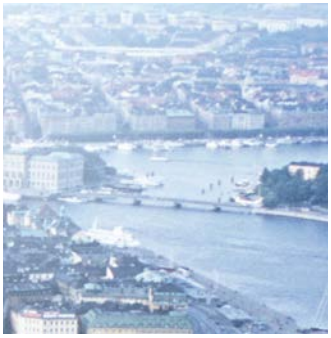
THE BEIJER INSTITUTE OF ECOLOGICAL ECONOMICS

ANNUAL REPORT 2014/2015



THE BEIJER INSTITUTE OF ECOLOGICAL ECONOMICS

KUNGL. VETENSKAPS-AKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

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The Beijer Institute of Ecological Economics

ANNUAL REPORT
1 JULY 2014 – 30 JUNE 2015

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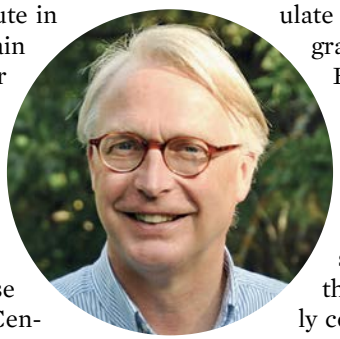
Director's column

THE WORLD seems to be in the midst of a paradigm shift. The prevailing view of the environment as a mere sector of society, separated from economic progress and societal development, is increasingly being replaced by the recognition that progress and development are integral parts of the environment, of the thin and fragile biosphere of planet Earth. It has become clear that our own future and wellbeing are at stake, as we are re-shaping the planet while still being fundamentally dependent on its functioning. This paradigm shift is taking place across societies and globally, in what is almost a new renaissance, and it is amazing to see new actors, from chefs, restaurants and art venues to multinational enterprises and development aid organisations, reconnecting people to the biosphere.

It is an exciting time to direct the Beijer Institute, which is carrying out research and stimulating cooperation to promote a deeper understanding of the interplay between ecological systems and social and economic development. Leading scholars, predominantly economists and ecologists, are interacting under the umbrella of the Beijer Institute in our research programmes and projects to gain new understandings and insights. The Beijer Board and Fellows are active and supportive and many are deeply engaged in our activities. Beijer programme directors and researchers do amazing work in extending scientific frontiers, experimenting, testing new areas and ways of interacting across disciplines, and learning during the journey. There is close collaboration with Stockholm Resilience Centre, Stockholm University, where the Beijer Institute serves as the core partner, and with the Family-Erling Persson Academy programme Global Economic Dynamics and the Biosphere (GEDB).



It is rewarding to experience that the whole is so much more than the sum of its parts and to witness the devotion of young skilful scientists and students from different parts of the world operating, collaborating and innovating at the international platform for ecological economics and sustainability science that we have created.

We are working together to answer questions such as: How can we develop our societies within the boundaries of the biosphere? How can we make sustainable use of nature's services and capital in an increasingly urbanised world? How can we capture the role of nature for our welfare in economic development? How can we manage the seas and develop aquaculture for fair and sustainable use of the world's food resources? How can we enhance our ability to live with uncertainty and complexity in a world undergoing rapid change? How can people's behaviour contribute to a resilient biosphere and improved human welfare?

New surprising findings are emerging and they are communicated and disseminated widely. Never before have we published so much in different top-ranking scientific journals, including *Science, Proceedings of the National Academy of Sciences (PNAS)*, USA, and *Philosophical Transactions of the Royal Society of London* and several of these articles have rapidly received widespread attention. It is inspiring and always surprising to learn about the uptake, influence and interest in our achievements, reflected in research, teaching, practice and policy across the world.

Working together with the permanent Secretary of the Academy, Staffan Normark, who is now stepping down from this post, has been exceptional. The continuous engagement, flexibility and professional support of the Academy in all dimensions is strongly appreciated. We warmly welcome the new leaders of the Academy and we are very much looking forward to collaborating with them. I would also like to gratefully acknowledge the support for our work and activities from charitable foundations and funding bodies.

The substantial and long-term investment of the Beijer Foundation in our interdisciplinary research institute at the Academy is truly unique. The core funding has not been provided to find quick solutions to specific problems or issues, but to establish an arena for knowledge innovation and understanding where different research areas can meet and interact. It has become an incubator for new ways of thinking and understanding to meet the challenges of the future and has allowed promising young researchers to flourish, stimulate each other and find new paths. We are most grateful to Anders Wall and the members of the Beijer Foundation for their visionary support and trust in our work and activities.

With the Beijer Foundation, an amazing and most exciting process took place during the year. It is the owner of the classic furniture store in Stockholm, Svenskt Tenn, and profits of the store enter the foundation and consequently contribute to funding the research of the Beijer Institute. To make this link explicit and test new ways of communicating via the Art-Science interface, the exhibition "Patterns of the Biosphere – Research for a Sustainable Future Supported by Svenskt Tenn" was developed. The two-month spring exhibition was a great success. Allow me to end this Director's Column with a quote by Anders Wall from the exhibition catalogue:

"I am proud that we acted so early in promoting an area of research that is now of acute relevance. The Beijer Institute is creating new understanding of the links between humans and nature and our need for a healthy biosphere. For me, a farmer's son, this connection is abundantly clear. There is a clear link between the Beijer Institute's aim of building a robust society with long-term sustainability and the quality and timeless beauty that characterise the Svenskt Tenn interior décor philosophy. Whether one mixes old and new, different styles of furniture, colours and patterns – objects that one loves will still blend together into a harmonious entity. This picture of a safe, harmonious and sustainable home interior also illustrates the concepts of biodiversity and resilience and their importance for the harmony of our global home."

