown how the perception affects then comparison between centralized and decentralized management, and different policies are discussed based on their likely effects on welfare.

Martin Quaas and Isha Dube
Leipzig University and German Centre for Integrative Biodiversity Research (iDiv)

Love of Variety and the Long-Term Welfare Effects of Trade in Open-access Renewable Resources

We analyze welfare effects of trade in open-access renewable resources, which is induced by consumer love of variety in resource consumption. We consider two countries that are heterogeneous in incomes—high and low income—and sym- metric in all other respects. We show that increasing trade freeness benefits the high-income country, as it improves access to a larger variety of resources and also increases the high-income country's resource stock. Welfare in the low-income country may depend on trade freeness in a non-monotonic fashion. We derive condi-tions such that welfare first decreases and then increases when trade freeness varies from autarky to costless trade. In direct comparison, autarky may generate higher welfare than costless trade only if the love of variety effect is sufficiently weak.

Monday 5th September 1400-1600

Session 2a - *Experiments for Resource Management*

Peter King, Martin Dallimer, Thomas Lundhede, Gail E. Austen, Jessica C. Fisher, Katherine N. Irvine, Robert D. Fish, Zoe G. Davies
Durrell Institute of Conservation and Ecology (DICE)

Willingness to pay for the colours, sounds, smells and ecological processes of forest biodiversity.

Forest expansion has become embedded in policy goals worldwide. Increasing tree cover results in landscape changes that have far-reaching socioeconomic consequences. However, there is limited evidence on public preferences and values for forests, and the biodiversity they contain. To address this, we used a choice experiment to explore the British public's willingness to pay (WTP) for different attributes of forest biodiversity (colours, smells, sounds, and ecological processes). Choice experiment attribute selection was based on in-depth participatory processes. Respondents (N = 1711) were willing to pay from £0.84 to £8.74 in additional annual local taxation for a greater diversity of colour, sound and smells, but not for improved ecological processes. Although WTP varied by frequency of forest visit and perceived quality, forest cover had no effect and relatively little spatial clustering was detected. If policy goals on forest expansion are to be implemented successfully, plans should take into account public preferences to ensure that biodiversity, and its attributes such as colours, smells and sounds, are not overlooked as landscape changes are planned and implemented.

Katherine Simpson, Mary Nthambi, Frans P. de Vries, Paul R. Armsworth, Martin Dallimer, Nick Hanley
Institute of Biodiversity Animal Health and Comparative Medicine

Comparing ecological and economic outcomes under a payment for results compared to a payment for actions agri-environment scheme

A key drawback of action-based agri-environment schemes is that the underlying uniform payments do not reflect spatial heterogeneity in costs and benefits across the landscape and this can significantly hinder the economic and ecological effectiveness of the scheme. Subsequently, payments for results schemes are being increasingly discussed in the academic literature and policy circles in Europe and the UK. In this paper, we develop an ecological-economic agent-based model to compare farmer participation in a payment for actions-based AES and a payment for results-based AES. We first model the predicted uptake of a payment for results based on the payment rate offered to landowners. Second, we model the predicted uptake compared to an equivalently subsidised payment for actions scheme. We then compare the economic and ecological outcomes across the landscape for the two alternative scheme designs. Our modelling shows that there is a significant divergence in economic and ecological outcomes under a payment for results AES compared to a payment for actions AES despite the same total subsidy payment and land management actions being required to "produce" the desired ecological benefit. Since these differences in outcomes relate to predictable spatial relationships in observable variables (agricultural profits), the results have broad implications for AES throughout Europe. It is clear that, if we wish to secure the most ecologically beneficial design of AES, whether that is based on habitat improvements, species or some other metric, we need to understand the economic decision-making processes of the landowners. We also need to design incentive-based policies that offer the highest incentives for conserving and enhancing the most ecologically beneficial sites in a landscape.

Tobias Börger, Nick Hanley, Robert Johnston, Keila Meginnis, Tom Ndebele, Ghamz E Ali Siya, Frans de Vries
Berlin School of Economics and Law

Equity preferences and abatement cost sharing in international environmental agreements

This paper examines empirically the importance of equity preferences for the formation of international environmental agreements (IEA) for transboundary pollution control. While it has been shown

theoretically that the existence of equity preferences among countries considering an IEA increases the chances for formation and stability of a coalition, empirical assessment of such preferences are limited to climate change mitigation and to single-country studies. We consider the case of marine plastic pollution as a transboundary pollution control problem of increasing policy concern, with properties that lead to distinct considerations for equity and sharing of abatement costs. We employ a coordinated choice experiment in the United Kingdom and United States to assess preferences for abatement cost allocations in a marine plastics IEA. Pairs of cooperating countries and relative allocation of abatement costs are varied experimentally. Results show systematic aversion to both advantageous and disadvantageous inequality with respect to abatement costs, but also that the relative strength of advantageous and disadvantageous inequality aversion differs across countries. Across both countries, there is evidence that left-leaning voters generally favour more equal international sharing of abatement costs. Differences of these results from the case of greenhouse gas emission reduction, and implications for current efforts to establish a legally binding global treaty on marine plastic pollution, are discussed.

Esther Schuch, Tum Nhim
Institute for Advanced Sustainability Studies (IASS)

Managing tipping point dynamics: Experimental evidence on the role of fairness, inequality aversion, and framing

Sociotechnical systems often have nonlinear dynamics such as tipping points which make the management of these systems difficult. Tipping points are critical thresholds within a system since these points shift the system suddenly from one stable state to another. The tipping point can trigger an improved or a deteriorated situation. Negative tipping points can be the failure to reduce CO2 emissions sufficiently, thus triggering climate change dynamics or more on a local level a deterioration of air quality. Thus, a successful reduction of CO2 emissions that results in an avoidance of climate change dynamics or improved air quality is an example for a positive tipping point. For a long time the narrative surrounding the energy transition, and climate change in general, was focused on avoiding a catastrophe, which is slowly changing by shifting the focus onto co-benefits of the energy transition. To test whether this shift in the narrative might increase support for the energy transition we perform a threshold public good game in which a threshold has to be reached before cooperation pays off. In particular, we are interested in whether we can see framing effects when presenting the game as a public good (positive tipping points) or a public bad (negative tipping points) game. Previous research has shown that contributions are higher if people aim to achieve something positive ('Warm Glow' of doing something good). Given that the optimal contribution strategy in threshold games depends on the contributions of the partners, we also elicit beliefs about the partners contributions. Lastly, we run an ultimatum game to elicit social norms on what constitutes "fair contributions" which allows us to disentangle the individual contributions towards the energy transition from conditional contribution patterns based on beliefs on social norms.

