WAGENINGEN UNIVERSITY & RESEARCH

iDiv German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig

Netherlands Environmental Assessment Agency

UNIVERSITY OF CAMBRIDGE

Federal Ministry of Education and Research

BIOECON XXI:
The 21st Annual BIOECON Conference

Inequality and poverty in biodiversity conservation and natural resource management

11-13 September 2019, Wageningen University, The Netherlands

CONFERENCE BOOK

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Welcome Message

Dear colleagues,

We want to give you a warm welcome to Wageningen! Many of you are regular BIOECON attendees, and it is now time to (finally!) bring BIOECON to Wageningen. Achieving economic development that is both environmentally sustainable and socially equitable is one of the key challenges of the 21st Century. Economic development should reduce poverty, enhance food security, and generate a sustainable foundation for future wealth creation. The mission of the Section Economics in Wageningen is to provide a better understanding of the economics of sustainable and equitable development. This is a goal we share with the BIOECON community, which is why we are excited to host BIOECON 21. We look forward to exchanging ideas and learning from each other.

Once again, welcome to Wageningen!

Erwin Bulte

Chair of the Section of Economics of Wageningen University

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BIOECON XXI: The 21st ANNUAL BIOECON CONFERENCE

Inequality and poverty in biodiversity conservation and natural resource management

11-13 September 2019, Wageningen University,

The Netherlands

Programme

WEDNESDAY 11 SEPTEMBER	DAY 1: THURSDAY 12 SEPTEMBER		DAY 2: FRIDAY 13 SEPTEMBER	
18.00-20.30 REGISTRATION AND WELCOME DRINKS including a simple buffet-style dinner *Loburg Café*	8.00 - 8.45	Registration		
	8.45 - 9.00	Welcome Address	8.45 - 9.00	Final Announcements
	9.00 - 10.00	Keynote lecture **Marten Scheffer**	9.00 - 10.00	Keynote lecture **Katharine Sims**
	10.00 - 10.30	Coffee break	10.00 - 10.30	Coffee break
	10.30 - 12.30	Parallel Sessions A1 - A4	10.30 - 12.30	Parallel Sessions D1 - D4
	12.30 - 13.30	Lunch	12.30 - 13.30	Lunch
	13.30 - 15.30	Parallel Sessions B1 - B4	13.30 - 14.30	Parallel Sessions E1 – E4
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	16.00 - 17.30	Parallel Sessions C1 – C4	15.00 - 16.30	Parallel Sessions F1 – F3
	17.30 - 18.00	Information Dasgupta Review Call for Evidence	16.30 - 17.30	Closing drinks
	17.30 - 18.30	BIOECON internal meeting		
	18.15 - 19.00	Pre-dinner drinks		
	19.00 - 22.00	Conference dinner		

WEDNESDAY 11 SEPTEMBER 2019

18:00 – 20:30 Registration and welcome drinks including a simple buffet-style dinner *Loburg Café*

THURSDAY 12 SEPTEMBER 2019

8:30 – 8:45 Registration *Lounge WICC*

8:45 – 9:00 Welcome Address *Haakzaal*

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9:00 – 10:00 Keynote lecture Marten SCHEFFER *Haakzaal*
Dominance by a few, what does it do?

10:00 – 10:30 Coffee break *Lounge WICC*

10:30 – 12:30 PARALLEL SESSIONS A1 – A4

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Discounting: Accounting for ecosystem services.

Chair: Gusta RENES, PBL Netherlands Environmental Assessment Agency

Moritz A. DRUPP, University of Hamburg, Germany
Relative Prices and Climate Policy: How the Scarcity of Non-Market Goods Drives Policy Evaluation
Discussant: Jetske Bouma (PBL Netherlands Environmental Assessment Agency)

Aart DE ZEEUW, Tilburg University, the Netherlands
Discounting in the Presence of Scarce Ecosystem Services
Discussant: Herman Vollebergh (PBL Netherlands Environmental Assessment Agency)

Xueqin ZHU, Wageningen University, the Netherlands
Empirical evidence for time-declining social discount rates: the role of intermediate ecosystem services in production
Discussant: Bert Hof (PBL Netherlands Environmental Assessment Agency)

10:30 – 12:30 PARALLEL SESSION A2 – Field experiments *Roghorstzaal*

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Sandra ROUSSEAU, KU Leuven, Belgium
Country borders and the value of scuba diving in an estuary: The case of the Oosterschelde
Discussant: Francisco Alpízar

Francisco ALPÍZAR, Wageningen University, the Netherlands
Input Efficiency as a Solution to Externalities: engineers vs behavioral scientists in a randomized controlled trial
Discussant: Adriana Bernal-Escobar

Adriana BERNAL-ESCOBAR, University of Osnabrück, Germany
Spillover effects from mixing conservation policies in neighboring areas: Evidence from a field experiment in Colombia
Discussant: Andreas Kontoleon

Emma WIIK, Bangor University, UK
Mechanisms and impacts of an incentive-based conservation scheme: evidence from a Randomized Control Trial in Bolivia
Discussant: Sandra Rousseau

10:30 – 12:30 PARALLEL SESSION A3 – Fisheries *Tarthorstzaal*

Chair: Luc DOYEN

Benjamin BLANZ, University of Hamburg, Germany
Three Types of Interaction in Multi-Species Fisheries and When They Need to be Considered
Discussant: Irmelin Slettemoen Helgesen

Irmelin SLETTEMOEN HELGESEN, Norwegian University of Science and Technology (NTNU), Norway
ITQs, Market Power and the Potential Efficiency Loss
Discussant: Luc Doyen

Luc DOYEN, University of Bordeaux, France
Risk averse policies foster bio-economic sustainability in mixed fisheries
Discussant: Benjamin Blanz

10:30 – 12:30 PARALLEL SESSION A4 – Agricultural Systems I *Peppelzaal*

Chair: Ludovic BEQUET

Zachary S. BROWN, North Carolina State University, USA
Willingness-to-Pay Effects of Gene Drive Insect Use for Agricultural Pest Management in Diverse U.S. Market Applications
Discussant: Margaux Lapierre

Margaux LAPIERRE, University of Montpellier, France
Improving Farm Environmental Performance through Technical Assistance: Empirical Evidence on Pesticide Use
Discussant: Nonka Markova Nenova

Nonka MARKOVA-NENOVA, Brandenburg University of Technology Cottbus-Senftenberg, Germany
Cost-effectiveness, Distributional Impacts and Regionalization in Agri-Environment Scheme Design. A case study of a Grassland Scheme in Saxony, Germany
Discussant: Ludovic Bequet

Ludovic BEQUET, University of Namur, Belgium
Agricultural Practices and Environmental Degradation - The Case of GM Corn in the Philippines
Discussant: Zachary Brown

12:30 – 13:30 Lunch *Restaurant WICC*

13:30 – 15:30 PARALLEL SESSIONS B1 – B4

13:30 – 15:30 PARALLEL SESSION B1 – Games *Haakzaal*

Chair: Erik ANSINK

Olli TAHVONEN, University of Helsinki, Finland
Optimal and Markov-perfect Nash equilibria in harvesting age-structured populations
Discussant: Adam Lampert

Adam LAMPERT, Arizona State University, USA
When establishing a common environmental project, countries that benefit less may need to contribute more
Discussant: Pauli Lappi

Pauli LAPPI, CMCC Foundation, Italy
Lobbying and environmental policy instruments
Discussant: Erik Ansink

Erik ANSINK, VU University Amsterdam, the Netherlands
Common pool resources: Is there support for conservationists?
Discussant: Olli Tahvonen

13:30 – 15:30 PARALLEL SESSION B2 – Lab in the field experiments *Roghorstzaal*

Chair: Christian KÖNIG-KERSTING

Michael BROCK, University of East Anglia, UK
The Can Challenge: Exploring the Best Way to Incentivise Pro-Environmental Behaviour
Discussant: Tum Nhim

Tum NHIM, Wageningen University, the Netherlands
Endogenous institutions and cooperation in natural resource governance: insights from an economic experiment in Cambodia
Discussant: Zachary Brown

Zachary S. BROWN, North Carolina State University, USA
Prices, Peers, and Perceptions: Field experiments on improved cookstove adoption in Ghana
Discussant: Christian König-Kersting

Christian KÖNIG-KERSTING, Heidelberg University, Germany
The nature of experience
Discussant: Mike Brock

13:30 – 15:30 PARALLEL SESSION B3 – Carbon, Climate, Ecosystems *Tarthorstzaal*

Chair: Martin DRECHSLER

Matthew AGARWALA, University of Cambridge, UK
Carbon Accounts for Measuring Sustainability under Globalization
Discussant: Elena Lagomarsino

Elena LAGOMARSINO, University of Genova, Italy
Ecosystem accounts for Marine Protected Areas: A proposed framework
Discussant: Sergei Schaub

Sergei SCHAUB, ETH Zürich, Switzerland
Species diversity-income relationship under increasing drought risk
Discussant: Martin Drechsler

Martin DRECHSLER, Helmholtz Centre for Environmental Research, Germany
The value of flexibility in conservation management in the face of climatic uncertainty
Discussant: Matthew Agarwala

13:30 – 15:30 PARALLEL SESSION B4 – Agricultural systems II *Peppelzaal*

Chair: Maria NARANJO BARRANTES

Guangcheng REN, Wageningen University, the Netherlands
The economic and environmental performance of farms: The impact of migration
Discussant: Paul Hofman

Paul HOFMAN, Wageningen University, the Netherlands
Local Economy effects of Large-Scale Agricultural Investments
Discussant: Maria Naranjo Barrantes

Maria NARANJO BARRANTES, Wageningen Economic Research, the Netherlands
Testing conditional cooperation: Local participation of farmers in agricultural cooperatives
Discussant: Guangcheng Ren

15:30 – 16:00 Coffee break *Lounge WICC*

16:00 – 17:30 PARALLEL SESSIONS C1 – C4

16:00 – 17:30 PARALLEL SESSION C1 – Special session sponsored by MarEEshift *Haakzaal*
Marine ecological-economic systems: Shifting the baseline to a regime of sustainability

Chair: Martin QUAAS

Stefan BAUMGÄRTNER, University of Freiburg, Germany
Responsibility for regime shifts in ecological-economic systems
Discussant: Thang Dao

Thang DAO, IBG Berlin, Germany
Regulating mixed commercial-recreational fisheries
Discussant: Martin Quaas

Martin QUAAS, Leipzig University, Germany
Harvesting efficiency and welfare in restricted open-access fisheries
Discussant: Stefan Baumgärtner

16:00 – 17:30 PARALLEL SESSION C2 – No session

16:00 – 17:30 PARALLEL SESSION C3 – Forestry *Tarthorstzaal*

Chair: Charles PALMER

Mandy MALAN, Wageningen University, the Netherlands
Can conservation be pro-poor? Evidence from an impact evaluation of a REDD+ program in Sierra Leone
Discussant: Tung Nguyen Huy

Tung NGUYEN HUY, Tilburg University, Netherlands
Combatting forest fires in arid Sub-Saharan Africa: Quasi-experimental evidence from Burkina Faso
Discussant: Charles Palmer

Charles PALMER, London School of Economics and Political Science (LSE), UK
Participatory policy approaches and cooperation in forest commons: Experimental evidence from Program Bolsa Floresta in Brazil
Discussant: Mandy Malan

16:00 – 17:30 PARALLEL SESSION C4 – Valuation and Time *Peppelzaal*

Chair: Eli FENICHEL

Masayuki SATO, Kobe University, Japan
Valuation and Discounting of Forest Ecosystem Services
Discussant: Eli Fenichel

Eli P. FENICHEL, Yale University, USA
Wait for it: Valuing natural capital when management is dominated by periods of inaction
Discussant: Masyuki Sato

17.30 - 18.00 Information session Dasgupta Review Call for Evidence *Haakzaal*

The secretariat of the Dasgupta Review on the Economics of Biodiversity, led by Professor Sir Partha Dasgupta, has launched a Call for Evidence asking for the latest evidence and strongest case studies on biodiversity and ecosystem services, the relationship between biodiversity and economic prosperity, causes of biodiversity loss, and actions to tackle biodiversity loss.

In this session, via a video link, the secretariat will give a brief overview of the Call for Evidence and instructions on how to submit responses, and answer questions.