Stockholm, 10 August, 2015

***Carl Folke** Director*

Research

The Beijer Institute of Ecological Economics provides a forum for researchers in economics and ecology and related disciplines to interact and develop joint research, seeking a deeper understanding of social-ecological systems. Research at the Beijer Institute is organised into five international programmes that comprise a diverse set of projects.

Aquaculture and Sustainable Seafood Production

Programme director: Max Troell

SUSTAINABILITY science emphasises reducing vulnerability and building resilience in social-ecological systems. In a world where aquaculture, crops, livestock and fisheries sectors are heavily intertwined through social, economic and environmental interactions over large distances and multiple scales, challenges for governance are mounting.

The Beijer Institute's research programme Aquaculture and Sustainable Seafood Production made some significant contributions during the year to the sustainability discussion worldwide through publications in e.g., the journals *PNAS* and *Science*. The perspective paper in the September 2014 issue of *PNAS* asked "Does aquaculture add resilience to the world's food portfolio?". The answer was not unambiguous, but in general aquaculture can constitute an opportunity for enhanced resilience in the global food system. This paper is presented in greater depth later in this report. In addition, a paper in the journal *Environment Research Letters* estimated the virtual water footprint of marine aquaculture, i.e., focusing on its link to agriculture. It laid the foundation for an international workshop at the Beijer Institute focusing on aquaculture's role for global freshwater consumption.

Transnational corporations are keystone actors

A paper in *PLOS One* showed how only a handful of transnational corporations dominate all segments of global seafood production and thus have a disproportionate influence on the structure and function of ecosystems. These operate through an extensive global network of subsidiaries and are profoundly involved in fisheries and aquaculture decision-making. Importantly, sustainable leadership by these actors could result in cascading effects throughout the entire seafood industry and enable critical transition towards improved management of marine living resources and ecosystems (for more detail, see later in this report). A paper in *Fish and Fisheries* added further knowledge to the global seafood complexity by explaining how the lack of reliable price feedback to the consumer, i.e. the fact that the price of fish generally does not reflect the state of fisheries and marine ecosystems, represents a challenge for sustainable fisheries governance, of which aquaculture constitutes a significant part.

China dominates the seas

In the January 2015 issue of the journal *Science,* the role that China's aquaculture development plays for world wild fisheries was analysed. As the world's leading producer and consumer of

"Sustainable leadership by these keystone actors could result in cascading effects throughout the entire seafood industry."

seafood, it became clear that the scale and complexity of China's aquaculture sector places it in a precarious position as regards global seafood availability. Even if fish processing wastes are increasingly recycled as aquaculture feeds, China's aquaculture industry will continue to strain wild fisheries, unless the country commits to stricter enforcement of regulations within and outside its fishing zones and to responsible sourcing of fishmeal and oil. Thus, aquaculture remains an emerging industry and requires further development of responsible management and best business practice, as well as strategic environmental planning and sustainability assessment. The article is presented later in this report.

Decrease antibiotics use and increase human welfare

In a response *PNAS* Letter in June 2015 to a recent study on antibiotic consumption in livestock around the world, we showed that aquaculture can offer a source of animal protein with relatively limited antimicrobial usage. However, the industry needs to continue to strive towards alternative and better practices aiming for further reductions in antimicrobial use.

The Aquaculture Programme is endeavouring to complement its global systemic focus with studies that further deepen understanding of aquaculture's role for improving human well-being, with specific emphasis on poverty alleviation. A study in the *Journal of Aquaculture* analysed social outcomes from aquaculture by looking at which factors determine who benefits and who is negatively impacted from aquaculture development. In addition, an international collaborative study (in review) investigated the contribution of fisheries and aquaculture to food security, economic growth and poverty reduction by assessing global peer-reviewed studies in the period 2003-2013. It showed that the links between fisheries and poverty alleviation are complex. Furthermore, the impacts of fish trade on food security and poverty alleviation are confounded by a focus on international trade statistics which do not show if and what social benefits reach fishers and aquaculture farmers. Aquaculture's role for poverty alleviation will be further studied through collaboration with Worldfish. The Swedish International Development Agency (Sida) together with the Australian Department of Foreign Affairs and Trade will fund research in Burma and East Africa.

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Cages for carp storage before marketing, Lake Qiandaohu, Zhejiang province, China. Photo: Wenbo

Behaviour, Economics and Nature Network - BENN

Programme Director: Marty J Anderies
Programme Manager: Therese Lindahl

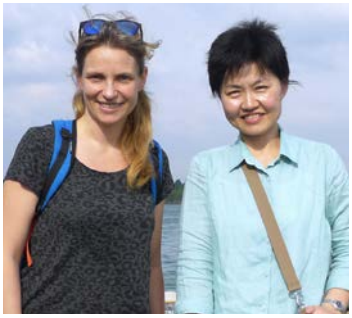
THERE is mounting scientific evidence that human actions have become the main driver of global environmental change. Furthermore, if the impacts of human activities cross a critical threshold, there is a risk of unpredictable and abrupt environmental change on local, regional and global scale. The potential for such abrupt change vastly increases the complexity and difficulty of managing human impacts through environmental policy. The mission of BENN is to move beyond current approaches to environmental policy and explore alternative approaches for living within planetary boundaries that emphasise achievement of a good 'fit' between human behaviour, the biophysical environment and governance.