Session 2b - ***Climate Change-Policy***

Ben Groom, Frederick van der Ploeg and Johannes Emmerling,
University of Exeter

The Social Cost of Carbon with Intragenerational Inequality under Economic Uncertainty

A formula is derived for the social cost of carbon (SCC) that takes account of intragenerational income inequality and its evolution with economic growth. The social discount rate (SDR) should be adjusted to account for intragenerational and intergenerational inequality aversion and for risk aversion. If growth increases (re- duces) intra-generational inequality, the SDR is lower (higher) and the SCC higher (lower) than along an inequality-neutral growth path, especially if intra-generational and intergenerational inequality aversion are higher. The same qualitative result is shown for two welfare specifications, one with a representative agent with equally distributed equivalent (EDE) income and the other considers individuals separately across the income distribution. The latter specification causes an additional impact of income inequality on the SDR and SCC because individuals are compared both within and between time periods. Our preferred EDE calibration to a scenario in which global intragenerational inequality declines over time, leads to a SCC in 2020 of $70=tCO2 compared to a value of $85=tCO2 without the effect of inequality.

Aino Assmuth, Jussi Lintunen, Henrik Wejberg and Antti Miettinen
Natural Resources Institute Finland (Luke)

Climate economics of boreal deforestation: the case of Finland

Deforestation, mostly driven by agricultural expansion, is a global problem that leads to loss of biodiversity and increase of greenhouse gas net emissions. This paper presents a theoretical framework for analyzing the deforestation decision, and a comprehensive method for determining the magnitude of the climate externality of deforestation in a boreal context. We show that an optimal deforestation fee internalizes the climate externality consisting of the loss of current and future carbon storage in biomass and changes in soil net emission profiles over time. We demonstrate that deforestation on peat soil causes a much larger climate harm than that on mineral soil, and that the effect of discount rate and the differences between Finnish biogeographical regions are much more subtle. Further, we show that the social optimality of deforesting one hectare depends on the profitability of agriculture, on total private deforestation costs (including the opportunity cost of forgone forestry revenues), and on the climate harm of deforestation. Based on data on agricultural land prices in Finland, we show that a deforestation fee would make deforestation widely suboptimal on peat soil. We argue that boreal deforestation causes a significant, currently unpriced externality that often greatly outweighs the private benefits of converting the forest to agricultural use.

Moritz A. Drupp and Jonas Heckenhahn
University of Hamburg

Relative Price Changes of Ecosystem Services: Evidence from Germany

Discounting future costs and benefits is a crucial yet contentious practice in the appraisal of longterm public projects with environmental consequences. The standard approach typically neglects that ecosystem services are not easily substitutable with manufactured goods and often exhibit considerably lower growth rates. Theory has shown that we should either apply differentiated discount rates, such as a lower environmental discount rate, or account for increases in relative scarcity by uplifting environmental values. Some governments already integrate this into their guidance, but empirical evidence is scarce. We provide first comprehensive country-specific evidence, taking Germany as a case study. We estimate growth rates of 15 ecosystem services and the degree of limited substitutability based on a meta-analysis of 36 willingness to pay studies in Germany. We find that the relative price of ecosystem services has increased by more than four percent per year in recent decades. Heterogeneity analysis suggests that relative price changes are most substantial for regulating ecosystem services. Our findings underscore the importance of considering relative price adjustments in governmental project appraisal and

environmental economic accounting.

Session 2c - ***Conservation and Development in the 21st Century Brazilian Amazon: Providing Evidence for Improved Governance (By Thiago Morello)***

André Sant'anna, Arthur Bragança, Romero Rocha, Rodrigo Carvalho
Fluminense Federal University

Land Grabbing and Deforestation in the Brazilian Amazon

This paper assesses the effects of Brazil's current president pro-landgrabbing discourse and actions on the deforestation of public lands in the Brazilian Amazon. We analyze the evolution of deforestation at the property level throughout the period 2012-2021. We analyze the effects of the current Brazilian government on deforestation in public lands. Since the president's voice and policies have been recurrently used to favor land grabbers, we analyze whether deforestation in public lands have upsurged relatively more than in private lands. Hence, we estimate a difference-indifferences model, where public properties in the Brazilian Amazon biome are our treatment group and private properties in the same region are used as our control group. Our results point that deforestation in public lands in the Brazilian Amazon have increased by 0.22 standard deviation. This result implies an aggregate effect of more than 190 thousand hectares of forest lost since 2019.

Erich Gimenes, Morello, T., Vieira, L.
University of ABC

An agri-environmental scheme to reduce agricultural fires: a study of the case of the Brazilian Amazon

Command-and-control (CAC) is the dominant approach for regulating agricultural fires in developing countries, despite its low cost-effectiveness. Agri-environmental schemes (AES) are a potentially successful alternative. However, their application to the technological substitution of fire-based land preparation is threatened by asymmetric information regarding opportunity cost and whether a hectare was burned intentionally or accidentally. Taking as reference the case of the Brazilian Amazon, this paper develops and numerically simulates a contract-based AES design consistent with the empirical probability distribution of accidental burnings. The design is, theoretically, refined enough to realize efficiency gains from avoiding twelve types of pure and mixed adverse selection and moral hazard. Nevertheless, numerical results exposed the limited power of contracts to prevent shirking. A CAC policy transferring accidental fire risk entirely to agents outperformed the contract policy on welfare grounds, mainly by requiring a fourteen-fold larger fire replacement from the agent type facing the highest replacement cost. Nevertheless, the great risk transfer could be contested in practice by powerful farmer coalitions, preventing implementation or enforcement of CAC. Being this likely, the contract design here developed could be the best option for policymakers.

Paula Pereda, Patricia G. C. Ruggiero
University of São Paulo

Land organization effects on the economic incentives for deforestation in Brazil

A range of factors explains deforestation. Economic factors are a critical driver of deforestation through natural resource exploitation or promoting infrastructure expansion over forested land. In this paper, we investigate how land governance may change the effect of economic incentives for deforestation. To do that, we gather various sources of microdata on deforestation, land property, and violence related to land conflicts, among others. We construct a municipality-level panel by year and estimate the effects of rural credits and land conflicts on deforestation by stage of land governance, from more organized areas to more unsettled ones. We find preliminary results that the status of land governance matters for the incentives for deforestation. In subsequent steps, we intend to improve the identification of the effects by using different instrumental variables. We also intend to explore different definitions of land governance.

Thiago Morello,
Federal University of ABC

The effect of fire-induced forest-degradation on rain-fed water supply: a causal inference analysis of the case of the Brazilian Amazon

Unprecedented evidence that fire-induced forest degradation is reducing, in the Amazon, regional rainfall and thus jeopardizing agriculture is unveiled. It adds to an emerging body of research showing that forest degradation is at least as environmentally detrimental as the well-documented deforestation. Two complimentary identification strategies were adopted. The first avoided omitted variable bias in the causal effect of agricultural fires on forest fires by exploring exogenous daily variation of wind direction at a fine geographical level. Secondly, mechanisms confounding the effect of forest fires on rainfall, and on its mediators, including reverse causation, were blocked and common support was expanded, by matching on correlates of the forest fire treatment. Accuracy was increased with postmatching fixed-effects regressions. These analyses were applied to a panel dataset with over 50,000 pixels along all months from 2008 to 2019. The effects estimated were significant, with upwind agricultural fires decreasing Amazon-wide precipitation by 0.06% and evapotranspiration by 0.03%. Additionally, the impact of unpredictable rainfall changes on agriculture was assessed with an output supply function. A negative rainfall shock of one-standard deviation reduced municipal agricultural output by 1%. In synthesis, fire-induced forest degradation diminished Amazonian ecosystem capacity to retain water in a magnitude large enough to concern regional farmers. Improved policy is needed and could take the form of REDD+-funded subsidies to fire-free land preparation and fire control. Ways to reduce rain-fed water usage could be also stimulated.