17.30 - 18.30 BIOECON internal meeting *Roghorstzaal*

18.15 - 19.00 Pre-dinner drinks *Restaurant WICC*

19.00 - 22.00 Social dinner *Restaurant WICC*

FRIDAY 13 SEPTEMBER 2019

8:45 – 9:00 BIOECON Announcements *Haakzaal*

9:00 – 10:00 PLENARY SESSION 2

9:00 – 10:00 Keynote lecture Katharine SIMS *Haakzaal*
From Forest Frontiers to Landscapes of Opportunity

10:00-10:30 Coffee break *Lounge WICC*

10:30 – 12:30 PARALLEL SESSIONS D1 – D4

10:30 – 12:30 PARALLEL SESSION D1 – Natural Capital *Haakzaal*

Chair: Stuart WHITTEN

Sturla F. KVAMSDAL, SNF – Centre for Applied Research at NHH, Norway
Ecosystem wealth in the Barents Sea
Discussant: Jasper Meya

Jasper N. MEYA, University of Oldenburg, Germany
Inter- and Intragenerational Distribution and the Valuation of Natural Capital
Discussant: Rintaro Yamaguchi

Rintaro YAMAGUCHI, National Institute for Environmental Studies, Japan
Discounting, inclusive wealth and sustainability
Discussant: Stuart Whitten

Stuart WHITTEN, CSIRO Land and Water, Australia
Natural capital and native grazing pastoral systems in Australia: A tale of the north and south
Discussant: Sturla Kvamsdal

10:30 – 12:30 PARALLEL SESSION D2 – Choice experiments II *Roghorstzaal*

Chair: Anna-Kaisa KOSENIUS

Margrethe AANESEN, UiT - Arctic University of Norway, Norway
Do we choose differently after a discussion? Results from a deliberative valuation study in Ireland
Discussant: Zhaoyang Liu

Zhaoyang LIU, University of Glasgow, UK
Effects of air pollution on Beijing residents' willingness to pay for green amenities
for green amenities
Discussant: Eiichiro Nishizawa

Eiichiro NISHIZAWA, Hosei University, Japan
Preferences for result-based agri-environmental measures: a choice experiment study with Japanese farmers
Discussant: Anna-Kaisa Kosenius

Anna-Kaisa KOSENIUS, University of Helsinki, Finland
Private forest owners' interest in forest conservation programs – analysis of motivation and preference heterogeneity
Discussant: Margrethe Aanesen

10:30 – 12:30 PARALLEL SESSION D3 – Valuation of ecosystem services *Tarthorstzaal*

Chair: Ernst-August NUPPENAU

Liselotte HAGEDOORN, VU University Amsterdam, the Netherlands
Ecosystem-based adaptation as a means to support the vulnerable: evidence from Central Vietnam
Discussant: Frits Bos

Frits BOS, CPB Netherlands Bureau for Economic Policy Analysis, the Netherlands
Biodiversity in the Dutch practice of cost-benefit analysis
Discussant: Shiri Zemah Shamir

Shiri ZEMAH SHAMIR, School of Sustainability IDC Herzliya, Israel
Economic valuation of the ecosystem services in the Israeli Mediterranean
Discussant: Ernst-August Nuppenau

Ernst-August NUPPENAU, Justus Liebig-University, Germany
Community Valuation of Eco-System Services as Social Capital Creation: On Joint Participation in Farming System, Landscape and Project Analysis
Discussant: Liselotte Hagedoorn

10:30 – 12:30 PARALLEL SESSION D4 – Special session: EU BioMonitor Project Session *Peppelzaal*

Chair: Hans VAN MEIJL, Wageningen Economic Research and Wageningen University, the Netherlands

In this session we provide an overview on how the EU Bioeconomy Strategy incorporates the global challenges and how this can be translated into a measurement and monitoring strategy. The theoretical model will be presented starting from the concept of genuine investment and advanced by explicitly considering irreversibility effects using the real option methodology. In a second presentation, the different implementation strategies and the state of the art of knowledge and monitoring are presented. It features the data needs and sources, tools employed, addressing the different spatial and time scales. The presentation also encompasses the challenges currently faced in capturing the potential and trade-offs of the bioeconomy. The third presentation addresses the possibility for linking material flow accounts including biomass with greenhouse gas emissions as proposed by the Central Bureau of Statistics, The Netherlands. After the presentation two international experts provide comments for opening the discussion.

Discussant: Herman Vollebergh, PBL Netherlands Environmental Assessment Agency.

Maximilian KARDUNG, Wageningen University, the Netherlands
BioEconomy Options and Sustainability

Myrna VAN LEEUWEN, Wageningen Economic Research, the Netherlands
Linking Material Flows with Economic Flows

Dusan DRABIK, Wageningen University, the Netherlands
Full Speed Ahead or Floating Around? Exploring the Dynamics of the EU Bioeconomies

12:30 – 13:30 Lunch *Restaurant WICC*

13:30 – 14:30 PARALLEL SESSIONS E1 – E4

13:30 – 14:30 PARALLEL SESSION E1 – Conservation auctions *Haakzaal*

Chair: Abel-Gautier KOUAKOU

Marc N. CONTE, Fordham University, USA
Coalitions, Competition, and Conservation: Spatial Procurement Auction Design and Performance
Discussant: Abel-Gautier Kouakou

Abel-Gautier Kouakou, Osnabrück University, Germany
Performance of conservation auctions: Does preexisting institution matter
Discussant: Marc Conte

13:30 – 14:30 PARALLEL SESSION E2 – Payments for ecosystem services I *Roghorstzaal*

Chair: Katsuya TANAKA

Knut Per HASUND, Swedish Board of Agriculture, Sweden
Result and Value Based Payments for Field Elements in the Agricultural Landscape – experience from Swedish Pilot study
Discussant: Katsuya Tanaka

Katsuya TANAKA, Shiga University, Japan
Farmers' Preferences Towards Outcome-based Payment for Ecosystem Service Schemes
Discussant: Knut Per Hasund

13:30 – 14:30 PARALLEL SESSIONS E3 – Biodiversity *Tarthorstzaal*

Chair: Frank WÄTZOLD

Yoomi KIM, Ewha Womans University, Republic of Korea
Quantitative analysis of the effectiveness of the Convention on Biological Diversity (CBD)
Discussant: Frank Wätzold

Frank WÄTZOLD, Brandenburgische Technische Universität Cottbus-Senftenberg, Germany
Biodiversity conservation in a dynamic world may lead to inefficiencies due to lock-in effects and path dependence
Discussant: Yoomi Kim

13:30 – 14:30 PARALLEL SESSION E4 – Regime shifts *Peppelzaal*

Chair: Esther SCHUCH

Katharina HEMBACH, Osnabrück University, Germany
Combined Impact of Exogenous Scarcity Shocks and Endogenous Regime Shifts on Common Pool Resource Management
Discussant: Esther Schuch

Esther SCHUCH, Wageningen University, the Netherlands
A threshold public good game with public good and public bad framing: evidence from farmers and fishers in Cambodia
Discussant: Katharina Hembach

14:30 – 15:00 Coffee break *Lounge WICC*

15:00 – 16:30 PARALLEL SESSION F1 – F3

15:00 – 16:30 PARALLEL SESSION F1 – Bio-economic models *Haakzaal*

Chair: Brooks KAISER

Pierre COURTOIS, CEE-M, INRA, Montpellier, France
Spatially explicit criterion for invasive species control
Discussant: David Finnoff

David C. FINNOFF, University of Wyoming, USA
Bioeconomic Grizzly Bear Management
Discussant: Brooks Kaiser

Brooks A. KAISER, University of Southern Denmark, Denmark
Growth, Transition, and Decline in Resource Based Socio-Ecological Systems
Discussant: Pierre Courtois

15:00 – 16:30 PARALLEL SESSION F2 – Behaviour *Roghorstzaal*

Chair: Andries RICHTER

Ilda DREONI, University of Southampton, UK
Favouritism breeds self-interest: an experimental study of procedural and outcome fairness
Discussant: Robbert Schaap

Robbert SCHAAP, Ruprechts-Karls University Heidelberg, Germany
Prudence and Precautionary Saving by Natural Resource Users
Discussant: Andries Richter

Andries RICHTER, Wageningen University, the Netherlands
Behavioural biases of experts and their influence on natural resource management
Discussant: Ilda Dreoni

15:00 – 16:30 PARALLEL SESSION F3 – Spatial models *Tarthorstzaal*

Chair: Jo ALBERS

César MARTINEZ, University of Montpellier, France
Private management of epidemics
Discussant: Stephen Newbold

Stephen C. Newbold, University of Wyoming, USA
Ecological benefit spillovers from nutrient load reductions and management improvements in a multispecies fishery
Discussant: Jo Albers

Jo ALBERS, University of Wyoming, USA
Optimal Siting, Sizing, and Enforcement of Marine Protected Areas
Discussant: César *Martinez*

16:30 – 17:30 Closing drinks	*Lounge WICC*

Keynote Speakers

Marten SCHEFFER

Marten Scheffer is a theoretical biologist recognized for his work on the stability of complex systems. He has worked on the ecology of lakes but is known particularly for his work on tipping points in complex systems ranging from the brain to ecosystems, the climate system and societies. Scheffer was born in Amsterdam and grew up in the Netherlands. He graduated from Utrecht University with a degree in biology. Working at the national water research institute RIZA he obtained his PhD at Utrecht University. He went on to become a professor of Water Quality at Wageningen University, where he has broadened his field of study since. He is a member of the Royal Dutch Academy of Sciences as well as a foreign associate of the National Academy of Sciences in the US.

Scheffer is interested in unravelling the mechanisms that determine the stability and resilience of complex systems. Although much of his work has focused on ecosystems, he also worked with a range of scientists from other disciplines to address issues of stability and shifts in natural and social systems. Examples include the feedback between atmospheric carbon and the earth temperature, the collapse of ancient societies, inertia and shifts in public opinion, evolutionary emergence of patterns of species similarity, the effect of climatic extremes on forest dynamics and the balance of facilitation and competition in plant communities.

Trained as a classical violinist, Scheffer is also a professional musician and has been seeking to connect art and science through cooperative projects including theatre productions and essays. He co-founded the South American Institute for Resilience and Sustainability Studies (SARAS) set-up to include arts, humanities and sciences as equal partners in researching complex issues. Scheffer is currently a distinguished professor at Wageningen University where his focus is on catalyzing novel connections between the different research fields.

Katharine R.E. SIMS

Katharine Sims studies how policies simultaneously affect environmental protection and economic development and how changes in policy design can improve the balance between multiple social goals.

She is an Associate Professor of Economics and Environmental Studies at Amherst College and currently Chair of the Economics Department. Her work includes long-term evaluations of protected areas, conditional cash transfers, community forestry management, local zoning and household energy interventions in multiple countries. She has also contributed to methods for evaluating the forest fragmentation and spatial spillover impacts of conservation policies.

She holds a Ph.D. in Political Economy and Government from Harvard University and a B.A. in Ecology and Evolutionary Biology from Princeton University. Her work has been supported by the National Science Foundation, the International Initiative for Impact Evaluation, the World Bank's Impact Evaluation to Development Impact programme and the Andrew Carnegie Fellows programme.

Book of Abstracts

PARALLEL SESSION A1 - Special Session on Discounting: accounting for ecosystem services
Sponsored by PBL Netherlands Environmental Assessment Agency

Relative Prices and Climate Policy: How the Scarcity of Non-Market Goods Drives Policy Evaluation
Moritz A. DRUPP, Department of Economics, University of Hamburg

Climate change not only impacts production and market consumption, but also the relative scarcity of non-market goods, such as environmental amenities. We study fundamental drivers of the resulting relative price changes, their potential magnitude, and their implications for climate policy in the prominent DICE model, thereby addressing one of its key criticisms. We propose plausible ranges for relative prices changes based on best available evidence. Our central calibration reveals that accounting for relative prices is equivalent to decreasing pure time preference by 0.5 percentage points and leads to a more than 40 percent higher social cost of carbon.

Discounting in the Presence of Scarce Ecosystem Services
Aart DE ZEEUW, Tilburg University and TSC

Discounting has to take account of ecosystem services in consumption and production. Previous literature focuses on the first aspect and shows the importance of the relative price effect, for given growth rates of consumption and ecosystem services. This paper focuses on intermediate ecosystem services in production and shows that for limited substitutability and a low growth rate of these ecosystem services, the growth rate of consumption, and thus the discount rate, declines towards a low value. Using a Ramsey optimal-growth framework, the paper distinguishes three cases. If ecosystem services can be easily substituted, then the discount rate converges to the usual value in the long term. Secondly, if ecosystem services can be easily substituted in production but not in consumption, the relative price effect is important. Finally, and most interestingly, if ecosystem services cannot be easily substituted in production, the discount rate declines towards a low value and the relative price effect is less important. Another part of the previous literature has shown that a declining discount rate is the result of introducing several forms of uncertainty, but this paper reaches that conclusion from an endogenous effect on the growth rate of the economy.

Empirical evidence for time-declining social discount rates: the role of intermediate ecosystem services in production
Xueqin ZHU, Wageningen University

Recent research shows that ecosystem services in consumer utility are becoming scarce relative to produced consumption goods and services, and substitutability between the two is limited. According to economic theory this implies that the relative price of final ecosystem services increases, and within a Ramsey optimal growth framework this means that in a social cost benefit analysis lower discount rates should be applied to investment projects on ecosystem services than to those on produced consumption goods and services. An important extension to these analyses and insights is related to the role of intermediate ecosystem services, or more specifically ecosystem services that are used in the production of consumption goods and services. The purpose of this paper is therefore to provide some empirical evidences of the low growth rates and the limited substitutability of ecosystem services and to show how we can use this information to guide the determination of the social discount rate. We do this in three steps: We empirically assess growth rates of essential ecosystem services (or indicators thereof) as inputs in production; We derive empirical evidence for the potential for substitution between ecosystem services and other input factors in production; We use these insights on growth rates and the elasticities of substitution of ecosystem services to assess the implications for the social discount rate. We derive growth rates of many relevant intermediate services, or indicators thereof, such as soil nutrients, soil erosion, and biodiversity. We show that growth rates are near zero or even negative. We furthermore empirically estimate the elasticities of substitution between ecosystem services such as pollination, soil fertility and pest control, and other input factors, and find that the elasticities of substitutions are in general less than

one, which implies the limited substitutability of ecosystem services in production. These two findings imply that we need to use a time-declining discount rate towards the long-run steady state value of the social discount rate, which is the pure rate of time preference if ecosystem services do not grow, or even negative if the growth rate of ecosystem services is negative and its absolute value is sufficiently high. We also find that most of the available data on ecosystem services are crude approximations of the relevant ecosystem services that are used in production, and we discuss and propose an agenda for future research aimed at obtaining the necessary relevant data and insights.

PARALLEL SESSION A2 – Field experiments

Country borders and the value of scuba diving in an estuary: The case of the Oosterschelde
Sandra ROUSSEAU, KU Leuven

In order to gain insight into the impact of different nationalities, distances and travel costs in valuation studies, we analyze divers' preferences regarding the Oosterschelde, an estuary in the Netherlands close to the border with Belgium. As such this study is one of the first to use both a travel cost method and a stated choice experiment to estimate the benefits from recreational diving in a temperate maritime climate. The travel cost estimates based on day trips reveal a surplus of 108 and 197 euro per diving trip for Dutch and Belgian divers respectively. This leads to an estimated total access value of 21.7 million euro per year for recreational diving in the Oosterschelde. The choice experiment reveals that divers are willing to pay for improvements in biodiversity as well as for having an agreeable diving experience. The results show that nationality, or cultural identity, has an impact on preferences for diving and biodiversity protection. We also find evidence of a travel cost decay.