Field experiments with fishermen

Human activities are triggering regime shifts to an increasing extent. This emphasises the importance of studying how people react to, and deal with, the potential for such abrupt changes, which is exactly the purpose of a BENN project launched in January 2014, building on laboratory experiments in earlier projects. In December 2014, the first set of field experiments, with artisanal fishermen, was established in Tha Chat Chai village, Phuket, Thailand. The aim was to obtain data to support the formulation of policies that protect local livelihoods and the ecological functions on which they depend, through a better understanding of social mechanisms underlying regime shifts in ecosystems.

Preliminary results indicate more cautious exploitation behaviour emerging among managers when facing a potential regime shift. However, such successful management is sensitive to changing conditions, especially if alternative income sources are limited. The second set of field experiments within this project will be conducted during the coming winter 2015/2016 in Colombia.

In a parallel project, BENN researchers are looking into the behavioural responses to regime shifts of Swedish fishermen. This project is focusing particularly on the implications of different types of policy instruments and laboratory experiments are also being conducted.



Left: Thai fishers taking part in a field experiment. Photo: Rawadee Jarungrattanapong

Below: Therese Lindahl and Rawadee Jarungrattanapong

Funding
Formas (Thailand, Colombia).
Project members
Anne-Sophie Crépin, Therese Lindahl and Caroline Schill, the Beijer Institute; Juan Carlos Rocha, SRC; and former Mäler Scholar Rawadee Jarungrattanapong, Sukhothai Thammathirat Open University, Thailand
Funding
Riksbankens Jubileumsfond (Sweden).
Project members
Therese Lindahl, Anne-Sophie Crépin and Nikolina Oreskovic the Beijer Institute.

Introducing AgentEx

Most common pool resource (CPR) research focuses on what facilitates cooperation, which is of course understandable - overcoming a CPR dilemma is a difficult, yet necessary, task. However, it is not sufficient. In this project an agent-based model (AgentEx) is designed. It is based on a series of experiments, with the aim of gaining a better understanding of the conditions where cooperation will (or will not) lead to sustainable resource management. In a nutshell, although having good individual knowledge in the cooperative group is important, it is equally important to have good group knowledge, which in turn is critically dependent on the distribution of individual knowledge, social skills and confidence in knowledge.

Project members
Therese Lindahl and Caroline Schill, the Beijer Institute; Maja Schlüter and Nanda Wijermans, SRC.

Supermarket nudging

One of the most important drivers of environmental degradation coupled to food consumption is diet changes, e.g. an increase in demand for meat, dairy products and luxury foods. However, from a policy perspective, food consumption behaviours are challenging to target through traditional instruments such as regulations, taxes and

Askö meeting 2014.
Back row: Scott Barrett, Nils Kautsky, Stephen Polasky, Scott Taylor, Simon Levin, Aart de Zeeuw, Carl Folke, Neild Adger, Paul Ehrlich, Terry Chapin, Brian Walker

Middle row: Lena Kautsky, Anastasios Xepapadeas, Therese Lindahl, Carole Levin, Anne-Sophie Crépin, Karine Nyborg, Caroline Schill, Christina Leijonhufvud, Agneta Sundin

Front row: Kenneth Arrow, Jim Wilen, Stephen Carpenter, Astrid Dannenberg, Marty Anderies, Marten Scheffer, Gretchen Daily, Maja Schlüter

subsidies. The entry point of this project is therefore to investigate the potential of *nudges* for promoting sustainable food consumption choices – a method of enticing people to behave in certain ways, without using coercion or force, but by changing small aspects of the decision-making environment or *choice architecture*. During spring 2015, Therese Lindahl and SRC Master's student Linda Lindström had the opportunity to implement a nudge tailored to reduce meat consumption in a number of food stores, in collaboration with one of the major food retailers in Sweden. The experiment ended in mid-June 2015 and the data will now be analysed.

Moreover, a report investigating and explaining the concept of nudging written by BENN researchers on behalf of the Swedish green think tank Fores was published in June 2015. Read more about the report *Nudges: The New Black in Environmental Policy?* later in this annual report.

Project members
Therese Lindahl and Linda Lindström.
Partner
ICA AB, Sweden.

Evaluating changes in energy consumption behaviour

A new mobile application to help Swedish households use energy more efficiently has been developed by Greenely, a company from KTH Royal Institute of Technology's innovation office. Using algorithms and analysis of energy data from the Smart Grid, it makes energy behaviour part of everyday life by providing graphical feedback to consumers about past and current use compared with a target level. BENN researchers and partners are working together with Greenely to verify the technology and measure the effects on household energy behaviour in a pilot field experiment currently involving about 700 households. The data will soon be analysed and the plan is then to scale up the experiment.

Project members
Therese Lindahl and Britt Stikvoort, the Beijer Institute; Peter Martinsson and Fredrik Carlsson, Department of Economics, Gothenburg University.
Partners
Greenely, KTH Royal Institute of Technology and the Swedish energy company Mälarenergi.