Session 2d - ***Valuation - Choice Experiments***

Maria L. Loureiro, Ana Castro-Atanes
University of Santiago de Compostela

Environmental and cultural ecosystem services valuation in post-fire risk assessments

This work aims to assess social preferences towards the restoration of environmental and cultural ecosystem services in the context of recently burned areas. For this purpose, a discrete choice experiment (DCE) is designed to provide an economic value associated with each of the ecosystem services at risk after a wildfire (mainly environmental and cultural ecosystem services).An innovative element of this work is the consideration of data quality aspects, a crucial problem for online surveys. To that end, we are able to filter the responses by different degrees of participants'attention based on the time used to respond each of the questions. The results indicate that among the considered post-fire restoration actions, the most valued are those that protect environmental services at risk, especially in protected areas. Our estimates are more consistent when controlling for data quality issues, while WTP estimates are of smaller size.

Valeria M. Toledo-Gallegos, Nguyen Hoang Diem My, Tran Huu Tuan, Tobias Börger
University of Stirling

Valuing ecosystem services and disservices of blue/green infrastructure. Evidence from a choice experiment in Vietnam

This paper examines public preferences for developing sponge parks using blue/green infrastructure in Can Tho city, the biggest and fast-growing city in the Vietnamese Mekong Delta. Particularly, the paper assesses the economic value associated with the provision of a set of ecosystem services (flood control, recreational activities, biodiversity) and ecosystem disservices (pest abundance) provided by blue/green infrastructure using a discrete choice experiment. Results indicated that flood control is the most highly valued ecosystem service, followed by recreation and biodiversity. Household willingness to pay for flood control-related benefits is higher than for the other ecosystem services and disservices. Results further suggest that overlooking the existence of ecosystem disservices generated by the installation of blue/green infrastructure measures, such as sponge parks, could lead to the overestimation of welfare effects. This is the first study to account for the value of potential ecosystem disservices associated with blue/green infrastructure in the context of developing countries. It is suggested that these policies should be designed in a way to strengthen cities' resilience and deliver the conditions needed to improve human wellbeing, while minimising the effects of welfare-reducing elements. Future research conducting environmental valuation studies should integrate both ecosystem services and disservices in order to generate policy recommendations that improve local communities' wellbeing.

Bartosz Bartkowski, Julian R. Massenberg, Nele Lienhoop
Helmholtz Centre for Environmental Research – UFZ,

Between complexity and unfamiliarity: preferences for soil-based ecosystem services

Soils provides multiple benefits for human well-being, which are largely invisible to most beneficiaries. Here, we present the results of a discrete choice experiment into the preferences of Germans for soil-based ecosystem services. To tackle complexity and unfamiliarity of soils, we express soil-based ecosystem service attributes relative to the site-specific potential of soils to provide them. We investigate how knowledge about soils, awareness of their contributions to human well-being and experience with droughts and floods affect the preferences. We find substantial yet heterogeneous preferences for soil-based ecosystem services. Only some measures of familiarity exhibit significant effects on preferences.

Marc N. Conte, Bernardo A. Bastien-Olvera, Frances C. Moore, and Xiaoli Dong
Fordham University

The Value of Species: Understanding Income Effects to Inform Integration of Natural Capital Into Climate Policy

The relative price effect has been shown to have the potential to significantly impact optimal climate policy when market goods and non-market environmental amenities are allowed to be imperfect substitutes. There exists a gap between the substitutability parameters used in theoretical papers to demonstrate the importance of this effect and those calculated in empirical studies based on calculations from existing stated-preference valuation studies. Most of the studies used for these calculations to this point have focused on use values from ecosystem services, which might be expected to have closer substitutes in market goods (e.g., built capital providing substitute ecosystem services) than values for species, which might primarily stem from existence and non-use value. We use a review of 81 stated-preference studies exploring the value of species to develop estimates of the income elasticity of willingness to pay, which is used to calculate values of substitutability parameters in a climate IAM that is modified to better incorporate natural capital. The average value from these studies is 0.65, which is higher than the value used in existing empirical studies exploring the relative price effect. Preliminary results from the modified IAM that employs a nested CES utility function suggest that this change in parameter value has a meaningful impact on the optimal emissions trajectory.

Session 2e - *Sustainable Agriculture*

Germán Sánchez and Montserrat Viladrich Grau
University of Lleida

Farmland economic value and the sustainability of a bird community:
A trade-off quantification for the Lleida Plain

Agricultural intensification has been accompanied by an increment in productivity which is translated into higher economic benefits and food supply. This sector, however, is directly linked with the natural environment and consequently land-use decisions have a clear impact on ecosystem services, including biodiversity. In our work, we propose a spatial landscape optimization model to identify the trade-offs between economic value and habitat suitability scores, solved by the Gurobi optimizer algorithm. We develop an index for species-specific habitat suitability responding to crop selection and intensification. We simulate crop yields under different management regimes considering soil and climate characteristics of each location with the STICS crop growth simulation model. Furthermore, we also account for changes in intensification constraints that allow us to design optimal conservation areas allocation and apply it to Lleida (Spain), where a conflict between agricultural intensification and biodiversity emerged during the last decades - highlighting the importance of steppe birds, whose populations levels have decreased during the last decades through habitat loss -. We find that the aggregate economic value can be significantly increased by reorganizing land uses spatially under the same level of habitat suitability. Also, Pareto improvements are possible by allocating conservation areas optimally.

Lea Nicita and Robert Mendelsohn
European Institute on Economics and the Environment, Italy.

What is the Value of Agrobiodiversity?

This study uses a Ricardian model and agricultural data from five Mediterranean countries to measure the effect of crop cover agrobiodiversity in the landscape on farmland value. We assess the impact of Shannon diversity index and of its components, evenness and richness, at local and regional level. Regional Shannon agrobiodiversity has a convex effect on farmland value. Northern France, Spain, and Italy are better off with little Shannon agrobiodiversity whereas the coastal Mediterranean regions are better off with a great deal of Shannon agrobiodiversity. The result is dominated by the evenness index. Local evenness should be high (low) when regional evenness is low (high). In contrast, richness has a concave effect on farmland value and regional and local richness are substitutes for each other. There is no single best agrobiodiversity policy across Europe. It is important to match agrobiodiversity policy to the conditions in each region.