Input Efficiency as a Solution to Externalities: engineers vs behavioral scientists in a randomized controlled trial
Francisco ALPÍZAR, Wageningen University

To address natural resource scarcity and externalities, economists focus on property rights and prices. In contrast, engineers and policymakers focus on resource-conserving technologies, such as energy-efficient or water-efficient technologies, and input-efficient (precision) agriculture and forestry. Proponents of public programs that encourage adoption of these technologies have identified numerous product adoption "puzzles," in which adoption rates are low despite engineering estimates that imply both users and the environment would benefit. Economists have been skeptical of such puzzles, but have relied on observational designs in which identification of treatment effects are challenging, or experimental designs with short horizons and low adoption rates. To shed light on this debate, we report results from a randomized trial using water-efficient technologies. First, we confirm prior claims that engineering estimates of input reductions are real, but substantially exaggerated. Second, we demonstrate that the divergence in impact estimates can be attributed to engineering and behavioral reasons other than the "rebound effect" that has attracted the most attention from economists. Third, by combining our experimental estimator, detailed cost information, and experimentally elicited and jointly estimated time and risk preferences from the target population, we demonstrate the private welfare gains from technology adoption are roughly zero, implying no "efficiency paradox."

Spillover effects from mixing conservation policies in neighboring areas: Evidence from a field experiment in Colombia
Adriana BERNAL-ESCOBAR, University of Osnabrück

Equity is increasingly being recognized as a crucial issue for environmental conservation, not just from an ethical, but also from an efficiency perspective. Ignoring the sociopolitical context while implementing policies could undermine their environmental effectiveness as perceived unfairness may erode cooperation and compliance by policy addressees. For example, the sanctions commonly implemented in Protected Areas raise equity concerns as local people depend on these areas to pursue livelihoods. Relocation and loss of control over land and resources has been reported to result in resentment, poaching and antagonism (Mbaiwa, 2005). On the contrary, positive incentives such as Payments for Ecosystem Services – PES, are often seen as a way to improve livelihoods. Exclusion from PES has been reported to result in rule breaking, protest and sabotage (To et al.,

2012). Nevertheless, when neighboring households of a protected area generate relevant levels of pressure on its border, practitioners could use PES as a complementary tool for buffer areas. Where state enforcement capacity is low, PES have also been discussed as complements to legal restrictions inside protected areas (Engel, 2016). However, the implications of implementing different policies in neighboring areas have not been formally studied yet. We use field experiments in rural Colombia to examine spillover effects from implementing different policies or policy mixes in neighboring areas. The framed field experiment was implemented with farmers from a region in Colombia that is highly relevant for the provision of water in the country. The experimental game design mimicked farmers' decision situation on their farm. All participants first played a baseline scenario of the game without policy. Then they participated in a second game, for which they were divided into two groups (inside and outside an environmental priority area). Each group was assigned to a different policy. In a first treatment we mimicked PES targeting, with one group remaining under the baseline condition (no policy) while the other is offered a reward policy. In a second treatment, we resembled the case where a protected area is surrounded by a buffer area targeted by a PES. The group of farmers living inside the priority area therefore faces (weak) sanctions while the one living outside of the priority area is offered a reward. Finally, in a third treatment we studied the impact of using a PES as a compensation mechanism within a protected area. Farmers living inside the priority area therefore face sanctions but also receive a reward, while the others are only offered a reward. Control treatments with equal policies were implemented to allow testing for spillover effects. We assessed the impact of the different policy combinations on fairness perceptions and pro-environmental behavior. As expected, preliminary results suggest that exclusion from PES in absence of further policy reduces pro-environmental behavior. Surprisingly, penalizing some while compensating others increases pro-environmental behavior of those penalized. Differences in the effect of fairness concerns are the main potential explanation for this behavior.

Mechanisms and impacts of an incentive-based conservation scheme: evidence from a Randomized Control Trial in Bolivia

Emma WIIK, Bangor University

There is strong interest in the potential of using positive incentives to encourage sustainable land management, conserve forests and protect biodiversity. Those promoting Payments for Ecosystem Services suggest that they can deliver positive environmental outcomes while avoiding the negative social impacts sometimes associated with strict protected areas. Following growing recognition of the poor evidence base underpinning many conservation interventions, there are calls for more high-quality evaluations, especially those that explore mechanisms as well as ultimate outcomes. We present results from an incentive-based forest, biodiversity and water conservation scheme in Bolivia known as Watershared, which was implemented as a randomised control trial in 129 communities in the Bolivian Andes. We present the theory of change of how the intervention is expected to impact intermediate and ultimate outcomes (including livelihood changes linked to land use change, perceptions of forest condition, reported incidents of diarrheal disease). We use responses from a household survey in Control and Treatment households at baseline (2010) and endline (2015) to explore the impact of the scheme on this range of outcomes. As is common in voluntary interventions, uptake was incomplete (49% of households in Treatment communities enrolled land in Watershared agreements). We carry out an 'as-randomised' analysis, comparing outcomes in all Treatment and Control households regardless of intervention uptake, to provide information on effectiveness of the intervention as implemented. We conduct a further 'as treated' analysis, comparing outcomes in Treated households (those that took up the scheme) with statistically matched Control households, to evaluate the impact of the intervention on those who participate. Here we present our detailed pre-analysis plan that registers the outcomes identified for analysis and the matching procedures planned. Our analysis will be completed by August 2019.

PARALLEL SESSION A3 – Fisheries

Three Types of Interaction in Multi-Species Fisheries and When They Need to be Considered
Benjamin BLANZ, University of Hamburg

Management of multi-species fisheries is made complicated by interaction between the different species involved. Interaction between species may take place within the ecosystem, through simultaneous inseparable harvesting or through consumer demand. While each of these types of interactions has been shown to be significant individually, analyses including all three are lacking. In this paper an analytical model of multi-species fisheries is used to determine optimal harvesting rates incorporating all three types of interactions. This is done in order to determine the consequences of omitting individual types of interaction and to investigate possible inter-dependencies. Furthermore their importance in the design of total allowable catch and quantity tax based management is investigated. While ecosystem interactions between species are almost trivially important in setting optimal harvesting quotas, the significance of the other types of interaction is less obvious. Depending on the goals of the manager, their specific properties and the management method they may be omitted.

ITQs, Market Power and the Potential Efficiency Loss
Irmelin SLETTEMOEN HELGESEN, Norwegian University of Science and Technology (NTNU)

Individual transferable quota (ITQ) regimes have been adopted in a number of fisheries. While the issue of market power in such regimes has been discussed, this paper adds to the literature by solving for explicit harvesting- and quota price expressions. The paper supports the standard result that efficiency loss is increasing in the deviation between the leader's demand for, and initial allocation of quotas. In addition, the explicit solution indicates that the relative cost of the market leader, as well as the size of the fringe, will have an effect on the magnitude of the efficiency loss. Certain differences between emission permits and ITQs suggest that the potential efficiency loss of market power could be greater in an ITQ regime that in an emission permits market. Inspired by the North-East Arctic cod fishery the paper is among the first to provide a numerical illustration of the potential efficiency loss of market power in a rights-based regime for fisheries. The numerical results support the theoretical findings, though market power does not appear to be a major issue in ITQ regimes.

Risk averse policies foster bio-economic sustainability in mixed fisheries
Luc DOYEN, GRETHA, University of Bordeaux

This paper examines the role of risk aversion on the sustainable management of mixed fisheries. We consider a bio-economic model of multiple species harvested by a single feet with uncertain costs of effort. We assume that the regulatory agency aims at reaching MMEY (Multispecies Maximum Economic Yield) by maximizing the expected utility of total profits, where the utility function captures risk aversion. We show analytically that such a risk-averse MMEY mitigates the risk of biological and economic overexploitation of the different species. It further enhances biodiversity in the sense of evenness within the portfolio of the fishery. Therefore risk aversion promotes sustainability. However, as risk aversion also lessens the expected profit and food production, it may imply a trade-off between different bio-economic goals. These findings are illustrated with the case study of the Australian South East Fishery, where small risk aversion levels allow for high global bio-economic performances and balanced management objectives, therefore fostering sustainability.

PARALLEL SESSION A4 – Agricultural Systems I

Willingness-to-Pay Effects of Gene Drive Insect Use for Agricultural Pest Management in Diverse U.S. Market Applications
Zachary S. BROWN, NC State University

In the early 2000s, governments implemented policies stimulating the use of ethanol and biodiesel to reduce carbon emissions and encourage domestic energy production. Blend mandates requiring gasoline or diesel to contain a minimum percentage of these biofuels were the most common policy instrument. A theoretical study

by Clancy and Moschini (2017) concluded that, if innovation were stimulated by mandates, then the socially optimal mandate would be higher than if innovation were not possible. We test the impact of blend mandates and other biofuels policies on innovation using bibliometric patent indicators that correspond with research effort and research output. Our analysis shows that ethanol blend mandates significantly increased both R&D effort and quality-weighted innovation output in biofuels technologies while reducing
the R&D inputs to plant technologies. This suggests that biofuels innovation increased in response to the policies, with firms substituting some R&D effort away from plant technologies and toward biofuels. However, output of plant innovation held steady as R&D effort shifted to biofuels, supporting the presence of a spillover effect between biofuels innovation and plant innovation. We find that biodiesel blend mandates did not significantly impact R&D efforts in either plant or biofuels technologies. Furthermore, policies other than blend mandates had varying effects, ranging from limited increases in R&D activity to significant decreases in innovation.

Improving Farm Environmental Performance through Technical Assistance: Empirical Evidence on Pesticide Use

Margaux LAPIERRE, CEE-M (Center for Environmental Economics - Montpellier)

The Ecophyto plan is a high stake program implemented in France since 2008 with the aim to halve pesticides use in the farming sector in 10 years. A central disposal of the program is the dephy network. It consists in providing technical assistance to groups of volunteer farms. Furthermore, the French government is currently trying to scale-up the program, which calls for the evaluation of its impacts on pesticide use and yields. Coupling Dephy data and national surveys from 2010 to 2016, we use a slate of quasi-experimental approaches - Matching, Difference-in-difference matching, Difference-in-difference, and quantile regressions to estimate the impact of participation in the program on pesticide use and crop yields on enrolled vineyards. We find that participants have achieved reductions in pesticide use that ranges from 8 to 22 percent, thanks to the program. We moreover find that the reduction in the use of chemicals was accompanied by an increase in the use of biocontrol products. Finally, we find that this change of practices resulted in a reduction in yields for a fraction of enrolled farms. Our study provides new evidence regarding the effectiveness of technical assistance alone in reducing pesticide use in the agricultural sector. It shed lights on potential beneficial impacts as well as warnings of the effects of such programs.

Cost-effectiveness, Distributional Impacts and Regionalization in Agri-Environment Scheme Design. A case study of a Grassland Scheme in Saxony, Germany

Nonka MARKOVA-NENOVA, Brandenburg University of Technology Cottbus-Senftenberg

Economic analysis of agri-environment schemes (AES) has focused mainly on improving their cost-effectiveness. In contrast, the distributional impacts of AES have received less attention in the economic literature, even though the implementation of cost-effective policies can receive much more support if their distributional impacts are desirable. We combine cost-effectiveness and distributional considerations and investigate empirically for a case study (a grassland program in Saxony, Germany) if trade-offs or synergies between improving the cost-effectiveness of an AES and its distributional impacts exist. We further contribute to the analysis of spatially differentiated AES by assessing the gains in cost-effectiveness through a regionally differentiated AES optimization. Using an ecological-economic modelling procedure, we simulate a Saxon AES and design two more cost-effective AES - one scheme with homogeneous payments and one regionally differentiated payment scheme. To compare the distributional impacts of the schemes we use the criteria of equality, equity and Rawls' maximin criterion. Our results suggest a trade-off between equality and cost-effectiveness, whereas equity increases with improved cost-effectiveness of the AES. Regional optimization of payments results in less inequality, but also less equity than homogeneous optimized payments. Regionalization also leads to higher cost-effectiveness in bird conservation, but is actually worse for butterflies and habitat type conservation than an overall cost-effective AES.

Agricultural Practices and Environmental Degradation - The Case of GM Corn in the Philippines
Ludovic BEQUET, University of Namur

Improved seeds varieties have led to an increase in agricultural production as well as to a change in agricultural practices and input use. A side effect of these changes that has received little attention to date is the impact of those new technologies on environmental degradation. Using an original survey method of 447 farming households of the Philippine island of Mindanao covering the past ten years, this paper finds a positive correlation between biotech corn cultivation and landslide occurrence, which cannot be explained by an endogenous allocation of crops on plots. Looking at the earth science literature and investigating mediating effects of the slope, it presents suggestive evidence that increased use of herbicide on biotech corn as well as cultivation on very steep slopes are the most likely mechanisms behind this result. Looking at the distribution of landslides as a function of wealth, landslides are found to increase socio-economic inequality by affecting most households similarly, except for the top tail of the landholding distribution.

PARALLEL SESSION B1 – Games

Optimal and Markov-perfect Nash equilibria in harvesting age-structured populations
Olli TAHVONEN, University of Helsinki

We specify an analytically solvable age-structured harvesting model for collectively optimal and Markov-perfect Nash equilibria in both deterministic and stochastic settings. The model has any number of age-classes and is assumed to be harvested from one or two age classes. The collectively optimal harvests are obtained in closed form as functions of the number of individuals in the given age class. The existence of sustainable solutions is shown to depend on fundamental biological factors and rate of discount in addition to the internal delays in the age-structured system. In a symmetric game all actors harvest both age classes and the existence of sustainable Nash equilibrium depends on the objective functional properties besides the rate of discount. In an asymmetric game, the sustainability depends on how the number of actors are divided into groups harvesting population age classes in different locations. The collectively optimal and Nash equilibria are shown to be globally asymptotically stable for optimal feedback solutions. Stochastic recruitment makes harvesting more conservative in both the optimal solution and various Nash equilibria.