"A new mobile application to help Swedish households use energy more efficiently"

Strengthening ties with neuroscience

To follow up on last year's BENN workshop (see Annual Report 2013/2014), two back-to-back workshops were held this year during three intense days, 8-10 June 2015. The purpose of the first meeting, *Living with Homo Economicus?*, was to continue working on the draft of the position paper initiated at last year's meeting. This year, an outline of the paper was quickly decided upon which was thereafter developed in smaller groups. The plan is to submit a finished draft during the autumn. During the second workshop, *Exploring the limbic system in CPR management*, the group finalised an experimental programme for a collaborative research project. Combining technologies developed by behavioural neuroscience, the aim is to answer questions regarding environmental decision-making in CPR settings. Potential funders were identified and an application for funding drafted. Financial support for these workshops by the Anna-Greta and Holger Crafoord fund is gratefully acknowledged.

Social norms, multiple equilibria and the environment

The 22nd annual Askö meeting, entitled *Social norms, multiple equilibria and the environment*, took place on 13-15 September 2014 and explored the concept of norms and the role of norms in the Anthropocene. As usual, internationally renowned researchers, predominantly ecologists and economists, met for discussions and this year's research question was: "We know that social norms can facilitate cooperation in small groups, but can social norms also help solve large-scale collective action problems like climate change?" Based on the discussion and insights from the workshop, the core writing team was able to start a policy paper on this topic.

Complex Systems

Programme directors: Aart de Zeeuw and Chuan-Zhong Li

SOME fifty years ago, Edmund Phelps published an influential paper in a fairy-tale style concerning capital accumulation and the golden rule of economic growth. The story had a typical ending where people in the wonderland all lived happily ever after under the golden rule with a maximum welfare level when the steady state was reached. In the real world, however, people are continually facing various risks arising from e.g. tipping points, nonlinearities and feedback on the way to the presumed golden rule state. With such risks, the golden rule needs to be modified to a 'green' golden rule that takes account of these risks. Natural resource management has to be adapted with realistic perspectives.

In this research programme, we are developing economic theory and policy instruments for improving the management of social-ecological systems that recognise the complexity of multiple interacting components of the various risks. Through small-scale integrated models, we are exploring the economic effects of links, feedbacks and tipping points in complex systems and their implications for improved resource management.

Effects on economic growth of the future risk of climate change

The project *Climate Tipping and Economic Growth* is investigating the effect of a potential non-marginal or substantial shock on total factor productivity due to the risk of climate change, which would lead to a regime shift in the accumulation of capital. There are two effects. First, the golden rule of capital accumulation will change. This means that precautionary saving is needed in order to be prepared for the possible drop in consumption. This can be viewed as a form of building resilience. Second, a higher tax rate on carbon emissions is needed, compared with the tax rate required in the event of only marginal damage arising due to climate change. This additional tax would be substantial, due to the structural changes that regime shifts imply. In a calibration of the world economy, the results show that the tax would be 55–70 USD per ton of CO_2, whereas the typical analysis of using the DICE model and assuming only marginal damage would give a tax of 15 USD per ton of CO_2. In a subsequent paper, the same question was investigated in a model with two world regions. When the regions cooperated, the same conclusions as above were reached, but when the regions did not cooperate, the precautionary saving and the carbon tax were too low.

Project members
Aart de Zeeuw, Tilburg University, the Netherlands, and the Beijer Institute; Rick van der Ploeg, University of Oxford, UK.

The future for water in South Africa

As a drought-prone and water-poor country with rapid population growth, South Africa is believed to face serious challenges to sustainable development. In the project *Growth, Water Resilience and Sustainability,* a dynamic stochastic general equilibrium model has been developed to analyse how water resilience may affect economic growth and dynamic welfare with special reference to South Africa. The findings indicate that with sufficient capital accumulation, development can still be sustainable despite increased water scarcity in future and decreased long-term sustainable welfare. While stochastic variation in precipitation had a negative effect on water resilience and social well-being, the effect of persistence in the precipitation pattern was positive. With heavier time discounting and lower capital formation, however, the current welfare level may not be sustainable.

Project members
Chuan-Zhong Li, Uppsala University and the Beijer Institute, and Ranjula Bali Swain, Uppsala University, Sweden.

Resilience pricing and dynamic welfare analysis

In the project *Threshold and Resilience in Fisheries,* the role of tipping points in Argentine's hake fishery and the interlinkage between ecological and economic resilience are being studied. In a theoretical model incorporated with the hazard function for resource management under alternative conditions, the optimal corrective tax can be derived. Applying the model to the case of Argentine's hake fishery, the study showed how fishery management can be improved by more precautionary fishing in the presence of risks of regime shifts.

Within the project *Dynamic Welfare Measurement and Sustainability,* Chuan-Zhong Li and Karl-Gustav Löfgren (2015) applied their theory of dynamic price indexing to data from the US covering the period 1959-2008. Among other things, the paper showed that the real green net national product, calculated with a properly constructed price index, may serve as an ideal measure for dynamic welfare and sustainability.

Ecosystem services valuation is another area that has attracted attention in recent years. In a new project, Åsa Gren, Gustav Engström and Chuan-Zhong Li are developing a simple resilience pricing model of pollination services with interacting insect species. The theory has now been formalised and the next step is to simulate the effects on the crop production value of different semi-natural areas, bee populations and climate change in the Stockholm area.

Project members
Chuan-Zhong Li, Gustav Engström and Åsa Gren, the Beijer Institute, Karl-Gustav Löfgren, Umeå University, Sweden, former Mäler Scholar Sebastian Villasante, University of Santiago de Compostela, Spain, and Xueqin Zhu, Wageningen University, the Netherlands.