Jenni Miettinen, Markku Ollikainen, Artti Juutinen, Jouni Siipilehto, Leena Stenberg, Anssi Ahtikoski, Hannu Hökkä, Sakari Sarkkola, Mika Nieminen
University of Helsinki

Strip harvesting in drained boreal peatlands when climate impacts and water quality matter

Pristine boreal peatlands are wet forest sites, where high ground water table limits tree growth. Over time, peatlands have been widely drained for forestry purposes in the boreal zone. Traditional forest management with clear-cuts and ditch network maintenance on drained boreal peatland forests causes nutrient and sediment loads and greenhouse gas emissions from peat soils. There is a need to reduce both water quality and climate externalities this causes to society. In order to reduce the environmental impacts in drained peatland forestry, strip harvesting is studied as an alternative forest management method, because it avoids large clear-cuts, which require ditch network maintenance to maintain water table. Strip harvesting helps to maintain the water table deep enough, but not too deep, to reduce greenhouse gas emissions and water quality impacts relative to the traditional forest management in drained peatland forest management. The economics of strip harvesting in drained peatlands entails maximization of harvest revenue subject to a constraint of keeping the water table at a level which

minimizes adverse environmental impacts. We characterize analytically the optimal harvesting cycle and determination of the strips harvested. A numerical model applied to Finnish forestry produces quantitative assessment on the size of the strips, harvesting cycles, timber yields and harvest revenue. Our results imply that strip harvesting may be less profitable than even-aged forest management in Scots pine stands in Southern Finland.

Salvatore Di Falco, Gemeda Olani and Gunnar Köhlin
University of Geneva, Switzerland

Learning about Sustainability: Experimental Evidence from Ethiopia

We run a field experiment (RCT) to investigate the impact of information delivery on sustainable technology adoption in rural Ethiopia. In particular we test whether the information generates more adoption when presented by a peer farmer. We find that that is indeed the case. Both partial and full adoption practices increase when information about sustainability is provided by another farmer. The results are robust to the inclusion of rainfall variability indicators in impact estimation. Our findings highlight the need for strengthening and targeting direct farmers' learning mechanisms as a conducive conduit for information communication to farmers to improve the uptakes of the adaptation practices, hence aiding farmers to fetch the maximum possible returns due to an implemented adaptation practice.

Tuesday 6th September 1100-1300

Session 3a - *Offsets*

Luc Doyen, Celine Huber, Sylvie Ferrari
CNRS, INSHS

When profitability meets conservation objectives through biodiversity offsets

Biodiversity Offsets (BOs) are increasingly used as economic instrumentsto manage biodiversity and ecosystem services in the context of economic development. This study investigates the sustainability conditions of BOs. It focuses especially on both the timing and pricing of BOs in development-offset projects. To address this issue, a minimal time control model is proposed, allowing a dynamic and multicriteria approach to be combined through both ecological and economic targets. We rely here on No Net Loss (nnl) and positive Net Present Value (npv) goals. In particular, we focus on an offset marginal price, called Offset Sustainability Value (osv), which equalizes the nnl and payback times. We prove analytically how this osv corresponds to a win-win solution in terms of ecological-economic synergy. We also show that this osv can be very high compared to the project rate of return, particularly when the biodiversity loss is high. More globally, a sensitivity analysis shows the extent to which the economic (such as the marginal revenue and discount rate) and biodiversity parameters impact the osv. Finally, a numerical application related to mangroves and aquaculture in Madagascar illustrates the analytical findings. For this case study, we argue that the current BO price is underestimated.

Sophus zu Ermgassen
University of Kent

Evaluating the impact of one of the world's oldest biodiversity offsetting systems on native vegetation

Biodiversity offsetting is an increasingly influential mechanism for reconciling potential trade-offs between land use change and biodiversity loss. However there is little robust empirical evidence on its real-world outcomes. Here we conduct the first quasi-experimental impact evaluation of a state offsetting policy (Victoria, Australia). We use a difference-in-differences framework to evaluate whether changes in woody vegetation cover across 196 offsets implemented between 2006-2008 were different from counterfactual sites between 1998-2018, and means-comparisons to evaluate whether offsets protecting existing native vegetation ("avoided loss") successfully avoided native vegetation clearance over the same time period. We also evaluate differences in the modelled mean vegetation condition between offsets and counterfactuals. We use two equally-justifiable counterfactuals, one using statistical matching on biophysical covariates and another a 'within-sample' approach comparing changes in offsets with changes in land parcels that would themselves in future become offsets, which might partially account for self-selection bias (where landholders opt into the programme who would already be implementing conservation-friendly management practices anyway, undermining offset additionality). The results are sensitive to counterfactual choice. The matching-based counterfactual indicates that offsets successfully increased native vegetation cover (by 2.9% more per year than in counterfactuals) and were associated with higher vegetation condition, but it remains inconclusive whether they prevented native vegetation losses that would otherwise have occurred. The within-sample approach indicates that offsets may have increased native vegetation cover, although the effect size is smaller (1.5% more per year than in counterfactuals). It also indicates offsets did not avoid vegetation losses, and were not associated with higher vegetation condition. The limited public information available on the vegetation losses associated with offsets suggest it is unlikely the policy achieved No Net Loss of woody vegetation. Our results also offer preliminary evidence that self-selection bias might be undermining the outcomes of biodiversity offsetting regulatory markets.

Jussi Lintunen
Natural Resources Institute Finland (Luke)

Mechanisms for Additional Forest Management Carbon Sequestration

In this study we investigate an optimal contract to incentivise additional carbon sequestration under asymmetric information over amenity valuations when the funds for the regulator are limited. We propose a contract consisting of type-dependent rotations and transfers, and characterize the contract under various assumptions about the distribution of valuations. We show first that under the typical monotone hazard rate assumption, the rotations and transfers increase in amenity valuations. Second, we analyse bunching, and show that bunching becomes optimal in a special case, where the amenity valuations are packed around zero. We also perform a quantitative assessment for a boreal forest conditions and different budgets, and show among other things, how the tightening budget will result in bunching, when the budget becomes low enough.

Frank Venmans, Ben Groom
London School of Economics and Political Science.

The social value of offsets

How much carbon should be stored in temporary and risky offsets to compensate an emission of 1 ton of CO2? We show how the Social Value of an Offset (SVO) is
a well-defined fraction of the Social Cost of Carbon which depends on the offset's
expected lifetime, risk of non-additionality and risk of failure. The key insight is that the SVO can be positive because delaying emissions is socially valuable. Offset
projects could therefore be part of ancient net-zero portfolio if their SVO to cost ratio exceeds the benefit-cost ratio of alternative projects. Since many offset projects are not riskless or perpetual, offset suppliers should supply transparent information about the permanence, risk and additionality of their offerings, so that the SVO can be calculated and offsets easily compared. We provide a matrix of risk correction factors to calculate the SVO for this purpose.