When establishing a common environmental project, countries that benefit less may need to contribute more
Adam LAMPERT, Arizona State University

Cooperation among multiple countries is essential for the effective establishment of commonenvironmental projects, such as the eradication of invasive species and diseases and the development of green technologies. However, each country has the incentive to contribute less to the project and freeride on the contribution of other countries. Therefore, a major question is how the contributions could be allocated among the countries, such that no country would have the incentive to reduce its contribution. Here we use a dynamic game model and consider a Markovian Nash equilibrium as a possible allocation of contributions. We prove that under general conditions, in each Nash equilibrium, among the countries that contribute, those that have smaller benefits from the project contribute more. Moreover, there are multiple Nash equilibria, where those Nash equilibria in which fewer countries contribute are more efficient and result in a faster establishment of the project. These results imply that an inherent tradeoff exists among fairness, efficiency, and stability when establishing a common project.

Lobbying and environmental policy instruments
Pauli LAPPI, CMCC Foundation

The choice of environmental policy instruments is analysed when the regulated firms have an option to join a lobby group that is able to influence the level of the chosen instrument. The choice of the instrument level is modeled with a threestage game, where the firms decide to join the lobby group, the regulator decides the instrument level under the influence of the formed lobby, and finally, the firms individually choose their

emissions. Hence the number of lobbying firms is endogenous, and the model characterizes the equilibrium number of lobbyists, instrument level and emissions. The results show that lobbying causes the aggregate emissions to be greater than in the social optimum. Although the aggregate emissions differ between the instruments, the regulator turns out to be indifferent between the instruments.

Common pool resources: Is there support for conservationists?
Erik ANSINK, VU University Amsterdam

We examine the role of support for coalition stability in common pool resource games such as fisheries games. Some players may not want to join a coalition that jointly manages a resource. Still, because they benefit from spillovers, they may want to support the coalition with a transfer payment in order to set incentives for others to join. We find that the impact of support on equilibria of this game is limited to games with three or five players.

PARALLEL SESSION B2 – Lab in the field experiments

The Can Challenge: Exploring the Best Way to Incentivise Pro-Environmental Behaviour
Michael BROCK, School of Economics, University of East Anglia

In light of a report published by The Voluntary and Economics Incentives Working Group in February 2018, the UK Government is currently in consultation over how to viably operate a Deposit Return Scheme (DRS) on drinks containers. This field experiment looks at two possible incentive mechanisms by which this could be conducted and assesses how likely each incentive is to yield a greater level of participation and engagement. The first of these is a piece-rate system, similar to that already used in some European countries, whilst the second uses a lottery-based system that the literature in behavioural economics has shown to be very effective. Both were implemented across three different locations across Norwich. For environmental economists, this study invites some interesting questions on how to best increase the public involvement in recycling. This is a particularly relevant question for the UK given they have a desire to implement a Deposit Return Scheme without having committed to an implementation strategy. Our findings show that the lottery incentive scheme is extremely effective in raising people's engagement with recycling in one location, whilst in another location neither scheme outperforms the other to any great extent.

Endogenous institutions and cooperation in natural resource governance: insights from an economic experiment in Cambodia
Tum NHIM, Wageningen University

In Cambodia, governance of natural resources such as water relies largely on informal agreements of community groups, organized per village. The agreements are non-binding, but stimulate social norms of cooperation, such as sharing water between farmers and villages. While some groups are successful, others face an overuse of water which can lead to conflicts between water users. The overall aim of this study is to analyze under which circumstances people are willing to contribute parts of their revenues for an institutional setting which fosters cooperation. Lab-in-the-field experiments were conducted with 303 Cambodian farmers in 21 villages across three communes in Kampong Chhnang Province. The subjects played one-shot public good games with an option to vote for a preferred institution. Firstly, the choice is between a costly tax system which ensures a minimum contribution to the public good, or a public goods setting which is purely voluntary. Secondly, the choice is between a costly monitoring system that discourages free-riding from the public good, or a costless monitoring system that free-riding from the public good might not be detected and punished. In both cases, contributions are made via the strategy-elicitation method, i.e. after having voted, but before knowing what others would have voted. Results show that the majority of participants voted for costly institutions that are designed to foster cooperation. They were in favor of a costly tax system that ensures a minimum contribution to the public goods, and a costly monitoring system that clearly discourage free-riding from the public goods. The likelihood of subjects choosing a costly institution is mainly explained by access to water. The findings from this study give insights into institutional designs that foster cooperation in natural resources governance.

Prices, Peers, and Perceptions: Field experiments on improved cookstove adoption in Ghana
Zachary S. BROWN, NC State University

Despite their potential health and social benefits, adoption of improved cookstoves has been low throughout much of the world. Explanations for low adoption rates of these technologies include prices that are not affordable for the target populations, limited opportunities for households to learn about cookstoves through peers, and perceptions that these technologies are not appropriate for local cooking needs. The P3 project, which is being conducted in the Kassena-Nankana Districts of Northern Ghana, employs a novel experimental design to explore each of these factors and their interactive effects on cookstove demand, adoption, and exposure outcomes. Leveraging an earlier improved cookstove study, the central design of the P3 experiment involves offering two types of improved biomass stoves at randomly varying prices to peers and non-peers of households that had previously received similar stoves for free. Preliminary analyses of households' stove orders are presented in this paper. Overall, willingness to pay for stoves is higher than expected based on results of stove auctions, and aligns fairly well with stated preference estimates from an earlier study in the area. We find some initial evidence that learning about improved stoves from prior recipients influenced the peer group's choices. Peer households appeared to value each of the stoves less individually, but had higher demand for the stove combination (one of each type of stove) compared with the non-peer group. Ongoing measurements and analysis will assess impacts of prices and peers on whether households actually follow up on their initial orders (i.e., make payments), as well as on perceptions of stove quality, use of traditional and improved stoves, and household air quality outcomes.

The nature of experience
Christian KÖNIG-KERSTING, Heidelberg University

In many environments, exogenous (`natural') and strategic uncertainty jointly determine outcomes for individuals and an increasing number of economic experiments attempt to study human behavior in such settings. We design a choice environment that allows to study how individuals change their actions in repeat play depending on whether natural or strategic factors uniquely caused an adverse outcome. As expected, we find no statistically significant evidence that the experience of a zeropayout events effects whether subjects change their choice between rounds. However, there is significant evidence for a `human factor': Despite statistical equivalence, subjects are significantly more likely to change their choice after experiencing adverse outcomes caused by strategic uncertainty, but not after experiencing the same outcome caused by natural uncertainty.

PARALLEL SESSION B3 – Carbon, Climate, Ecosystems

Carbon Accounts for Measuring Sustainability under Globalization
Matthew AGARWALA, University of Cambridge

We contribute to sustainability accounting by examining three potential attribution rules, constructing a global account for each. We shift the focus from the location of emissions to the location of damages to introduce a new carbon accounting perspective that is fully consistent with: (i) sustainability theory, (ii) climate economics, and (iii) sustainability accounting for a world in which countries are not compensated for climate damages. Our approach extends the supply chain of virtual carbon flows beyond extraction, production, and consumption to incorporate the distribution of the global climate externality. We determine the distribution of these damages in two ways, using a 140 region 57-sector multi-regional input-output model (MRIO): a regional integrated assessment model with global coverage (Nordhaus & Boyer 2000); and econometric modelling of the historical relationship between GDP growth and temperature change (Burke et al 2015). Our results show that the damage based accounting approach using the former method has similar distributional implications to the production and consumption based approaches, but using the more recent method implies far more unequal outcomes, with some northern rich countries initially benefiting from warming while larger damages fall on other countries. We conclude that the observed progress towards national and global sustainability is sensitive to the accounting perspective used, suggesting that sustainability accounting requires a 'dashboard' approach combining multiple carbon accounts. The damage based approach has implications relating to the design of international climate

agreements, the potential for climate compensation, and multiple Sustainable Development Goals: 8.4 Economic Growth), 10.b (Reduced Inequality), 12 (Responsible Production and Consumption), 13 (Climate Action), 17.11 (Trade), and 17.19 (Monitoring and Accountability).

Ecosystem accounts for Marine Protected Areas: A proposed framework
Elena LAGOMARSINO, University of Genova

Many policy initiatives and scientific studies promote the use of economic accounting as a statistical basis for end-users and policy makers in order to evaluate the distributive and allocative effects of implementing environmental and economic policies. This could help in assessing cost-benefit analysis on taxes and subsidies, public expenditure on environment protection, payment schemes for ecosystem services or the construction of "green" gross product indicators. In this paper we develop an ecosystem-economic accounting framework for testing some practical issues connected with building disaggregated accounts for single institutional units. We focus in particular on MPAs for the direct relationship they have with ecosystems and their flows and for the strong contribution of ecosystems to productive and consumptive activities. The accounting framework is designed to be integrated into the System of Environmental and Economic Accounting – Experimental Ecosystem Accounting (SEEA-EEA) recommendations, and to serve as a management tool for protected areas managers.

Species diversity-income relationship under increasing drought risk
Sergei SCHAUB, ETH Zürich

Droughts adversely affect grassland production. Climate change is predicted to cause increasing drought risk and thus to have negative effects on farmers' income and increases income risk. We investigate grassland species diversity as risk management instrument to mitigate adverse drought effects on hay yield. In our paper we, first, provide a theoretical model to investigate effects of increasing drought risk and risk aversion on optimal species diversity choices. We extent earlier work by accounting for different farm types, i.e. whether farmers are net sellers or buyers of hay, as well as market responses to droughts via the hay price. Second, we empirically estimate drought and species diversity effects on hay yield and its variability as well as drought effects on the hay price and its variability. Third, we integrate theoretical and empirical components to simulate implications of species diversity choices. Our theoretical analysis reveals that increasing drought risk negatively affects farmers' certainty equivalent and that species diversity can mitigate these effects. Thus, under increasing drought risk farmers' optimal species diversity level increases. The magnitude of these effects increase with farmers' risk aversion and depend on farm type, i.e. risk exposure. Furthermore, our first empirical results show a substantial positive drought effects on hay price and positive effects on hay price variability, thus price risk. We conclude that species diversity should be taken into consideration in the sustainable management of increasing drought risk, that the extent to use species diversity depends on farmers' risk aversion and farm type and that droughts strongly affect the hay price.

The value of flexibility in conservation management in the face of climatic uncertainty
Martin DRECHSLER, Helmholtz Centre for Environmental Research

Climate change is uncertain and has uncertain effects on the suitabilities of habitats for species. Conservation policies and strategies have to take this uncertainty into account. An approach to address uncertainty is flexibility. The present paper explores the value of flexibility using a stylized model with two regions in which conservation measures can be carried out. Two time periods, the present and a future time, are considered and a conservation manager has to decide how much of a conservation budget to spend in which period and in which region. The challenge is that the costs and benefits of conservation change in time in an uncertain manner. Two strategies are compared: a fixed one under which the conservation manager has to decide in the first period how to allocate the budget over the two periods and regions, and a flexible strategy under which s/he has to decide how much of the budget and where to spend in the first period, while the allocation of the remaining period-2 budget over the two regions has to be decided only in the second period when the costs and benefits functions in that period are known. The results show, among others, that the value of flexibility depends on the level of uncertainty but only insofar as it affects the relative performances of the different allocations.

PARALLEL SESSION B4 – Agricultural systems II

The economic and environmental performance of farms: The impact of migration
Guangcheng REN, Wageningen University

Both economic and environmental performance of farms has received widespread attention. Migration of rural labour force is another growing phenomenon of many developing countries, including China. Theoretically, migration is considered as an important influencing factor of farms' economic and environmental performance. The objectives of this paper are therefore to estimate the technical and fertilizer use efficiency scores of rice production, and to examine the causal effect of migration and migration intensity on technical and fertilizer use efficiency. Applying the stochastic frontier analysis (SFA) and propensity score matching (PSM) analysis to survey data collected in four provinces, we found the average of technical efficiency among interviewed rice production households is 0.92, while the average of fertilizer use efficiency is only 0.22. The results of PSM suggest a negative impact of migration on both economic and environmental performance of farms, and the impact is amplified for households participated in migration more intensively.

Local Economy effects of Large-Scale Agricultural Investments
Paul HOFMAN, Wageningen University

The last decade has seen a surge in land acquisitions in developing countries by foreign companies. To date there has been little rigorous quantitative evidence on the impacts of such investments. We examine the economic impacts of a large-scale biofuel plantation in Sierra Leone - a major target investments in land. We conduct a difference in difference analysis using three waves of a large n survey in both communities directly affected by the plantation and those outside the catchment area. We find a large average drop in incomes, mainly driven by lower revenues from agricultural activities. These findings are consistent with a labour demand shock, caused by a clash between the private and commercial agricultural calendar, increasing
the local price of labour. A spillover analysis confirms that the impacts are at least partially transmitted by a shock to the local economy. Within host communities, households that are employed at the plantation see their incomes and assets increase. However, as a result, village-level inequality increases.

Testing conditional cooperation: Local participation of farmers in agricultural cooperatives
Maria NARANJO BARRANTES, Wageningen Economic Research

In this paper, we test the internal and external validity of the typology of a conditional cooperator classified by using a public goods game together with the strategy method. Individuals categorized as conditional cooperators adapt their behavior to the group to which they belong. In Costa Rica, coffee farmers are traditionally organized in agricultural cooperatives, a setting very similar to the scenario presented to an individual facing the strategy method in a public goods game: how much to cooperate, given what others do. Our results show that conditional cooperators believe they contribute to the public good by matching the contribution of others in the experiment. However, we find no evidence that those classified as conditional cooperators in the experiment also behave this way when it comes to bringing coffee to the local cooperative in real life. We show supporting evidence to conclude that the typology of a conditional cooperator is internally consistent, but do not find evidence that the typology of conditional cooperators is externally valid. Our paper is a contribution to the external validity of context-free experiments and helps in understanding cooperative behavior relevant to the sustainability of agricultural cooperatives in the developing world.