Hot topics on the policy arena

In recent years, climate change has moved to the forefront of the policy scene and the literature on macroeconomic aspects of climate change has expanded rapidly. In the project *Optimal Taxation in the Macroeconomics of Climate Change,* Gustav Engström and Johan Gars review the literature with special attention to the important qualitative question of optimal carbon taxes. The review covers topics such as spatial aspects of carbon taxes, interactions with other taxes, uncertainty and technological change.

Project members

Gustav Engström, the Beijer Institute and Johan Gars, GEDB

In the project *Inertia in Risk: Improving Economic Models of Catastrophes,* Anne-Sophie Crépin and Eric Nævdal provide an alternative risk structure termed inertia risk. In this risk structure, the probability of a catastrophe ever occurring is endogenously determined and may vary between 0 and 1. Inertia risk accounts for dynamic lags between physical variables and the probability of a catastrophe. Furthermore, the alternative risk structure shows how inertia risk may also lead to choices with irreversible impacts and demonstrates implications for policy. This approach contrasts with the usual ways of modelling endogenous catastrophic risk in dynamic management problems, which most likely underestimate the true value of a resource. The results were presented at the annual conference of the European Association of Environmental and Resource Economists in Helsinki, Finland, on 24–27 July.

Project members

Anne-Sophie Crépin, the Beijer Institute, and Eric Nævdal, University of Oslo, Norway.

Therese Lindahl, Anne-Sophie Crépin and Caroline Schill have developed a new theory on the behavioural response by resource users to abrupt changes in the resource they manage. Further details are provided in the section on the BENN programme.

In addition, following last year's workshop on the subject (see annual report 2013/2014), work continues on a special issue of the journal *Environmental and Resource Economics* on the economics of complex systems which is expected to be published in spring 2016.

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Urban Social-Ecological Systems

Programme director: Johan Colding

CITIES and towns represent key human conglomerations that shape and influence life on Earth. While urban systems offer immense benefits for humans, they also create great demands for natural resources and generate large volumes of waste. The conditions that make cities attractive cannot be taken for granted. Resilient cities need to be managed and governed in wise and informed ways and scientific insights from the natural and social sciences need to be more firmly integrated in urban planning and design. Yet at the same time, resilient urban development depends on resilient rural areas and functional smaller-sized cities. While urbanisation rate is currently very high, about a quarter of the world's cities are shrinking.

The research programme Urban Social-Ecological Systems strives to take the lead in research that will have a direct impact on reconnecting humans to the conditions that the biosphere requires in order to sustain desirable life foundations. Of key importance is research that can be used to promote resilience building and make city inhabitants more aware of their dependence on ecosystems inside and outside cities. With a focus on urban form, ecosystem services, institutions and resilience science, we are striving to translate such research insights into new urban planning principles and management policies, as well as novel landscape designs that could have a real impact on the ground and in theory.

A new Stockholm node for urban sustainability

In recent years, and due to the threat posed by climate change and loss of ecosystem services, urban policy makers and planners in many parts of the world have been eager to learn more about conditions and factors that promote resilience in linked social and ecological systems. One example of this is the Stockholm region, where ecosystem services and resilience thinking have entered the domain of regional planning and policies, to a large extent facilitated by the Beijer Institute and Stockholm Resilience Centre (SRC) urban research group. Over the past year, these activities have intensified. We are currently in the process of building a Stockholm node of Mistra Urban Futures, an international centre for sustainable urban development. Tentatively called Stockholm Urban Laboratory, it will be located at SRC. Mistra Urban Futures offers an arena for the development and transmission of knowledge, in which cooperation with business, NGOs

View over Stockholm. The urban researchers at the Beijer Institute and SRC are involved in several projects together with Stockholm County planners. Photo: Steven Zeff/Azote

"We are striving to translate such research insights into new urban planning principles."

and the general public is developed. The centre has four local platforms, in Cape Town, South Africa, Kisumu, Kenya, Gothenburg, Sweden and Manchester, UK.

Public and private partnerships for resilient urban development

This Stockholm platform also draws on existing relations with bodies outside academia in the Stockholm region, through well-established connections and a series of research projects and expert commissions over the years. For instance, together with the City Planning Office, a project concerning participatory processes in urban planning and design has been initiated, entitled Gemenskapad Stad (Common Created City). The aims are to investigate how new knowledge and tools from research could play a critical role in informing participatory planning processes.

A similar partnership has been developed on regional level with Stockholm County Council. Plans are being drawn up with the agency Growth, Environment and Regional Planning (TMR) for a second report concerning regional resilience. Contacts are also being established with other municipalities in the region.

The SRC's and Beijer Institute's Urban Research team arranged a conference in Stockholm on 7 November 2014 at which 70 actors in the Stockholm-Lake Mälaren region met to discuss the future of the region from a social-ecological perspective. The conference (in Swedish) *Research and practice concerning the Stockholm-Lake Mälaren region's future – a day for mutual learning* is described in more detail later in this report. A follow-up meeting with Stockholm County Council was held at SRC on 17 April 2015 and further cooperation is planned.

In preparation for a new regional development plan for Stockholm County, a report has been released (in Swedish) by Stockholm County Council. It is called *Seven Perspectives on Sustainable Development (Sju perspektiv på hållbar utveckling)*. Johan Colding contributed a chapter entitled 'Increased sustainability'.