Session 3b - ***Planning Resource Management***

Mette Termansen, Raphael Filippelli, Mette Termansen, Berit Hasler, Andreas Holbach, Karen Timmermann, Maria Konrad, Gregor Levin
University of Copenhagen

Integrated environmental-economic modelling for cross sectoral water policy evaluation

The Water Framework Directive (WFD) has set a deadline for 2027 to reach at least good ecological status (GES) in coastal and marine waters in the EU. In this paper, we take an integrated environmental-economic modelling approach to assess alternative strategies to mitigate non-point source pollution. A spatially explicit optimization model, TargetEconN, is implemented at the Danish national scale and extended to include mussel production as a marine mitigation measure. Different eutrophication mitigation strategies investigated in the model are characterized by whether nitrogen emissions are reduced at the source, between the source and the recipient e.g. by establishing wetlands, or in the recipient itself. We run scenarios exploring the uncertainty in baseline load assumptions and the effects of mussel farming. The results show that the potential for marine measures depends on the baseline load assumptions and that marine measures have a limited impact on the overall costs of achieving GES. The results also show that including marine measures has a significant indirect impact through the influence on the spatial distribution of landbased measures. We conclude that including mussel farming in policy initiatives to meet WFD targets has potential, but that the distributional effects across sectors and spillover effects to other policy targets should be a central part of the ex-ante policy discussions. We argue therefore that spatially explicit integrated modelling, as the model developed for this paper, can offer useful insights to manage the unescapable trade-offs in effective policy design to meet the WFD.

Itsaso Lopetegui, Ikerne del Valle
University of the Basque Country

An efficient portfolio approach towards ecosystem-based fisheries governance in EU

In the framework of multispecies fisheries governance, the main objective of this paper is to apply modern portfolio theory (MPT) to the North-East Atlantic European fisheries, including all the key commercial fish species subject to total allowable catches (TAC) and quota regimes within the EU. This is done, first, quantifying the inherent return and risk of the potential fish portfolios and, secondly, estimating an individual constrained financial efficient frontier (FEF) for each of the nine fishing countries in the North-East Atlantic. Unlike previous studies in the field of financial fisheries economics, and due to its major robustness under non-normality and the presence of fat tails, we are using Conditional Value-at-Risk (CVaR) instead of the conventional mean-variance optimization (MVO) as the method to solve the optimization problem of minimizing risk under a set of alternative constraints so as to obtain the respective FEFs. Our results show that changing the species portfolio distribution, it would be possible to improve efficiency, that is to say, to simultaneously get increasing returns and decreasing risk levels. Moreover, this efficiency gain would be compatible with specific quota transfers among fishing countries.

Amelie Luhede, Houda Yaqine, Reza Bahmanbijari, Michael Römer, Thorsten Upmann
Bielefeld University

The value of monitoring information for water quality management

Environmental managers face high degrees of uncertainty when deciding upon management actions. The value of information (VoI) analysis is a tool for assessing the economical benefit of reducing uncertainty. This approach addresses whether or not it is worth to collect more information rather than investing directly into management actions. The acquisition of information through monitoring is essential to evaluate the state of the ecosystem and to decide whether or not policy interventions are necessary. Monitoring activities are at the core of understanding the ecosystem's state and its response to stressors. In this paper, we conduct a VoI analysis to estimate the value of monitoring nitrogen concentrations as a proxy for the ecological status in the Weser River basin in Northern Germany. Our results show that the value of monitoring information is substantially higher than its cost. Furthermore, we identify a significant dependency of VoI on the prior distribution and the cost of management actions: VoI is maximal when

action costs are high and the prior probability of a good ecological status is moderate while low and high cost or prior probabilities both reduce the value of monitoring.

Ian Bateman, Day, B.H., Binner, A., Cho, F.H.T., Collins, R.M., Eisenbarth, S., Fezzi, C., Ferrini, S., Gannon, K., Groom, B., Harwood, A., Hillier, J., Hulme, M., Lee, C.F., Mancini, M., Matthews, R., Morison, J.I.L., Siriwardena, G., Smith, P., Snowdon, P., Vetter, S. and Vinjili, S., Williamson, D.
University of Exeter

How to make decisions! Markets, scenarios and natural capital approaches to land use policy

Agriculture is the main driver of both land use change and associated environmental impact globally, yet the effectiveness of agri-environmental policy depends crucially on whether or not it is targeted to those areas where it will be most beneficial. However, this targeting is overwhelmingly left to "Market Allocation" as governments around the world offer subsidies which are taken up by landowners according to their economic circumstances rather than the environmental outcomes that will be delivered1,2,3. An increasingly popular alternative is the use of "Scenario Analyses" for targeting policy through consultation across stakeholder groups4. More recently this has been supplemented by the use of integrated "Natural Capital" decision support systems, fusing environmental science and data with economic analyses5,6. However, systematic comparison of these three alternative approaches has yet to be undertaken. Here we show that an identical policy objective to generate a set area of land use change from agriculture to forestry, when implemented via these three approaches, resulted in significantly different outcomes in terms of the spatial targeting of planting, environmental consequences, and economic costs and benefits. We find that the integrated science of the Natural Capital approach outperformed its more commonly applied alternatives in terms of both environmental consequences and costs and benefits. Extending this approach also highlighted alternative options for delivering similar net benefits with much lower resource requirements. Our results demonstrate that the way in which a policy is analysed can dominate assessments and the consequences of implementation. The global dominance of Market Allocation approaches, and the inability of Scenario Analyses to adequately correct its failings, means that a switch to a comprehensive Natural Capital approach is an urgent priority given the need to respond to major environmental challenges, such as attaining net zero greenhouse gas emissions7 and bending the curve on biodiversity loss8, which require extensive land use change, generating substantial environmental and economic trade-offs.

Session 3c - ***Tipping Points and Regime Shifts***

Stefan Baumgätner and Michael Stecher *(Presented by M.S. on behalf of S.B.)*
University of Freiburg

With limited power comes limited responsibility: a novel dynamic measure of causation and its implications

Sustainability puts moral obligations on currently living generations to preserve natural systems in a good state for future generations. Since it is a generally accepted ethical principle that one can only be obligated to do what one is able to do, an important question is whether present generations actually have the capacity to cause desired system states over the inherently uncertain long-term future. In addition to the potentially infinite time horizon characteristic for sustainability policy, agents' causal efficacy is limited by complex and stochastic dynamics of many relevant systems. For instance, many ecosystems exhibit tipping points which enable small changes in external forcing or stochastic perturbations to cause dramatic changes in ecosystem structure and functioning that are often difficult or impossible to reverse. To gauge how far causal efficacy extends into the future, we develop quantitative measures for the degree of causation of the state of dynamical systems by different actions. In particular, we generalise the concept of partial causal responsibility to deterministic and stochastic dynamical systems. We find that the time path of causal responsibility varies substantially both across different types of systems for comparable actions and across different types of actions within the same system. Our results indicate that some norms may be inconsistent with actors' capacity to cause a particular system state in the future, which has important implications for sustainability policy.