PARALLEL SESSION C1 – Special session: Ecological Economic Systems

Responsibility for regime shifts in ecological-economic systems
Stefan BAUMGÄRTNER, University of Freiburg

I develop a quantitative measure of a manager's responsibility for a regime shift in a managed ecosystem with stochastic dynamics. I build on an established and clearly defined concept of responsibility, which I

operationalize in a simple generic model. Causal responsibility is the degree of causation of an outcome due to the manager's action, which is in contrast to chance influences ("good luck" or "bad luck") that may also have caused the outcome. Normative responsibility is the manager's obligation to see to it that the system does, or does not, undergo a regime shift. It implies a particular management action. Virtuous responsibility is the degree to which the manager lives up to her normative responsibility when taking a management action. The quantitative measurement of responsibility is relevant to judge the quality of different management actions, to reward or punish the manager based on the extent of her (ir)responsibility, and to design institutions that enable and encourage responsible management of ecosystems with potential regime shifts develop a quantitative measure of a manager's responsibility for a regime shift in a managed ecosystem with stochastic dynamics. I build on an established and clearly defined concept of responsibility, which I operationalize in a simple generic model. Causal responsibility is the degree of causation of an outcome due to the manager's action, which is in contrast to chance influences ("good luck" or "bad luck") that may also have caused the outcome. Normative responsibility is the manager's obligation to see to it that the system does, or does not, undergo a regime shift. It implies a particular management action. Virtuous responsibility is the degree to which the manager lives up to her normative responsibility when taking a management action. The quantitative measurement of responsibility is relevant to judge the quality of different management actions, to reward or punish the manager based on the extent of her (ir)responsibility, and to design institutions that enable and encourage responsible management of ecosystems with potential regime shifts I develop a quantitative measure of a manager's responsibility for a regime shift in a managed ecosystem with stochastic dynamics. I build on an established and clearly defined concept of responsibility, which I operationalize in a simple generic model. Causal responsibility is the degree of causation of an outcome due to the manager's action, which is in contrast to chance influences ("good luck" or "bad luck") that may also have caused the outcome. Normative responsibility is the manager's obligation to see to it that the system does, or does not, undergo a regime shift. It implies a particular management action. Virtuous responsibility is the degree to which the manager lives up to her normative responsibility when taking a management action. The quantitative measurement of responsibility is relevant to judge the quality of different management actions, to reward or punish the manager based on the extent of her (ir)responsibility, and to design institutions that enable and encourage responsible management of ecosystems with potential regime shifts I develop a quantitative measure of a manager's responsibility for a regime shift in a managed ecosystem with stochastic dynamics. I build on an established and clearly defined concept of responsibility, which I operationalize in a simple generic model. Causal responsibility is the degree of causation of an outcome due to the manager's action, which is in contrast to chance influences ("good luck" or "bad luck") that may also have caused the outcome. Normative responsibility is the manager's obligation to see to it that the system does, or does not, undergo a regime shift. It implies a particular management action. Virtuous responsibility is the degree to which the manager lives up to her normative responsibility when taking a management action. The quantitative measurement of responsibility is relevant to judge the quality of different management actions, to reward or punish the manager based on the extent of her (ir)responsibility, and to design institutions that enable and encourage responsible management of ecosystems with potential regime shifts.

Regulating mixed commercial-recreational fisheries
Thang DAO, IGB Berlin
N.A.

Harvesting efficiency and welfare in restricted open-access fisheries
Martin QUAAS, Leipzig University

Small-scale and recreational fisheries often operate under conditions of restricted open access with a limited number of licensed fishers. Harvesting efficiency is limited both by the state of technology and by regulations of fishing gear and fishing practices, but under these constraints individual fishers can choose the amount of catch. We study how an increase in harvesting efficiency changes the different components of welfare –consumer surplus and producer surplus –in a restricted open access fishery in steady state, taking the feedback of harvesting on stock dynamics into account. We find that both components of welfare change in the same direction. If and only if initial efficiency is low enough that there is no maximum sustainable yield (MSY) overfishing in steady state, an improvement of harvesting efficiency increases welfare.

PARALLEL SESSION C2 – No session

PARALLEL SESSION C3 – Forestry

Can conservation be pro-poor? Evidence from an impact evaluation of a REDD+ program in Sierra Leone
Mandy MALAN, Wageningen University

Protecting Tropical Forests is key in reducing global warming and loss of biodiversity. This is of special concern in Africa, where deforestation rates are twice that of the rest of the world (FAO 2010). Deforestation is seen as an important cause of global warming (Fearnside 2000). For this reason, reducing deforestation is high on the agenda for a range of international actors. One worldwide approach to reducing deforestation are the Reduced Emissions from Deforestation and forest Degradation (REDD) programs. REDD programs are aimed at conserving forest areas to offset carbon emissions. However, conservation programs often have implications for the livelihoods of surrounding communities, potentially weakening economic indicators. REDD+ programs therefore also aim to provide support to the communities affected by the conservation efforts. Land is an increasingly scarce resource in Sierra Leone, where deforestation is caused by agricultural expansion, logging, and mining activities. In eastern Sierra Leone, the Gola REDD+ project conserves the forested area of Gola Rainforest National Park (GRNP). In total, the area comprises of 68,515 ha of original tropical forest. In 2014, the program commenced with a range of livelihood activities supporting 114 impoverished communities directly surrounding the forest. Activities included agricultural training programs, cocoa production support, and the establishment of savings and loans associations. In 2014, we collected baseline data for a sample of 30 non-project communities and 29 REDD+ project communities. During March 2019, we collected a new round of data. Presently, May/June 2019, we are processing and analyzing the data. We then aim to analyze the impact of the REDD+ program on communities using a difference-in-difference approach, during summer 2019. In total, we have panel data on 651 households in 59 communities. With the help of pre-baseline data from the same communities, collected in 2010, we can provide supporting evidence for the parallel trends assumption. We estimate impact on two families of outcomes: economic outcomes and conservation outcomes. Each family consists of a range of relevant outcomes, which are assessed Independently and grouped in their family in order to provide a better understanding of the potential trade-off between conservation and livelihoods. Few papers have rigorously examined the impact of conservation programs on economic and conservation outcomes. Within conservation science there are calls for increasing the number of impact evaluations of conservation projects (Baylis et al. 2016; Ferraro 2002). Evaluations to date either make strong identifying assumptions (Miranda et al. 2016; Sims 2010) or are related to conditional cash transfers (Jayachandran et al. 2017). Our paper thus makes a significant contribution by using fewer identifying assumptions and considering an unconditional program. In addition to measuring the impact of the REDD+ program, we conducted a priors survey, asking local policy makers, NGO staff, and experts in economics, conservation what they expect the impact of this program to be. This allows us to explore how realistic and accurate the expected effect of experts in the field are compared to the actual effect. Secondly, a comparison across different types of experts can be informative, as the project attempts to achieve two often opposed domains, i.e. conservation versus economic development This exercise thus gives insight into how these two larger goals are perceived by academics from the different backgrounds. Even more so, this exercise can reveal potential competing views between policy makers, academics, and implementers and thereby offer some new perspectives for designing similar programs in the future.

Combatting forest fires in arid Sub-Saharan Africa: Quasi-experimental evidence from Burkina Faso
Tung NGUYEN HUY, Tilburg University

Forest fires have been identified as one of the main drivers of deforestation and forest degradation Sub-Saharan Africa. We study the (short-run) effects of a program targeted at reducing the incidence of forest fires in 12 gazetted forests in arid Burkina Faso. Making use of detailed satellite images on forest fires and remaining vegetation cover in, in total, 78 forests over the period 2014-2018, we estimate the average treatment effect of the intervention using the Synthetic Control Method. We find that the intervention resulted in a significant decrease in (the severity of) forest fires in the periods where forest fires tend to be most prevalent { at the end of the agricultural season (in November), and at the onset of the new agricultural season (in March). However,

these estimates are likely to be partially driven by imperfect fitting on pre-treatment outcomes. We find mixed evidence on the extent to which this resulted in increased vegetation cover.

Participatory policy approaches and cooperation in forest commons: Experimental evidence from Program Bolsa Floresta in Brazil
Charles PALMER, London School of Economics and Political Science (LSE)

Policy interventions with a strong participatory element, which aim to protect natural resources and reduce poverty, have become increasingly popular in developing countries. A setting akin to a natural experiment is exploited to evaluate the extent to which the participatory aspects of Brazil's Program Bolsa Floresta (PBF) influenced the willingness of community members to cooperate in forest commons. The process of participation, in workshops to develop alternative livelihoods and sources of income, is hypothesised to empower community members thus generating non-pecuniary benefits and an incentive to conserve forests (motivational crowding). We carried out a common-pool resource game and household survey in Amazonas State to test this hypothesis. Using data collected from 160 households in seven communities, empirical results suggest support for the hypothesis, namely that PBF has led to the crowding in of cooperative behaviour in forest commons. Policy interventions with a strong participatory element, which aim to protect natural resources and reduce poverty, have become increasingly popular in developing countries. A setting akin to a natural experiment is exploited to evaluate the extent to which the participatory aspects of Brazil's Program Bolsa Floresta (PBF) influenced the willingness of community members to cooperate in forest commons. The process of participation, in workshops to develop alternative livelihoods and sources of income, is hypothesised to empower community members thus generating non-pecuniary benefits and an incentive to conserve forests (motivational crowding). We carried out a common-pool resource game and household survey in Amazonas State to test this hypothesis. Using data collected from 160 households in seven communities, empirical results suggest support for the hypothesis, namely that PBF has led to the crowding in of cooperative behaviour in forest commons.

PARALLEL SESSION C4 – Valuation and Time

Valuation and Discounting of Forest Ecosystem Services
Masayuki SATO, Kobe University

Non-market valuation techniques have been applied to the valuation of ecosystem services. This piece of information can be utilized for estimating the shadow price of natural capital, defined as its marginal contribution to the discounted sum of future utility. In this paper, we not only value forest ecosystem services by their multiple functions, but also estimate the discount rate applied to forest ecosystem services, using an original dataset of two choice experiments regarding forest conservation policy. Our results suggest that regulating services as a public good are valued higher than provisioning services in Japan. Moreover, we also compute implicit discount rates that depend on the relative growth rate of natural capital. For policy application, it is advisable that ecosystem service valuation and natural capital valuation be prepared in a consistent manner. The implicit discount rates that combine consumption discounting and natural capital regeneration are more plausible than the usual consumption discount rate for evaluation of natural capital conservation project and design of payment for ecosystem services.

Wait for it: Valuing natural capital when management is dominated by periods of inaction
Eli P. FENICHEL, Yale University

Valuing natural assets is important for tracking management performance and for wealth accounting sustainability assessments. Measuring the value of service flows from ecosystems is also important for environmental income and product accounting and benefit-cost analysis of specific projects. Developments in valuing natural capital have focused on implicit intertemporal exchange revealed by management feedback rules that map the state of the system in continuous fashion onto a management response. However, the management of many real assets, including many natural capital assets, is best described as doing nothing with

punctuated adjustment – an important type of non-convexity. We extend the current theory of natural capital asset valuation for such cases. In so doing, we develop an approach for measuring revealed non-use value. We develop a case study for Oregon Douglas fir forests managed by clear cutting, where forest may provide an amenity flow while standing and timber at harvest. We find that the non-use, "amenity," flow value of the forests is positive and depends on site class, and that wealth held in Oregon Douglas fir forests increased over the first decade of the 21st century.

PARALLEL SESSION D1 – Natural Capital

Ecosystem wealth in the Barents Sea
Sturla F. KVAMSDAL, SNF – Centre for Applied Research at NHH

We develop an inclusive wealth type index for natural capital in the Barents Sea that accounts for ecosystem services via trophic interactions. We consider three key fish species in the Barents Sea under stochastic growth dynamics. Compared to evaluation at market prices, the estimated wealth from the inclusive wealth approach is several times higher. Ecosystem wealth depends on the management scheme, and we consider both business as usual (BAU) and an optimized ecosystem-based management scheme (EBM). While BAU maintains wealth near its current level (5% increase in the long run), EBM increases wealth with almost 20% in the short run and more than 25% in the long run. Realized shadow prices suggest that prey species stocks are undervalued when evaluated at market prices.

Inter- and Intragenerational Distribution and the Valuation of Natural Capital
Jasper N. MEYA, University of Oldenburg

This paper studies how the intra- and intergenerational distribution of income affects the economic valuation of non-use environmental public goods derived from natural capital. We show that society's mean WTP for natural capital decreases (increases) with intratemporal income inequality if environmental goods derived from natural capital and consumption goods are substitutes (complements). We further find that the intergenerational distribution affects the intertemporal valuation of environmental goods derived from natural capital. Specifically, societal WTP elicited as a constant payment fraction increases with income growth for complements or the Cobb-Douglas case. However, it is possible that WTP declines with income growth in the case of substitutes. Finally, we obtain closed-form adjustment factors for benefit transfer to control for differences in dynamic aspects between study and policy sites, such as income growth, the growth rate of the environmental goods, and interest rates. These results are in particular relevant for natural capital accounting and management.

Discounting, inclusive wealth and sustainability
Rintaro YAMAGUCHI, National Institute for Environmental Studies

Capital approach to sustainability focuses on whether wealth as an aggregate of capital assets is not on the decline over time. Although sustainability hinges on how we frame intergenerational ethics, the role of discounting in this sustainability assessment has not been extensively studied yet. This paper rebuilds the produced, human, and natural capital framework, in which the role of discounting in shadow prices of capital assets is clarified. We uncover how relevant parameters—such as the pure rate of time preference, elasticity of marginal utility, consumption and natural capital growth rates, marginal regeneration of natural capital — affect human and natural capital income discount rates, shadow prices, and the level and change in inclusive wealth. Numerical examples for selected countries demonstrate that, among other results, under a plausible set of parameters and assumptions, human capital income discount rates are likely higher than forest capital income discount rates.