Download at
http://www.trf.sll.se/Global/Dokument/publ/2015/PM-samling_lowres.pdf

Efforts are also being made to establish ties with public and private bodies that deal with infrastructure and buildings. The objective is to establish co-creation projects where the Beijer Institute and partners can have an influence from the start, but also use the projects as case studies for research.

Art and Science

The Stockholm Platform will take part in the event *Experiment Stockholm* to be held at Färgfabriken, Stockholm, between 23 September and 29 November 2015. In a combination of exhibitions, seminars, debates and other events, Experiment Stockholm seeks to examine and experiment with strategies and solutions for dealing with the challenges of a rapidly growing Stockholm region. It deals with questions such as: What kind of society are we building for future generations? How are we to cope with unforeseen events? How do built areas and green areas interact in the city environment?

Learn more at: www.fargfabriken.se

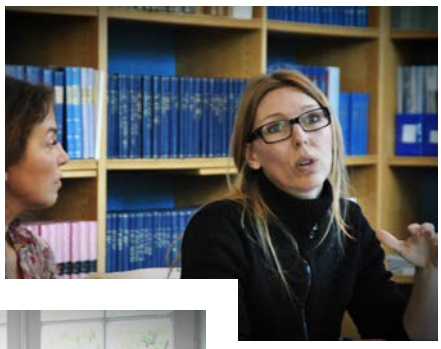
Four films in the series *Urban Green Commons*, which was presented in last year's Annual Report, are now available for viewing at the site www.urbangreencommons.com

Workshop for healthy and sustainable cities

On 8-9 June 2015, Åsa Gren, on behalf of the Urban Research group and the URBES project at the Beijer Institute and SRC, held the workshop *Planning for healthy and sustainable cities: Unpacking the urban green box* at the Royal Swedish Academy of Sciences.

The possibilities of moving beyond the *green/not green* dichotomy that still dominates much of the research in this context were explored, with the focus on how to start 'unpacking' the health benefits generated by urban green areas. Physical and mental health was used as a starting point for the discussions. Representatives from the fields of environmental psychology, sustainable urban planning, medicine and urban ecosystem services were invited to come together to take on this challenge.

The first output from the workshop will be a scientific article synthesising insights from the discussions on how to better identify and assess different health benefits generated when people interact with urban green areas, on how to link these benefits to different classes of urban green areas and how to incorporate the insights into urban planning and design. This type of knowledge is urgently needed bearing in mind the imminent urban expansion in many parts of the world.



Participants of the workshop for healthy and sustainable cities.

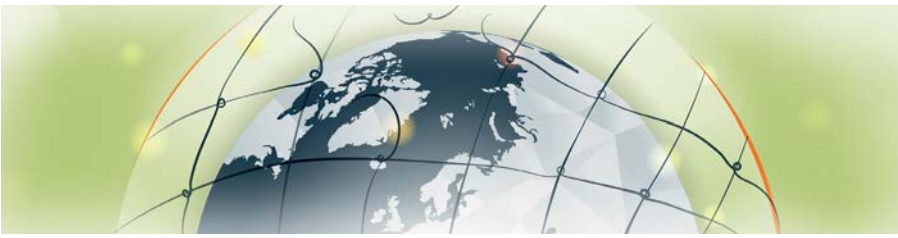
Standing: Michal Korek, Karolinska Institutet, Stockholm, Nikolina Oreskovic, the Beijer Institute, Marika Haeggman, SRC, Caroline Hägerhäll, Swedish University of Agricultural Sciences (SLU), Mare Löhmus, Karolinska Institutet, Matteo, Giusti, SRC.

Sitting: Erik Andersson, SRC and Åsa Gren, the Beijer Institute. Other participants: Terry Hartig, Uppsala University and Lars Marcus, Chalmers, Gothenburg, Sweden.

photo: Agneta Sundin

Global Dynamics and Resilience

Programme director: Anne-Sophie Crépin



WHAT are the social-ecological interactions that may trigger regime shifts at the planetary scale and what kinds of governance structures can create long-term conditions for human development? These are the questions that the Global Dynamics and Resilience programme aims to address. The programme is part of Changing Planet (www.changingplanet.se), a joint collaborative initiative with Stockholm Resilience Centre and with the research programme Global Economic Dynamics and the Biosphere (GEDB) of the Royal Swedish Academy of Sciences.

In this past year, we have harvested the fruits of many activities related to the programme, which we are happy to report resulted in several important publications related to planetary boundaries, global environmental crises and biosphere economics.

Planetary boundaries update

Four of nine planetary boundaries have now been crossed as a result of human activity, according to an international team of 18 researchers reporting in the journal *Science*, with support from this programme. The paper is a development of the Planetary Boundaries concept, which was first published in the journal *Nature* in 2009 and identifies nine global priorities relating to human-induced changes to the environment. Read more in the section 'Selected publications' in this report.