Daniele Rinaldo and Neha Deopa
University of Exeter

Scenes from a Monopoly: Quickest Detection of Ecological Regimes

Decisions under ecological uncertainty are a crucial part of resource management as ecological systems often undergo abrupt regime shifts, frequently triggered by the actions of economic agents. We study the stochastic dynamics of a renewable resource extracted by a monopolist whose actions affect the resource's regeneration, resulting in sequential regime shifts. The firm faces further uncertainty in the timing of these shifts. We encapsulate in our model environmental surveillance of ecological dynamics where the firm has to find the profitmaximizing extraction policy while simultaneously detecting in the quickest time possible the change in regime. We characterize the detection procedure as an optimal stopping problem. We provide the conditions that determine whether a regime shift can lead to both aggressive and precautionary extraction policies. We show the potential emergence of catastrophic risk and prove Pareto optimality of the detection procedure. We apply this framework to the case of the Cantareira water reservoir in São Paulo, Brazil, and the events that led to its catastrophic depletion and the consequent water crisis.

Frikk Nesje, Florian Diekert, Daniel Heyen, and Soheil Shayegh
University of Copenhagen and CESifo Research Network

Early warning of tipping points improve management but may encourage risk taking

We study how receiving early warning signals (EWS) of tipping improves ecosystem management. Many socio-ecological systems are expected to collapse once pressure exceeds a tipping point. A fundamental problem is that the location of tipping points is almost always unknown. We take a stylized ecosystem model with an unknown tipping point that produces EWS. We then demonstrate the necessary steps to utilize EWS and show why this improves ecosystem management. We uncover the tension between better information and increased risk, highlighting that EWS may increase the risk of collapse, even in managed systems. Our study offers a first step and a framework to complement the emerging knowledge on detecting EWS with a better understanding of how, when, and why EWS improve management.

Michael Stecher, Stefan Baumgärtner, Christian Möllmann, Martin Quaas
University of Freiburg

Catastrophic shifts in the Western Baltic Sea - who's responsible?

The Western Baltic cod stock has recently crossed a tipping point towards a low productivity state, which has ecological, economic, and social consequences. Overfishing and climate change have been the main drivers of this regime shift, but other factors, including stochastic influences, likely played a role as well. Here, we quantitatively measure the degree to which each of these factors is causally responsible for tipping the Western Baltic cod stock into its current state. Specifically, we calibrate a generic model of a stochastic ecosystem with alternative stable states to the Western Baltic Sea. We then calculate how the different factors have modified the probability of regime shift over time and attribute causal responsibility using the established concept of partial responsibility in a stochastic system. Knowing the degree to which different factors have caused the regime shift of Western Baltic cod provides valuable information to fisheries management about the potential to tip the stock back into a more sustainable state. Our analysis also provides insights to the related questions of who is to blame for triggering the undesired regime shift and who is to be held accountable for its consequences.

Session 3d - ***Valuation - Revealed Preferences***

Yacouba Kassouri, Jasper Meya and Martin Quaas
German Centre for Integrative Biodiversity Research (iDiv)

Well-being and the Environment: A two-step approach to value multiple, spatially-heterogeneous public goods

This study advances the state-of-the-art of integrating welfare analysis models and non-tradable valuation models to address the need for the valuation of multiple public goods subject to substitutability relationships and heterogeneity in their level of provision across income gradients. As a result, we offer a two-step valuation methodology to assess the shadow price for multiple and spatially heterogeneous environmental goods, including both biodiversity and landscape attributes. For an empirical illustration, we use a 10-year panel data on 294 urban and rural major counties (landkreise) in Germany. Improving upon the shortcomings of former studies, our identification approach relies on panel fixed effect and instrumental variable strategies, using spatial patterns of household income belonging to the same state as exogenous shocks to local income. The results reveal a substantial social demand for bird species richness as captured by its highest shadow price (5eper population of species) among the underlying attributes. We identify substitutability relationships among amenities and ecosystem services provided by natural protected areas and green spaces. Omitting this substitution effect under independent valuation of each attribute tends to overestimate their social values. Consequently, we establish that non-market values of both natural protected areas and green spaces could evolve in a decreasing fashion depending on their level of provision and changes in the evolution of their substitutes. Furthermore, we demonstrate that there is a much clearer signal for the luxury effect on the provision of natural protected areas and bird species richness as their shadow prices are relatively higher in high-income geographic areas. This is reflective of environmental injustice as social welfare benefits associated with these attributes are not equitably shared across German counties.

Maria Teresa Gonzalez Valencia, David Maddison and Allan Beltrán
University of Birmingham

The Near-Miss Effect of Forest Fires: Evidence from Western Australia

Using the hedonic price technique, we identify the near-miss effect of the Waroona Fire in Western Australia (WA) in 2016. Our strategy for identification relies on the use of difference-indifferences. The dataset includes more than 51,000 property transactions from the Peel and South West regions in WA for the period of 2010 to 2019. Compared to existing hedonic analyses of the impact of forest fires, uniquely we distinguish between near-miss areas that received warnings and areas that were merely close to the burn scar. Our findings suggest that the proximity treatment effect is positive, whereas the warning treatment effect is negative. We argue that the proximity treatment effect is an impure near-miss effect that entangles a positive risk reduction effect from burnt fuel and a disamenity impact from the burnt landscape.

Yacov Tsur, Aliza Fleischer and Yadin Gindin
The Hebrew University of Jerusalem

Freshwater Ecosystem Services within a Dynamic Water Economy Framework

In this work we formulate the economic values of ecosystem services (ESS) generated by natural water (freshwater) within a dynamic water economy framework and investigate their impacts on optimal water allocation policies. A distinction is made between flows (streams, rivers) and stocks (lakes, swamps, reservoirs), accounting for the different ESS generated by each source of surface water, and the indirect contributions of groundwater to ESS are incorporated. The recreational ESS values are estimated for Israel's water economy and used in a numerical example to demonstrate possible effects on optimal water allocation policies. We find that accounting for these ESS leads to doubling the allocation of instream water for environmental purposes compared to the situation in which they are ignored.

Allan Beltrán, Owen Lloyd and David Maddison
University of Birmingham

The Disamenity Impact of Anaerobic Digestion

Unlike other forms of renewable energy, biogas is dispatchable and storable. As such, it has an important role to play in achieving net zero carbon emissions in both the UK and elsewhere. Anaerobic digestion is however not wholly free of disamenity impacts, there are concerns about the odour from such facilities as well as other forms of impacts. Using a repeat sales approach, we analyse the effect of anaerobic digestion plants in England and Wales on property transactions covering the period January 1995 to March 2020. These plants vary greatly in terms of scale and the feedstock they utilise. Using detailed information on the inputs and outputs of such facilities combined with information on prevailing wind patterns we find that there is a significant difference between the results for anaerobic digestion plants that utilise exclusively agricultural inputs from those that utilise non-agricultural inputs where the disamenity impacts are much more apparent. These impacts depend on both distance from the site and whether a property is immediately downwind. Our results strongly support the idea that odour is indeed a problem. We believe that whereas operations utilising agricultural inputs might lessen disamenity impacts, activities involving non-agricultural inputs worsen localised environmental impacts.