Natural capital and native grazing pastoral systems in Australia: A tale of the north and south
Stuart WHITTEN, CSIRO Land and Water

Native pastures, and their natural capitals, such as biodiversity and healthy soils, support a diverse range of low input livestock grazing enterprises across extensive pastoral systems around world, including more than half of the Australian continent. Maintaining the financial and productive sustainability of such farming enterprises has always been a challenge in Australia's climate of high inter-annual weather variation so it is highly likely that maintaining these natural capitals will become even more challenging under climate change. Despite the importance of native systems in the Australian context there has been little exploration of the extent to which maintaining or improving natural capital is likely to support agricultural productivity over the long term, even during times of drought. Unfortunately the evidence is clear that many landholders have already lost some degree of native pasture natural capital through shifts in pasture species composition and cover and feedbacks to the natural system. In this paper we use ecological state and transition models to inform an appropriate couple bio-physical and economic model of two Australian grazing systems with important natural capital outcomes to land managers and the wider community: savanna grazing systems in the Great Barrier Reef watersheds and grassy woodlands in south eastern Australia. Our focus is on the private benefits from natural capital and we conclude these are related to the nature of the ecological system and that they are likely to increase under climate change.

PARALLEL SESSION D2 – Choice experiments II

Do we choose differently after a discussion? Results from a deliberative valuation study in Ireland
Margrethe AANESEN, UiT - Arctic University of Norway

A criticism against traditional stated preference surveys is that people often make choices as members of social groups and as a result of deliberation. To explore the effects of deliberation and the robustness of traditional techniques a choice experiment was implemented as a series of valuation workshops where respondents were given information and an opportunity to discuss. They made their choices individually both before and after the group discussion. Although stated preferences turned out to be relatively stable across the two elicitation situations, on average respondents did state different preferences after the discussion compared to before. The stated preferences became more homogenous after the discussion. Somewhat surprisingly, people being well informed about the good and people stating they were certain of their choices were the ones that to the largest degree changed their stated preferences after the discussion.

Effects of air pollution on Beijing residents' willingness to pay for green amenities
Zhaoyang LIU, University of Glasgow

In this paper, we investigate the effects of urban air pollution on the value of green amenities. On the one hand, residents of severely polluted areas may derive additional benefits from green amenities, as trees are commonly believed able to enhance air quality. On the other hand, air pollution may as well devalue green amenities, by forcing people to reduce outdoor activities on high pollution days. Thirdly, where people choose to locate in a city, as reflected by their exposure to air pollution, may imply their preferences or demand for greenspace which would otherwise be hard to measure. We undertook choice experiment surveys in Beijing at different locations and times to elicit the value of green amenities in the form of the public's willingness to pay (WTP). We purposefully valued three types of green amenities, including a neighbourhood park near a respondent's home, a city park in central Beijing and a nature reserve type of national park in an outlying location. We use real-time pollution data to help explain the spatial and temporal variation in WTP, whilst controlling for other possible influencing factors. Our results suggest that respondents exposed to higher levels of pollution are willing to pay more for neighbourhood parks, which is likely attributable to trees' air purification effect. In contrast, short-term exposure to higher levels of pollution seems associated with lower WTP for the city park. This finding is possibly due to people's inclination to reduce outdoor activities on heavily polluted days. However, we find no such effect for long-term pollution exposure. Moreover, we find no connection between pollution and WTP for the national park.

Preferences for result-based agri-environmental measures: a choice experiment study with Japanese farmers
Eiichiro NISHIZAWA, Hosei University

The agri-environmental payment, which is rewarded to farmers who adopt environmentally friendly techniques, is one of the main policy tools for improvement for or maintenance of the environmental quality. Despite of its long history, its effectiveness and efficiency have been discussed. Result-based payment scheme has been drawing an attention as a cost-effective agri-environment measure and eleven countries have implemented this scheme mainly for biodiversity conservation in Europe. Empirical studies on result-based payment scheme have conducted survey or interview to farmers, but none of them use stated-preference approach. This paper is to reveal farmers' willingness to accept (WTA) for participating result-based payment scheme by choice experiments in hypothetical setting in Japan. We set up a hypothetical payment scheme for conserving red dragonflies, Sympetrum spp. These are the most common species that use paddy fields as reproductive sites, but the population is rapidly and severely declining since 1990s. Respondents of the choice experiment prefer result-based scheme to one action -based scheme, the nonuse of certain insecticides, but do not to another action -based scheme, the change in the draining paddy fields.

Private forest owners' interest in forest conservation programs – analysis of motivation and preference heterogeneity
Anna-Kaisa KOSENIUS, University of Helsinki

This paper models the interest of non-industrial private forest owners (NIPFs) for forest conservation programs that are targeted to climate change mitigation and biodiversity conservation and characterizes preference and motivation heterogeneity. A recently developed method, a hybrid of best-worst scaling and discrete choice methods provides a tool for exploring the trade-offs between and preferences for selected design aspects of forest conservation programs: level of payment to forest owner for enrolling on program and length of contract period and a less studied aspect: program implementer. Survey data, collected in February 2019, consists of 405 forest owners and their forest holdings located all over Finland. Conditional logit model shows that shorter contracts, higher payments and non-profit organization as an implementer instead of authorities or for-profit company increase forest owner's interest in forest conservation program. Latent class binary random effects logit model for panel data assigns forest owners to two classes, one of which is more sensitive to level of payment and overall less positive to participation in forest conservation program. Forest owner in this class is characterized as being more dependent on forest related revenue, older, and less likely to currently own any forest conservation areas. For member in this class, the annual WTA for enrolling land on forest conservation program for 40 years was 690€, the WTA for members in another class being 190€. Factor analysis of statements confirms various motivations for forest ownership: economic, socio-cultural, and environmental. Results challenge current forest conservation programs implemented by authorities and traditional timber-production-oriented identity of forest owners by highlighting importance of non-profit implementer of conservation program and acceptability of earning forest related revenue from provision of biodiversity or carbon sequestration services.

PARALLEL SESSION D3 – Valuation of ecosystem services

Ecosystem-based adaptation as a means to support the vulnerable: evidence from Central Vietnam
Liselotte HAGEDOORN, VU University Amsterdam

Many countries in Asia, and especially developing countries, are increasingly vulnerable to floods. Traditional flood risk management, using structural measures, can however create patterns of inequality. Ecosystem-based adaptation (EbA) provides a complimentary approach that is argued to be more inclusive to the groups in society that are especially vulnerable to floods and negatively affected by traditional measures. This paper provides a quantitative analysis of the preferences of two vulnerable groups, the poor and women, for changes in ecosystem services that occur due to the implementation of EbA measures. We do so using data collected through a household survey and discrete choice experiment conducted in urban and rural Central Vietnam. The results reveal higher preferences for most of the changes in ecosystem services that result

from the EbA measures, which include reduced impacts from floods, increases in seafood abundance and tourist numbers, and improvement of recreation suitability. These changes can lead to poverty prevention as well as reduction while improving gender equality through economic opportunities and reduced burdens during and after floods. These results provide crucial in sights for future implementation of EbA projects and for complying to the Sendai Framework and meeting the targets set by the Sustainable Development Goals.

Biodiversity in the Dutch practice of cost-benefit analysis
Frits BOS, CPB

According to the Dutch cost-benefit guidelines, biodiversity points are an innovative and practical method to measure the impact of policy measures on biodiversity. A major use is to compare the cost-effectiveness of project alternatives with respect to their impact on biodiversity. For assessing the net benefits of projects, it is more informative than qualitative or ordinal expert opinions on a policy measure's impact on biodiversity. This paper provides the first overview of this method in Dutch CBA practice. The way nature has been incorporated in Dutch CBA has changed drastically over time: from CBAs in which major impacts on nature were not even mentioned to CBAs that value the impact on ecosystem services as much as possible and measure effects on biodiversity by biodiversity points. The calculation and use of biodiversity points are illustrated by five case studies on water management with nature as a trade-off or co-benefit. These examples show that the applicability of biodiversity points differs per type of nature. It is more difficult for water quality related biodiversity than for land biodiversity, as the impact area is larger and the impacts are more difficult to define. The usefulness of biodiversity points in CBA can be advanced by providing overviews of their costs per point at various locations and for various habitats. This provides insights into the cost-effectiveness of alternative compensation or protection measures. Also the willingness to pay for such points can be investigated and may then later incorporated in future CBAs.

Economic valuation of the ecosystem services in the Israeli Mediterranean
Shiri ZEMAH SHAMIR, School of Sustainability IDC Herzliya

While many current and potential uses of the Israeli Mediterranean have clearly defined economic value and apparent benefits to various stakeholders (e.g. energy and raw materials extraction, maritime traffic), the marine ecosystem's benefits are severely underexplored and are not manifested in economic terms. Coupled with increasingly changing environmental conditions (e.g. climate change, biological invasion), the need for performing both monetary valuations and spatial analyses to the benefits derived from this ecosystem, is clearly evident. In this paper we performed an evaluation of marine and coastal ecosystem services in order to better quantify and map their importance to society. By employing various economic valuation methods, the benefits of the assessed ecosystem services were monetized. In addition, the study performed spatial analyses to the ecosystem service in order to map distribution of values, identify critical areas of ecosystem services' supply, and provide predicative supply trends given expected scenarios. Our main tool for applying the spatial analysis was ARtifical Intelligence for Ecosystem Services (ARIES), a modelling platform which enables the construction of Ad-hoc deterministic or probabilistic models, suited to given case studies and local conditions while at the same time acknowledges missing or uncertain data.

Community Valuation of Eco-System Services as Social Capital Creation: On Joint Participation in Farming System, Landscape and Project Analysis
Ernst-August NUPPENAU, Justus Liebig-University

This paper focuses on the idea of merging the concept of farming system analysis (FSA) and ecosystem services (ESS) at a landscape level for community valuation and social capital creation. It offers a conceptual framework for participants to appreciate a landscape as unit of providing eco-system services ESS and becoming a joint asset rendered as social capital. Beside farmers non-farm concerns in land use of nature conservation and improving nature provision for cultural landscapes are integrated. We show how to improve sensitivity for ESS at landscape level under collective decision making processes. In a first step we clarify the issue and acquaint the reader with discussions on the importance of ecosystem function (ESF) and services (ESS). Then well-being

is acquired by a group of users as benefits from a self-reliant cultural landscapes being an institution and semi-autonomous unit; hence we surpass methodological individualism. Secondly we inform about deliberations on possible ways for the inclusion of ESS in landscape management, currently popular in upcoming projects and policies. The ESS concept shall serve as a vehicle to promote "more conducive" land use systems and we look at analyses broadening the concept of farming as system analysis to landscape analysis in sense of balanced needs. In a third step, we emphasize landscape aspects (features) for ESS provision, and finally come to possible responses by users. The aim is to create new insights by looking into ESS concepts and scrutinizing them for landscapes. The principal message is that there is scope for a new synthesis, called landscape system analysis (LSA). An advanced LSA requires integration of ESS as public management, inclusion of community concerns, and promotion of farm related ESS.

PARALLEL SESSION D4 – EU BioMonitor Project Session

BioEconomy Options and Sustainability
Maximilian KARDUNG, Wageningen University

The development of the bioeconomy is driven by innovation for alternative uses of biomass. The sustainability of using different forms of conversion is widely debated. We propose to use the genuine investment framework for assessing the sustainability of the bioeconomy. We first introduce the concept based on the seminal paper by Arrow et al (2012) and advance their model by including uncertainty and irreversibility explicitly and link the model with the EU bioeconomy strategy and discuss the implications for measuring and monitoring the development of the EU Bioeconomy.

Linking Material Flows with Economic Flows
Myrna VAN LEEUWEN, Wageningen Economic Research

In recent years, there has been more focus on the Circular Economy (CE) in policies and society. The aim of the Dutch Government-wide programme for a Circular Economy is to reduce a-biotic raw materials by half in 2030. In 2050, the aim is to have a fully Circular Economy with zero waste and all materials being reused. To monitor the transition to a Circular Economy, the Material Flow Monitor (MFM) can be used and linked with the system of national economic accounting (SNA). The MFM is a macro-economic database of all material flows within the economy, imports and exports and flows between the economy and the environment. The methodology used by the Dutch Central Bureau of Statistics (CBS) and preliminary results will be presented and the challenges for linking the MFM with the system of national accounts discussed.

Full Speed Ahead or Floating Around? Exploring the Dynamics of the EU Bioeconomies
Dusan DRABIK, Wageningen University

The EU bioeconomy is a complex system of interactions among various actors at regional and national levels. The system is evolving over time, and a plethora of indications have been proposed to monitor either its status quo or changes. Policymakers and industry representatives are typically interested only in subsets of them, which can create a bias in providing a reliable picture of the evolution of the EU bioeconomy. In contrast to that, our framework—based on Markov transition matrices—can handle any number of well-defined quantitative indicators. For practical reasons, we use the UN sustainable development goals and circular economy indicators related to the bioeconomy in ten EU countries between 2006 and 2016 as provided by Eurostat. We identify which indicators improve most over time and what the intra distribution dynamics of the indicators are. We also point to similarities and differences in the development of the ten bioeconomies. Our paper contributes to the current literature by providing a more comprehensive view of where and how fast the bioeconomy in ten EU countries is moving.

PARALLEL SESSION E1 – Conservation auctions

Coalitions, Competition, and Conservation: Spatial Procurement Auction Design and Performance
Marc N. CONTE, Fordham University

One objective of payment-for-ecosystem services programs that utilize procurement auctions to allocate payments is to motivate bids from producers who implement similar conservation practices and are located spatially adjacent to each other. This spatial coordination of winners is beneficial for enhanced production of many ecosystem services and biodiversity conservation. In this paper, we introduce a model of bidder behavior in a spatial procurement auction, which offers a bonus payment and quality premium to bids that are part of a coalition of adjacent bidders, to motivate a laboratory experiment in which participants submit bids in auctions under different information, communication, and landscape treatments. We find that auction design leads to different impacts on auction performance and bidder behavior based on the landscape type in which the auction is conducted. Whether due to excessive rent-seeking or the challenges of coordination among large coalitions, auction performance in a landscape with a single large coalition is shown to lag behind that of landscapes in which there are multiple, smaller coalitions.