The need for biosphere economics

Drawing on economics literature, in an article in *International Review of Environmental and Resource Economics,* Anne-Sophie Crépin and Carl Folke investigate the specific conditions in which the economics literature suggests that remaining within these boundaries is an optimal policy. They assert that existing uncertainties, combined with potentially very negative impacts of trespassing planetary thresholds, clearly legitimise the use of precautionary approaches and often even safe minimum standards to remain within these thresholds. Moreover, information about the risk structure, including potential large-scale regime shifts, could help refine policies on relating to the zones of uncertainty in the boundaries. Planetary boundaries can be interpreted as 'limits to growth', especially in relation to the biophysical expansion of the human dimension. Crépin and Folke portray them as warning signs creating incentives for shifting development in new directions, new pathways, where growth in human well-being is the focus, rather than growth in GDP. They emphasise the need for "biosphere economics" to help navigate globalisation within the capacity of the biosphere as the complex adaptive system it truly is.

"Multiple stresses can interact within a single social-ecological system to cause a shift in that system's behaviour."

An architecture of global crises

Recent global crises, such as the 2008-09 financial-energy and food-energy crises, have revealed potential combinations of events and actions that could lead to the birth and progress of further global crises. An article in the journal *Ecology and Society* by Homer-Dixon et al. identifies deep causes, intermediate processes and ultimate outcomes of potential future crises. It shows how multiple stresses can interact within a single social-ecological system to cause a shift in that system's behaviour. It also shows how simultaneous shifts of this kind in several largely disconnected social-ecological systems can interact to cause a far larger crisis hitting multiple systems, which can then rapidly propagate to the global scale.

Other activities

During spring 2015, we entered into more formal cooperation with the Stockholm School of Economics through joint activities with their newly started Mistra Center for Sustainable Markets (MISUM). In particular, a joint workshop was organised in Sigtuna, Sweden, 1–2 June at which researchers from the Beijer Institute and GEDB had the opportunity to present an overview of their research and listen to similar presentations by MISUM researchers. Workshop discussions and activities resulted in several ideas for joint collaboration.

The Global Dynamics and Resilience programme also focuses on cross-scale interactions and in particular is focusing on one region of particular significance for global dynamics: the Arctic Ocean. Geophysical dynamics in the Arctic have global impacts on the Earth's climate and ocean dynamics. In addition, the imminent substantial loss of Arctic summer ice is likely to change the socio-economic conditions in the Arctic Ocean region, which may have impacts on the world economy. The 7th framework EU project Arctic Climate Change Economy and Society (ACCESS), in which the Beijer Institute took part, came to an end in February 2015 after producing a substantial amount of data and several reports summarising these. See separate article.

Gustav Engström and Chandra Kiran Krishnamurthy, together with Johan Gars, GEDB, have received five million Swedish kronor (SEK) in project funding from the Ragnar Söderberg Foundation, to investigate the links between the macroeconomy and biophysical processes. One objective is to study the importance these links have for the use of economic policy instruments in relation to global environmental problems.

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Photo: Sven-Erik Arndt/Azote

Arctic Climate Change Economy and Society - ACCESS

by Anne-Sophie Crépin

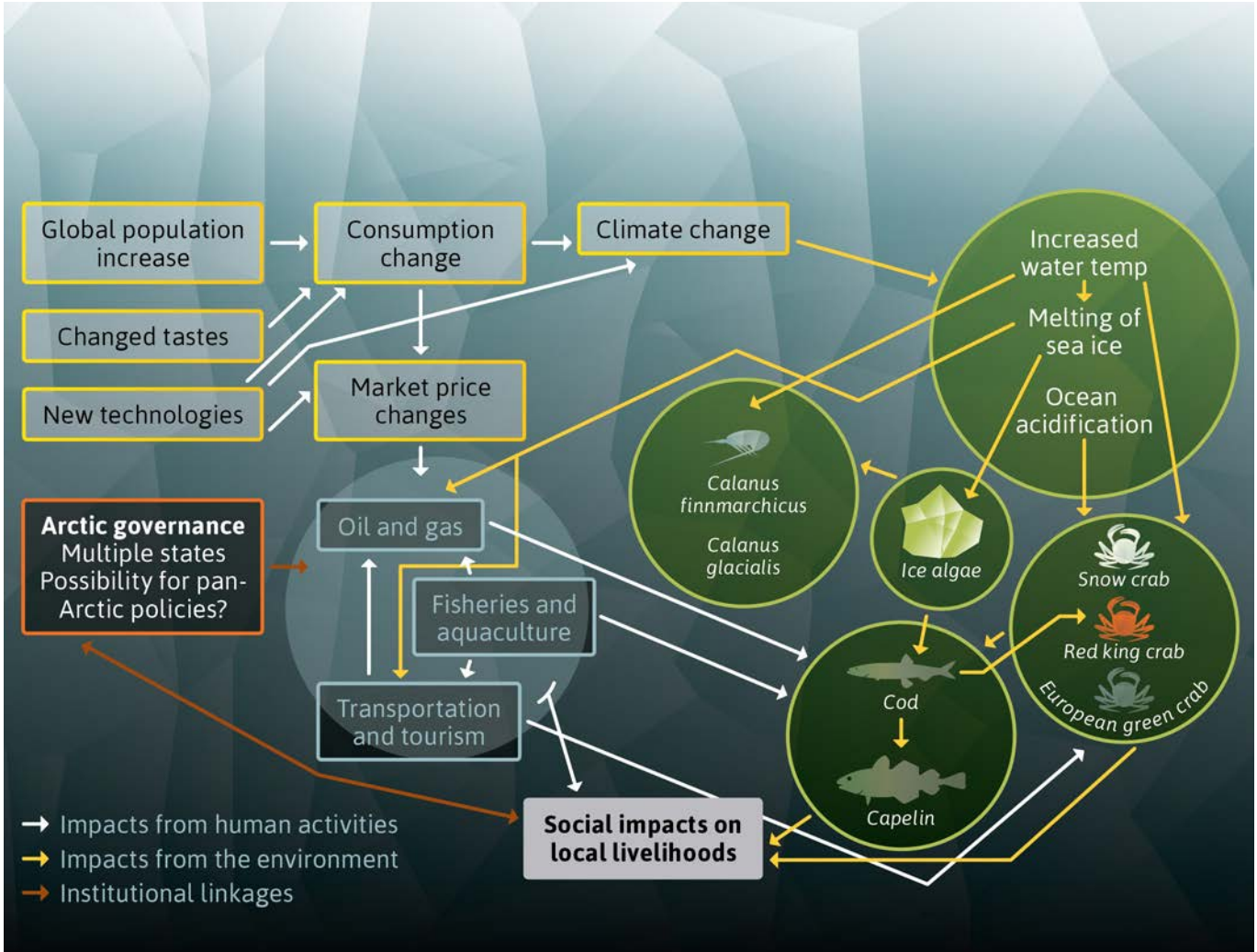
DURING the last four years, the Beijer Institute participated as a major partner in the European Union's Seventh Framework programme, ACCESS, within the call Ocean of Tomorrow. The project, which spanned over several of the Beijer Institute research programmes, ended on 28 February 2015. A substantial part was devoted to continued observations and research related to the geophysical and climate system of the Arctic Ocean, but the project also addressed marine transportation, tourism, fisheries, aquaculture, and oil, gas and mineral exploitation. In addition, the project hosted a whole work package devoted to governance and synthesis issues, which Anne-Sophie Crépin co-led with Lindsay Parson, Maritime Zone Solutions Ltd, UK.