Session 3e - ***Environmental Market Design***

Frank Wätzold, Gerling, C., Drechsler, M., Keuler, K., Leins, J.A., Sturm, A.,.
Brandenburg University of Technology Cottbus- Senftenberg

Flexibility of policy instruments for cost-effective biodiversity conservation under climate change: land purchase versus conservation contracts

Under climate change, current conservation efforts may become less cost-effective as both the effectiveness and costs of conservation sites and measures may change. Flexible conservation policy instruments that allow for the adaptation of conservation measures ("local flexibility") and sites ("spatial flexibility") may therefore improve the cost-effectiveness of conservation under climate change. However, trade-offs between local and spatial flexibility may exist depending on the policy instrument. Here, we analyse land purchase (high degree of local flexibility, limited spatial flexibility) and long-term individual conservation contracts (medium degree of local and spatial flexibility). We develop a climate-ecological-economic model further by considering the different degrees of flexibility of the two policy instruments and myopic decision-making based on imperfect information. We apply the model to the conservation of the large marsh grasshopper on agricultural grasslands in a case study area and consider climate scenarios RCP4.5 and RCP8.5. In the case study, land purchase has a higher cost-effectiveness than conservation contracts if the conservation agency is able to generate profits from extensive land use. However, when the agency is not able to generate full profits, transfers to farmers under land purchase make conservation contracts more cost-effective. Local flexibility only plays a small role in the case study, but spatial flexibility is important when the available budget is small and only allows for small extensions of the conservation network to adapt to climate change. Ecological spillover effects increase with the size of the conservation network. Finally, we find that conservation contracts based on myopic decision-making may lead to unexpected transfers but may also represent an "insurance" against increasing harvest volatility under uncertain climate change.

Martin Drechsler
Helmholtz Centre for Environmental Research

Improving models of coordination incentives for biodiversity conservation by fitting a multi-agent simulation model to a lab experiment

Coordination incentives (CI) like the agglomeration bonus that reward the spatial agglomeration (or other spatial patterns) of biodiversity conservation measures are gaining increasing attention. Experiments on CI, accompanied by statistical analyses, reveal insights into the behaviour of human subjects. However, the scope of statistical models is limited and one may, as in other sciences like physics or ecology, gain additional insights by fitting mechanistic process models to the experimental data. I present the first application of this type in the context of CI and fit a multi-agent simulation model to a seminal experiment of the authors of the agglomeration bonus. Comparing two basic approaches for the decision making of the model agents, reinforcement learning and using expectations of the future, reveals that the latter is much better able to replicate the observations of the experiment. Improved models of agent behaviour are indispensable in the modelling and development of effective and cost-effective CI for the conservation of biodiversity.

Zhaoyang Liu, Simanti Banerjee, Timothy N. Cason, Nick Hanley, Qi Liu, Jintao Xu, Andreas Kontoleon
University of Cambridge

Spatially coordinated conservation auctions: a framed field experiment

This paper presents a framed field experiment study on a spatially coordinated (SC) auction mechanism for the allocation of agri-environmental contracts, which pay farmers to change their agricultural practices as a means to provide environmental benefits. The SC auction is designed to maximise a metric of environmental benefit which depends both on site-specific environmental values and benefits due to spatial coordination of conserved patches, subject to a budget constraint. We investigate whether the performance of such a SC auction can be improved by the introduction of agglomeration bonus (AB) and joint bidding (JB) mechanisms. The AB in this study is a bonus payment awarded to neighbouring farmers

who bid individually but receive agri-environmental contracts simultaneously. The JB mechanism allows neighbouring farmers to bid jointly and provides a bonus payment for successful joint bids. We conducted experimental SC auctions with a total of 432 Chinese farmers divided equally into 72 auction groups. These auction groups were randomly assigned to one of four treatment arms which differed in whether the AB and JB mechanisms were adopted, following a two-by-two full factorial experimental design. Our empirical results suggest that the SC auction has similar environmental performance no matter whether an AB is provided or not, although the cost-effectiveness is slightly higher when AB is not provided. Moreover, introducing the JB mechanism into the SC auction leads to lower environmental performance and lower cost-effectiveness, in contrast to the lab-based findings of Banerjee et al (2021).

David Simpson, Stephen C. Newbold
American University

Allocating 'nonuse rights' for natural resources: when do markets improve efficiency?

Many natural resources are allocated using market mechanisms: individual transferable quotas are assigned in fisheries, ranchers bid for grazing rights, and hunters purchase permits to take game animals. In most cases a "cap" is first set to determine the allowable quantity of harvest, then permits are auctioned to, or can be traded among, participants. The cap may be set by consultation among scientists and/or civil society. But what if, when the cap has been set, conservationists would be willing to pay more for a permit than would resource extractors? This is not allowed in many natural resource permit markets. A recent Policy Forum contribution in Science argues that conservationists should be allowed to bid for "nonuse rights." Economists often tout the efficiency of competitive markets. Allowing more competition in resource markets might make them more efficient. A couple of concerns may arise, however. Fishers, ranchers, and hunters bid for rights in rival and excludable goods. Nonuse rights are nonrival and nonexcludable. Hence free-riding problems may arise. The cap set under a cap-and-trade program addresses these concerns. If conservationists are allowed to bid for nonuse rights, however, should some fraction of resource stocks still be set aside? In this paper we contrast outcomes in which conservationists may bid against extractors in permit markets with no caps to those in which they lobby against extractors to set caps, but then do not bid for permits. We highlight three results. First, less free-riding among conservationists may result in better outcomes for them under bidding. Heuristically, the less free-riding there is, the less intense is competition and hence, the lower the cost of conservation. Second, conservationists might prefer accepting the cap determined by lobbying to the result of bidding. Lobbying may mute competition and so reduce costs vis a vis bidding. Finally, lobbying might result in more conservation and, under some circumstances, lobbying could result in the efficient level of conservation despite free-riding. Our results arise from simple models chosen for their tractability rather than their generality or realism; we cannot claim they are robust. By the same token, however, they illustrate intriguing possibilities and potential pitfalls. The Policy Forum article is a timely contribution to an important public policy debate. We join with its authors in calling for additional research to determine when and how bidding in nonuse rights should be implemented.