Performance of conservation auctions: Does preexisting institution matter
Abel-Gautier KOUAKOU, Osnabrück University

This paper presents experimental evidence that the performance of institutions governing conservation outcomes depend on the order in which these institutions are introduced. We study a conservation setting where conservation contracts to landowners can be distributed by different allocation mechanisms: a fixed-price scheme or a conservation auction. Our data shows that subjects who had experienced a fixed-price scheme before a conservation auction is in place adjust their bids in the auction according to the observed fixed-price level. This in turn hampers the budgetary cost-effectiveness of conservation auctions when compared to auctions without a pre-existing institution in place. Multiple round bidding cannot attenuate this behavioral bias. However, these effects are significant only in a setting where the fixed price is high. Moreover, despite the behavioral bias induced by the pre-existing institution, the auction still performs better than a fixed-price scheme.

PARALLEL SESSION E2 – Payments for ecosystem services I

Result and Value Based Payments for Field Elements in the Agricultural Landscape – experience from Swedish Pilot study
Knut Per HASUND, Swedish Board of Agriculture

Result Based and Value Based agri-environmental Payments are potentially significantly more efficient for some environmental problems than the currently dominating Management Based and Cost Based Payments. A Swedish pilot study is testing such payments for field elements and forest edges. The study explores innovative approaches of structure indicators and reduction of farmers' risk with mainly positive results. Since stone walls and other field elements are heterogenouos objects, composite indicators are developed to reflect a set of environmental quality variables on biodiversity, cultural heritage and socio-cultural landscape public goods.

Farmers' Preferences Towards Outcome-based Payment for Ecosystem Service Schemes
Katsuya TANAKA, Research Center for Sustainability and Environment Shiga University

In this paper we estimate farmer's preferences for enrolling in an outcome-based payments scheme, using a choice experiment implemented with a sample of Japanese rice farmers. The conservation literature has argued in favour of such outcome-based payment schemes as a means of producing better biodiversity outcomes on farmland, although economists have cautioned about likely lower rates of participation compared to action-based payment schemes. A growing use of outcome-based schemes has been noted in Europe. In the choice experiment reported here, we use the number of fish species recorded in paddy fields to determine payments

received by farmers. Other contract attributes included are monitoring arrangements, the provision of technical assistance in switching to more wildlife-friendly farming methods, whether an eco-certification is offered to scheme participants, and the payment rate. Farmers were asked to choose which contract to accept, and how many hectares they would enroll. This allows us to predict the total level of land entered into the scheme, dependent on contract design.

PARALLEL SESSIONS E3 – Biodiversity

Quantitative analysis of the effectiveness of the Convention on Biological Diversity (CBD)
Yoomi KIM, Ewha Womans University

The Convention on Biological Diversity (CBD), signed in 1993, was designed to secure international interests in the conservation of biological diversity. However, there have been few attempts to evaluate its impact. To provide a quantitative measure of the effectiveness of the CBD, this study investigates the relationship between participation in the CBD and conservation effort in member countries, using an original dataset on 205 countries from 1990 to 2010. The direct measure of conservation effort is protected areas. However, we also consider socioeconomic variables that measure the opportunity cost of conservation. Our results show a positive and significant relation between participation in the CBD and the area under protection. The area under protection is also increasing in forest area, a proxy for species richness and endemism, population density, and GDP. Wealthier, more populous, species rich countries tend to commit more land to protection than poorer, less populous, species-poor countries. The area under protection is, however, negatively related to our proxies for the opportunity cost of conservation, primary and secondary industry. The more land that is committed to industrial production, the less land that is reserved for biodiversity conservation.

Biodiversity conservation in a dynamic world may lead to inefficiencies due to lock-in effects and path dependence
Frank WÄTZOLD, Brandenburgische Technische Universität Cottbus-Senftenberg

Although biodiversity is still diminishing at an alarming rate, in some areas its conservation is expanding. The exact path of this expansion, however, is uncertain. This can lead to problems of path-dependence and lock-in effects. Path dependence describes situations where history strongly influences present decisions and lock-in effects refer to situations where an earlier decision provides strong incentives to follow a particular path, even if more efficient alternatives are available later on. Both concepts have been studied by economists and social scientists in various applications. However, to our knowledge these concepts have not been applied to the analysis of biodiversity conservation policies and strategies in a modelling framework. Here, we develop a conceptual ecological-economic model to investigate which ecological and economic parameters favour the appearance of efficiency losses in biodiversity conservation due to path dependence and lock-in effects in a dynamic two-period two-region model. Generally we find that efficiency losses occur if there are signals that guide the first-period budget into a region that later turns out to be suboptimal if both time periods had been considered right from the beginning. This is, for example, the case if level and slope of marginal costs are small in the region with the less convex ecological benefit function, so that the first-period budget is misguided into the less costly region, ignoring that for larger budgets the ecological benefit is lower than in the other region. To illustrate the conservation relevance of our findings, we present potential efficiency losses through path dependence in the hypothetical case of applying offsets to conserving the endangered Maculinea teleius butterfly near the city of Landau in Germany.

PARALLEL SESSION E4 – Regime shifts

Combined Impact of Exogenous Scarcity Shocks and Endogenous Regime Shifts on Common Pool Resource Management
Katharina HEMBACH, Osnabrück University

The overexploitation of resources beyond critical thresholds threatens many ecosystems, but knowledge of critical thresholds can also motivate cooperation amongst resource users to prevent endogenously driven regime shifts. However, climate change imposes an enormous threat to local resource management by increasing the frequency of extreme weather events that cause exogenous scarcity shocks. We analyse how exogenous scarcity shocks that drive resources close to their critical thresholds may undermine the coordinating effect of threshold knowledge, eventually leading to a collapse of resources due to overexploitation. To do this, we designed a (quasi-) continuous-time common pool resource experiment for the laboratory. We hypothesized that the experience of an exogenous scarcity shock decreases cooperation and consequently increases the likelihood of a resource collapse due to endogenous overexploitation even in the presence of a critical threshold level. The results of our experiment will help to understand if an increase in scarcity shocks due to climate change has the potential to diminish cooperation and thus cause a domino effect that inhibits efficient resource management even if resource users are aware of the threat of an impending regime shift.

A threshold public good game with public good and public bad framing: evidence from farmers and fishers in Cambodia
Esther SCHUCH, Wageningen University

In Cambodia, fishery governance relies largely on informal agreements of community groups, organized per village. The agreements are non-binding but stimulate social norms of cooperation. At the same time, enforcement of these agreements is weak or completely absent. Also, the access to water and fish is an institutional right in Cambodia, which increases the difficulties in resource management. Thus, farmers and fishers rely on the management of the resources through social norms to avoid a collapse of the resource (e.g. the fish stock collapse) or to ensure access to a resource (maintaining irrigation infrastructure). We conduct lab-in-the-field experiments in 21 villages in Cambodia. We perform a threshold public good games to understand how the cooperation evolves when a threshold has to be reached before cooperation pays off. In particular, we are interested whether we can see framing effects when presenting the game as a public good or a public bad game. We find that the level of cooperation is higher in a public good than a public bad framing. This results in a higher success rate of achieving the public good than avoiding the public bad. The effect is partially driven by the differing beliefs about the partners' contributions. In the public bad framing we see that people place high hopes on the contributions of the other group members while in the public good framing the contributions about other group members contributions are anticipated to be insufficient to reach the threshold.

PARALLEL SESSION F1 – Bio-economic models

Spatially explicit criterion for invasive species control
Pierre COURTOIS, CEE-M, INRA, Montpellier

Because management funds available to control biological invasions are often limited, there is a need to rationalize efforts and identify priority locations where invasions are to be targeted first. This paper proposes a spatially explicit cost-benefit decision criterion for optimal resource allocation over space. We construct a cost-benefit optimization framework that incorporates spatially explicit costs and benefits of control as well as invasion spatial dynamics. This framework offers the theoretical foundations of a simple and operational method for the spatial management of invasive species under a limited budget. It takes the form of a decision criterion a landscape manager could use in order to choose how to allocate his annual budget for maximizing the benefit-cost ratio of management. We apply this criterion to the spatial management of primrose willow (L.peploides) in the Brière marshland in France and we offer management recommendations. A key contribution of the paper is to define and apply this decision support tool and to make heuristic recommendations on how to assist local decision makers in rationalizing their efforts.

Bioeconomic Grizzly Bear Management
David C. FINNOFF, University of Wyoming

Grizzly bears are managed in accordance with the North American Model of Wildlife Conservation, which requires that wildlife be managed to balance tradeoffs from ecosystem services. Balancing competing ecosystem services of these animals is complicated by the legacy of past conflicts with humans, which initially led to population decline and listing under the Endangered Species Act (ESA). As grizzly bears have recovered and spread across the landscape, they have triggered a contentious, nationwide debate between alternative stakeholders on how best to manage the grizzly bears in the future. Listed or not, nuisance bears are managed by relocation or non-hunting mortality. If grizzly bears were to be delisted, we demonstrate the opportunity that exists for management agencies to capture more of the value associated with these iconic bears and to simultaneously reduce the risk of human-bear conflicts through the creation of a trophy hunting program. The key role non-hunting mortality plays in the growth and success of the species is a focal component of the analysis

Growth, Transition, and Decline in Resource Based Socio-Ecological Systems
Brooks A. KAISER, University of Southern Denmark

The process of globalization transforms communities. Increased trade and technology can disrupt existing socio-ecological systems that may have persisted for hundreds or thousands of years. Whole socio-ecological systems may be destroyed or subsumed into a new dominant culture, as has occurred with many indigenous cultures worldwide. In this context, I examine the Thule Inuit culture as a dynamic and multi-trophic socio-ecological system. Lessons from the study clarify fundamentals of trade and development: mutual benefits from trade require equitable terms that sustain the original stewards of the ecological resource base; the ability to achieve such equitable terms is a function of governance mechanisms and capabilities; and all trading parties must recognize the need for such institutional tools. The multi-trophic model includes a composite ecosystem resource base, a resource-dependent human population, and a top-trophic human group of Traditional Ecological Knowledge (TEK) holders connected through caloric productivity and use. I calibrate the model with what can be known or deduced from the historical record and ecological evidence. I examine how new stressors to the Thule Inuit system, including the foreign commercial whaling and fur trading that brought particularly rapid shifts from the 1820s forward, transformed the system dynamics. Differences in the ways in which the two commercial enterprises evolved across Inuit communities, particularly in terms of net changes in access to calories and new technologies, provide comparative insights into how socio-ecological systems can gain or lose as the introduction of trade and technology can shift relative rates of return amongst ecosystem components.

PARALLEL SESSION F2 – Behaviour

Favouritism breeds self-interest: an experimental study of procedural and outcome fairness
Ilda DREONI, University of Southampton

We investigate the effect of different procedures for assigning decision-making roles for the distribution of collective resources using a dictator game. Three role allocation procedures are tested, namely random, meritocratic, and favouritism. We contribute to the literature by employing an unfair procedure for the first time and by combining variations across procedures together with the provision of different endowments to recipients. Our study design provides insight into the relationship between procedural and outcome fairness. Findings show that individual choices motivated by outcome fairness are strongly dependent on the degree of procedural fairness. Dictators who obtain their role through unfair mechanisms transfer significantly less money to recipients than dictators exposed to fair procedures.

Prudence and Precautionary Saving by Natural Resource Users
Robbert SCHAAP, Ruprechts-Karls University Heidelberg

An experimental literature is emerging investigating the theoretically predicted relation between higher-order risk preference and financial behaviour. This paper utilizes the institutional framework and diversity of the

artisinal Chilean fisheries to link precautionary savings behaviour with prudence. In this environment we test if prudence is a predictor of precautionary savings and whether prudence relates to occupational choice. We find substantially lower levels of prudence in our sample compared to previous research with non-fishers. We detect differences in prudence and precautionary savings based on target species and demographic correlates. However, we do not find a direct relation between prudence and precautionary savings.

Behavioural biases of experts and their influence on natural resource management
Andries RICHTER, Wageningen University

Natural resource management relies upon expert judgements due to the inherent uncertainty. While experts are assumed to be rational actors, research has shown that their judgements are subject to behavioural biases. Most of the biases in expert judgement, e.g. anchoring, overconfidence bias, or reluctance to revise results, cause an overemphasis of previous results, leading to a status quo bias. Since the assessments conducted by experts are used to inform policy makers, an overemphasis of prior results can endanger the sustainability of the resource. While the prevalence of biases in expert judgements is known, the extent to which they actually influence scientific assessments for policy recommendations is not. Here we show that in the case of fish stock assessments there is a clear status quo bias due to behavioural biases. We find that whenever the setting of the assessment process allows for judgement calls we see a status quo bias. Further, the experts awareness of the use of their work has an impact upon their judgements. In a stressful situation (e.g. assessing a fish stock that is already in a critical stock status) the behavioural biases are stronger. Our results show that behavioural biases are impacting fish stock assessments. This impacts fisheries policy twofold. The direct effect is by providing biased estimates to the policy makers which they translate into annual quotas. There is also an indirect effect, since by confirming the status quo, a sense of security generated which can lead to riskier quota setting

PARALLEL SESSION F3 – Spatial models

Private management of epidemics
César MARTINEZ, CEE-M, Montpellier Univ., INRA, CNRS, SupAgro

Optimal control of epidemics is a major challenge as control is costly and damages are substantial. Complementing the raising literature on the topic, we focus in this paper on coordination and cooperation issues related to control strategies. Modeling an epidemics affecting perennial crops over space and time, we consider a dynamic game where several land owners choose whether to control an epidemics within their property. Analyzing the game both in a cooperative and non-cooperative fashion, we draw insights on initial conditions likely to produce inefficiencies and coordination issues due to private management. We characterize game situations according to spread intensity and infection levels and focus on landowners strategic behaviors generating inefficiencies within a network.