Tuesday 6th September 1545-1715

Session 4a - *Energy*

Charlotte Geiger, Paul Lehmann, Philip Tafarte, Elisabeth Wolfram
Leipzig University

Wind Power Development in Germany: Spatial Planning Instruments and Externality Trade-offs

By 2030, the German government aims at producing 80% of gross electricity consumption from renewable energies [1]. To reach this goal, a substantial expansion of wind power production onshore is necessary. Yet, while wind power production reduces carbon dioxide emissions in the power sector, wind turbines may also excert negative externalities for humans and nature. For example, turbines can be associated with noise emissions, reduced landscape quality or negative effects on wind power sensitive bird and bat species [2]. The level of these effects varies at a spatial scale, e.g. due to different levels of scenic quality or bird habitat quality [3,4]. To reduce the negative externalities from wind turbines, the selection of areas for wind power development is usually governed by spatial planning tools, such as distance regulations or the exclusion of specific areas. In Germany, for example, depending on the federal state of interest, wind power development is restricted in forest areas or at certain distances to settlements. While such spatial planning tools can be very effective in reducing the level of individual externalties, they typically do not account for changes in the level of other exteranlities that they provoke. In a spatial context, this aspect is especially relevant when it comes the the above described externalities. For example, excluding forest areas from wind power development can imply that instead, wind turbines need to be installed closer to settlements, thereby increasing associated negative effects for residents. In addition, the combined effect of individual spatial planning policies on the overall availability of area for wind power development can be critical when specific expansion targets are in place. Against this background, we analyse the externality trade-offs from wind power development for different spatial planning policy scenarios in Germany. We quantify the trade-offs between the levels of different externalities that are associated with spatial planning tools targeted at indivudal externalities only, with and without a power production target in place. Likewise, we quantify the combined effect of all spatial planning tools considered on the availability of area for and the generation potential from wind power deployment and on the average levelized cost of electricity (LCOE) generation for a specific production target.

Paul Lehmann, Philip Tafarte
University of Leipzig and Helmholtz Centre for Environmental Research – UFZ

The opportunity cost of binary land-use restrictions for renewable energy deployment

Binary land-use restrictions are a common policy to address environmental impacts of human land-use, including the deployment of renewable energy sources. While binary land-use restrictions may provide environmental benefits, they may also bring about opportunity costs if production is shifted to more costly sites. This paper aims to understand and quantify the drivers determining the opportunity costs related to land-use restrictions. Using a simple analytical model, we propose that opportunity costs can be decomposed into a scope and a structure effect. The scope effect arises because banning production on some sites may imply that production is expanded on eligible sites to compensate for the ban. Even if eligible and banned sites have the same cost structure, opportunity costs will rise because production costs move up the marginal cost function on eligible sites. In addition, a structure effect will occur if the structure of cost function varies between banned and eligible sites. If marginal costs are generally higher (lower) on eligible sites than on banned sites, opportunity costs are aggravated (mitigated). Subsequently, we provide numerical illustration using the example of banning wind power deployment from forests in Germany. Our numerical results

suggest that a forest ban primarily produces opportunity costs in terms of increased disamenity costs for local residents as well as higher impacts on wind-power sensitive birds. In contrast, opportunity costs in terms of generation costs, impacts on landscape aesthetic quality and ecological conflict risks are likely small. The main driver behind the opportunity costs observed in our analysis is the scope effect. The structure effect is negative for all cost criteria considered and therefore mitigates total opportunity costs.

<u>Session 4b</u> - ***Blue biodiversity - supporting sustainable development, marine conservation and restoration (By Carlo Fezzi & Tiziana Luisetti)***

Carlo Fezzi, Derek J. Ford, and Kirsten L.L. Oleson
University of Trento

The economic value of coral reef restoration in the face of climate change

We develop a travel-cost random utility model to estimate the value of recreational ecosystem services provided by more than 170 outdoor sites located on the island of Maui (Hawaii, USA). Particular emphasis is placed on the role of coastal ecosystems by combining recent fine-scale data on coral cover and fish biomass with information on almost 3000 recreation trips taken by Maui's residents. Our approach is grounded in economic theory and provides estimates that are directly applicable to inform a wide array of spatial planning questions for coastal management. We apply our model to calculate the economic losses caused by the 2014-2015 coral bleaching event, which are in the order of $25M per year. We also identify the areas where coral reef restoration would maximize welfare gains. Impacts can vary up to a factor of 1000 across locations, demonstrating the need to carefully consider such heterogeneity in spatial prioritization. Our simulations also show how access fees can raise funds for financing conservation measures aimed at bolstering coral reefs resilience to climate change.

Luke Brander, Florian Eppink, Christine Madden Hof, Joshua Bishop, Kimberley Riskas,Victoria Guisado Goñi, Lydia Teh, Louise The
Vrije Universiteit Amsterdam

Turtle Economic Value: Estimating the non-use value of marine turtles in the Asia-Pacific region

Marine turtle species in the Asia-Pacific region face loss of habitat, population decline and serious risk of extinction. Understanding the associated loss in human welfare can motivate conservation finance, policy reforms and other actions to protect and restore marine turtle populations. This paper estimates non-use values for marine turtles in the Asia-Pacific region using a large-sample (n=7,765) global household survey. The survey focused on six countries in the region (China, Fiji, Indonesia, Malaysia, the Philippines and Vietnam) and received responses from over 80 countries in total. A discrete choice experiment is used to elicit willingness-to-pay (WTP) for marine turtles, defined in terms of population trends (increasing, stable or declining) and species diversity (avoided extinctions). We find that a high proportion of households (82%) expressed a positive WTP for turtle conservation, and that the donation amounts are substantial. The median WTP for ensuring stable marine turtle populations, adjusted for demographic differences between the survey sample and the general population, is estimated at US $79 per household per year. A scenario analysis is used to estimate the economic welfare changes that would result from policy inaction (in which turtle populations continue to decline and two species become extinct) versus strong policy action (resulting in increasing turtle populations and no extinctions). The annual economic welfare loss that results from not acting is estimated to be US $40 billion, whereas the potential welfare gain from taking policy action to conserve, manage and protect marine turtles is estimated at US $55 billion. These results present a strong economic justification for governments in the region to align environmental policies and budgets with Asia-Pacific peoples' stated WTP for turtle conservation.

Tiziana Luisetti and Lisa Benson
Fisheries and Aquaculture Science

Blue carbon: an opportunity for a 'new normal' sustainable economic growth.

Following the Covid-19 pandemic, an increasing number of countries around the globe have been considering following a different economic growth path for their recovery than the traditional economic development path in Western countries. Blue carbon ecosystems (mangroves, seagrasses,

and saltmarshes) provide a range of ecosystems services: regulating (climate mitigation and adaptation); provisioning (food such as fish) and cultural (nature enjoyment through tourism). Small Islands Developing States (SIDS) are particularly rich of these ecosystems on which their lives depend upon. Here, we investigate how a new sustainable economic growth may be achieved conserving blue carbon ecosystems within a framework of a blue economy. We have reviewed the policy, financial and market instruments currently available to support the conservation of blue carbon ecosystems and their biodiversity investigating how this may incentivise a new sustainable blue economy (e.g. creating new jobs). We find that SIDS already lead worldwide on blue economy as wells as blue carbon conservation and enhancement. Although still lots needs to be done to reduce the uncertainties in science and economic estimates to include mangroves and seagrasses in policy instruments like the Nationally Determined Contributions (NDCs), we argue that marine natural capital/ecosystem accounting can help coastal states worldwide to overcome the evaluation and monitoring issues needed to shape a 'new normal' economic growth.