Ecological benefit spillovers from nutrient load reductions and management improvements in a multispecies fishery
Stephen C. NEWBOLD, University of Wyoming

Analysts face a variety of conceptual and practical challenges when attempting to quantify the private and public benefits of environmental quality improvements for harvested biological resources. In this paper we address two of these challenges in the context of a multi-species coastal fishery: 1) the spatial extent of the ecological benefits will be influenced by the species' dispersal and migration patterns and may not be confined to the area where habitat conditions are improved, and 2) the sustainable magnitude of the benefits generally will depend on the nature of the management regime in the affected fisheries. To address these challenges, it often will be necessary to explicitly account for spatial spillovers and to integrate non-market valuation approaches with dynamic models of fishery harvest management in a unified framework. We develop and apply an integrated ecological and economic model of the effect of water quality improvements on the biological production and commercial harvest levels of 14 fish and shellfish species in the Chesapeake Bay, which is the second largest estuary in the world and the largest in North America. We use the model to estimate the benefits of the

Chesapeake Bay Total Maximum Daily Load (TMDL) requirements for producers and consumers of the modeled species, which account for more than 80% of the total commercial fishery revenues in the region. We account for species' movements in and out of the Bay, which allows us to estimate the total benefits to consumers in the Bay and along the remainder of the U.S. Atlantic coast. In our benchmark model, we assume that the affected fisheries are regulated to protect the biological sustainability of the exploited species but that fishing effort is not fully controlled so harvester profits are dissipated in equilibrium. We also consider two alternative scenarios in which the affected fisheries are managed to maximize 1) producer surplus, and 2) producer + consumer surplus. Comparing these scenarios to our benchmark results allows us to examine the influence of the nature of the management regime on the spatial distribution and the magnitude of the ecological benefits from water quality improvements in the Bay. The three main research questions we address in this paper are: How large are the economic benefits of water quality improvements in the Chesapeake Bay? What fraction of benefits are due to spatial spillovers to areas where water quality is not improved? How are the magnitude and spatial distribution of these benefits influenced by the nature of the management regime in the affected fisheries?

Optimal Siting, Sizing, and Enforcement of Marine Protected Areas
Jo ALBERS, University of Wyoming

The economic empirical analysis assessing the effectiveness of parks uses predictions of threats to resources to determine “avoided deforestation” yet such predictions are not commonly used in determining the siting and management of parks in order to maximize their effectiveness. Especially in cases of incomplete enforcement that are abundant in lower income countries, the reaction of potential resource extractors determines both the conservation and economic outcomes from protected areas (PAs). Agents may respond either by shifting extraction to areas outside the PA or by illegally extracting within an incompletely enforced PA. In designing PAs, it is crucial to consider how both types of response will alter outcomes under the PA policy and use those outcomes to define optimal PAs. Our model analyzes how a manager designs a PA (MPA) to achieve either conservation or economic goals by incorporating fishers’ spatial equilibrium response to the policy. We incorporate three salient features of (M)PA policies in developing countries -- spatially explicit travel costs; wage labor as an outside option with diminishing marginal returns; and incomplete enforcement -- each of which is essential to characterize the interplay between (M)PA policy design and fishers’ equilibrium response to the policy. Using a spatially-explicit bio-economic model of fish dispersal and fisher location and labor allocation decisions resulting in a spatial Nash equilibrium, this paper demonstrates how the optimal size, enforcement, and location for a marine protected area (MPA) and the resulting effectiveness of the MPA depend critically on the optimization and equilibrium response of fishers. This analysis shows that optimal MPAs differ markedly across goals and across enforcement budget levels; that illegal harvest in MPAs can be optimal, especially when small levels of enforcement solve some of the open access over-extraction problem; and that fish dispersal and fishers’ location decisions interact with MPA policies to have marinescape-wide implications including leakage. The analysis characterizes the costly mistakes generated by failing to incorporate the re-optimization of fishers in response to the MPA and incomplete enforcement when making MPA siting and enforcement decisions. Overall, this paper defines the microfoundations of fishers’ location and labor decisions, and uses those to determine the most effective size, configuration, and enforcement of MPA networks.

Logistical Details

Getting to Wageningen

Public transportation: take the train to station Ede-Wageningen. From Ede-Wageningen station you can take Syntus bus 84, 86 or 88 to the bus stop: Bus station Wageningen. This bus stop is within walking distance of the hotel/conference venue.

Getting to the hotel/conference venue from the bus station: 5 minute walk (417m)

Head west on Stadsbrink towards N255 Lawickse Allee, cross the road at Olympiaplein and continue to follow N255 Lawickse Allee. The destination, Wageningen International Congress Centre (WICC), at Lawickse Allee 9, will be on the left.

Conference venue

The 21st BIOECON Conference will take place at Wageningen International Congress Centre (WICC), Lawickse Allee 9. All activities will take place in this building except for the welcome drinks.
During the conference we will make use of the following rooms: Haakzaal, Roghorstzaal, Tarthorstzaal, Peppelzaal. Coffee breaks will be held in the WICC Lounge. Lunches and Dinner will take place in the WICC Restaurant.

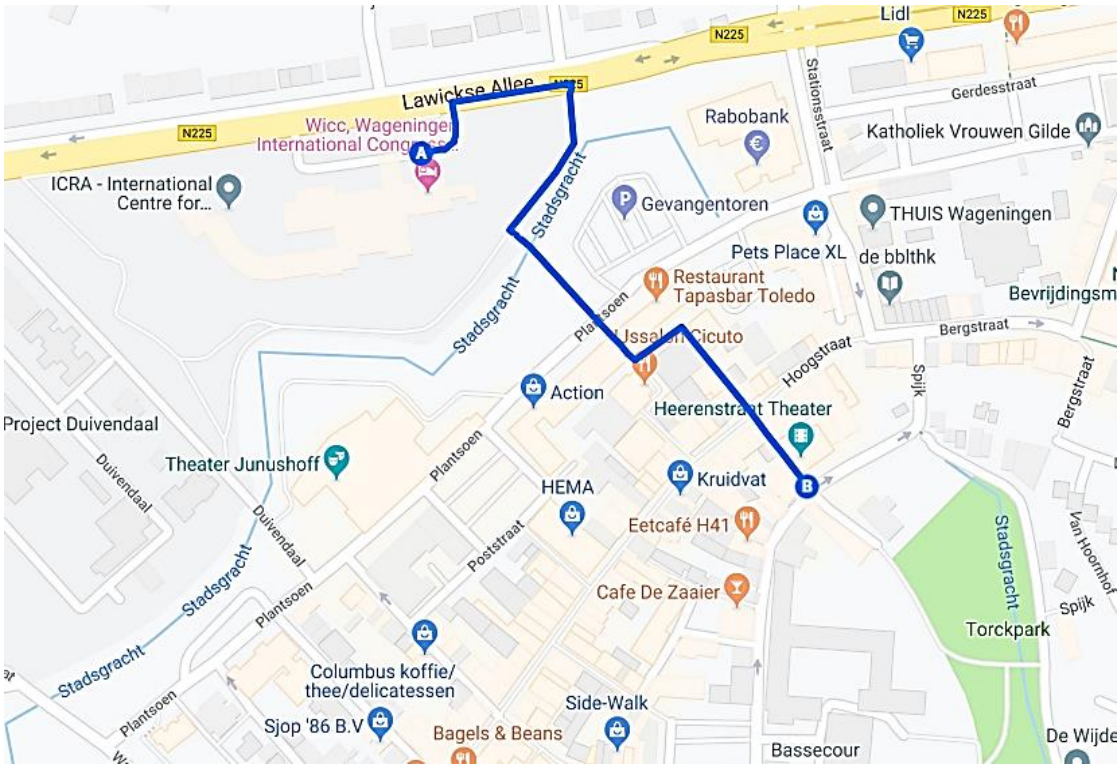
Welcome reception

The welcome reception with drinks and a simple buffet will be held on September 11th , 18:00 hrs. at Café Loburg, Molenstraat 6, Wageningen

Getting to the reception venue from the WICC: 5 minute walk (436m)

Head east towards Lawickse Allee, turn left towards and follow Schuijlensteeg(+/- 100m), turn left onto Schoolstraat continue on to Molenstraat(+/-140m). Destination will be on the right.

See the map on the next page.



Instructions for paper presenters, discussants and session chairs

The seminar rooms will be equipped with a laptop, beamer and screen.

Paper presenters are requested to upload their presentations on the seminar room's laptop 10 minutes before the start of their session.

Paper discussants: Most (if not all) paper presenters also act as discussant to another paper in their session. Please consult the programme to see if and which papers you are to discuss. Paper discussants are kindly requested to download the paper and prepare your comments. If you have any difficulties in downloading papers please notify the Bioecon secretariat at bioecon.2019@wur.nl.

Session chairs: Please consult the programme to see if you are chairing any sessions. If so please promptly proceed to the relevant seminar room and confirm that presenters and discussants are present. Please ensure that all speakers stay within the time limits. If there are any IT difficulties during the session please contact the student assistant assigned to the room. If you are unable to chair the session please inform the organisers as soon as possible.

Internet access

Details on how to access Wi-Fi within WICC will be provided at the conference desk.

Conference Sponsors

'To explore the potential of nature to improve the quality of life'. That is the mission of **Wageningen University & Research**. Over 6,500 employees and 12,000 students from more than hundred countries work everywhere around the world in the domain of healthy food and living environment for governments and the business community-at-large.
The aim of the **Section of Economics** at Wageningen University is to be a key player in research and education on economics of sustainable development. We aspire to produce output that is both socially and academically relevant. The section of economics consists of five chair groups, home to the staff and faculty: Agricultural Economics and Rural Policy (AEP), Urban Economics (UEC), Environmental Economics and Natural Resources (ENR), Development Economics (DEC), and Rural and Environmental History (RHI).

PBL Netherlands Environmental Assessment Agency is the national institute for strategic policy analysis in the fields of the environment, nature and spatial planning.
We contribute to improving the quality of political and administrative decision-making by conducting outlook studies, analyses and evaluations in which an integrated approach is considered paramount. Policy relevance is the prime concern in all of our studies. We conduct solicited and unsolicited research that is independent and scientifically sound.
PBL is an autonomous research institute in the fields of the environment, nature and spatial planning. It is part of the Dutch Government organisation; more specifically, the Ministry of Infrastructure. Public Works and Water Management.
Other government departments may also ask PBL to conduct research into issues related to the environment, nature and spatial planning – in particular the Ministry of Economic Affairs and Climate Policy, the Ministry of the Interior and Kingdom Relations, the Ministry of Agriculture, Nature and Food Quality and the Ministry of Foreign Affairs.

marEEshift

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Federal Ministry of Education and Research

marEEshift is a collaborative project funded by the German Federal Ministry of Education and Research (BMBF) under the BioTip program. marEEshift partners are Leipzig University (PI Martin Quaas), University of Hamburg (PIs Christian Möllmann and Moritz Drupp), University of Freiburg (PI Stefan Baumgärtner), Thünen Institute Rostock (PI Harry Strehlow), and IGB Berlin (PI Robert Arlinghaus). The project studies tipping points towards sustainability in the marine ecological economic system of the Western Baltic sea and beyond, with a focus on commercial and marine fisheries.

iDiv
German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig

The **German Centre for Integrative Biodiversity Research (iDiv)** Halle-Jena-Leipzig is a National Research Centre funded by the German Research Foundation (DFG). Its central mission is to promote theory-driven synthesis and data-driven theory in this emerging field. It is located in the city of Leipzig and it's a central institution of the Leipzig University, jointly hosted by the Martin-Luther-University Halle-Wittenberg, the Friedrich Schiller University Jena and the Helmholtz Centre for Environmental Research (UFZ).

UNIVERSITY OF CAMBRIDGE
Department of Land Economy
50th Anniversary 1962-2012

The **University of Cambridge** is one of the world's foremost research universities. The University is made up of 31 Colleges and over 150 departments, faculties, schools and other institutions. Cambridge has many notable alumni, including 90 Nobel laureates who have been affiliated with it.
The **Department of Land Economy** is a leading international centre, providing a full programme of taught courses and research groups focusing on the law and economics of property, spatial planning, and environment.

About Bioecon

BIOECON (BIOdiversity and Economics for Conservation – BIOECON) is an interdisciplinary network aiming to advance economic theory and policy for biodiversity conservation. BIOECON assembles economists, lawyers and scientists from leading international academic and research institutions and main policy organisations working on design and implementation of cutting edge economic incentives for biodiversity conservation.

The network is the outgrowth of a project supported by the European Commission under the Fifth Framework Programme contributing to the implementation of Key Action 2: Global Change, Climate and Biodiversity within the Energy, Environment and Sustainable Development Programme. After its conclusion, the partners have continued to operate the conference in recognition of the large group of students and academics interested in working in this field, and in recognition of the need for a forum for their work. Over the past ten years, the network and conference has also served as a forum for policy organisations and government analysts to gather and to consider biodiversity and conservation issues as well.

In 2011 the Network was institutionalised, enlarging its partnership to outstanding institutions and research centres all over the world, working on biodiversity issues under different perspectives, reaching thus the number of thirty members.

The principal aim of BIOECON is to investigate the economic and policy driven forces responsible for decline of biodiversity, and accordingly, to develop and implement tools, i.e. incentive mechanisms, that could halt if not reverse the effects of these forces.

BIOECON wants to encourage: (i) to utilise a multidisciplinary approach to assess the social forces behind biodiversity change; (ii) to assess the ecological and socio-economic consequences of this change, (iii) to comprehend the interplay of these consequences; and (iv) to provide concrete policy responses for addressing biodiversity change. These overarching aims are pursued via individual projects developed within the network partnership on all three levels of biodiversity, namely the genetic, species, and ecosystem level.

BIOECON serves as a catalyst to spread the main results of research and practices on these themes, through a series of activities, amongst which its annual meeting, that represents an opportunity for networking, and sharing lessons and experiences with other researchers, environmental professionals, international organizations and policy makers.

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