Marine seafood production

The Beijer Institute provided substantial contributions relating to marine seafood production in the form of a report on Arctic aquaculture and indicators for sustainable development, as described in last year's annual report. In addition, a series of laboratory experiments was performed aimed at assessing the behavioural response of resource users, such as fishermen, to abrupt change and policy. These results are reported in more detail in the BENN section of this report. Another substantial contribution of the Beijer Institute lay in providing a framework for integrated ecosystem-based management in the Arctic.

A framework for integrated ecosystem-based management

As society is better prepared for dealing with slow, marginal change rather than abrupt, substantial change, this framework places particular focus on how to handle the latter. The framework uses a holistic systems approach for management and seeks to account for all aspects of Arctic developments of importance for sustainable development. Its essential role is to advance science related to integrated management of complex systems and help managers deal with systemic and non-systemic changes, with the overall aim of improved and sustained human well-being. It provides



Essential social-ecological connections in the Arctic. Green circles represent natural systems, blue squares Arctic economic sectors, yellow squares global drivers, orange squares governance and grey squares social aspects. (Source: ACCESS deliverable report D5.71)

general guidelines to support managers in building their own solutions adapted to their particular problem. Ecosystem services play a critical role as the base for most human activities and human well-being. Some of these services in the Arctic Ocean were identified as part of the framework and social-ecological system connections between Arctic geo physical and ecological processes and multiple economic and social sectors were highlighted. The framework builds on existing knowledge and tools already available, such as Marine Spatial Planning, Arctic Resilience Assessment and Sustainability Indicator, and provides suggestions on how to use these tools in combination.

2nd ACCESS Summer School participants and course organisers.

ACCESS synthesis and summer school

The Beijer Institute team and Anne-Sophie Crépin in particular were instrumental in organising the ACCESS synthesis work, which was delivered to the EU in the form of a synthesis report. In addition, the ACCESS research team plans to publish results in the form of a special issue and a synthesis report for the broader public. Through the organisation of a summer school (described below), synthesis results were disseminated and further improved. Results were also delivered to the Arctic Resilience Report research team hosted at Stockholm Resilience Centre (SRC).

The ACCESS and Arctic Resilience Report Summer School took place in the week of 22-26 September 2014, at the Royal Swedish Academy of Sciences and SRC. Fifteen students from a diverse set of scientific disciplines were accepted for participation and attended the lectures. Thirteen of these completed the course and received ETCS PhD level credits. The aim was to provide the students with the opportunity to learn about different aspects of Arctic resilience, with the focus on Arctic climate change and its impacts on geophysical and ecological systems, as well as on the economic sectors of shipping, fisheries, aquaculture, and oil and gas exploitation. They also learned about approaches and useful analysis tools: resilience assessment, ecosystem services and marine spatial planning.

The students presented their findings from course case studies to researchers from ACCESS and SRC and these findings were also published in the final ACCESS newsletter.

Above picture. Top row: Enoil de Souza Júnior, Universidade Federal do Rio Grande do Sul, Brazil, Heather Jane Bell, Melanie Flyn, United Nations University and University of Bonn, Germany. Second row: Alexander Winkler and Clara Burgard, University of Hamburg, Germany, Elin Högström, Vienna University of Technology, Austria, Chris Cosgrove and Katrin Lindbäck, Uppsala University, Sweden. Third row: Yasir Muhammad, University of Hamburg, Vivi Mellegard,SRC, Shealagh Pope, the Arctic Science Policy Integration Directorate Canada, Dries Stevens, Stockholm University. Bottom row: Alex Patonia, University of Liverpool, UK, Adrian Braun, University of Lapland, Finland, Anne-Sophie Crépin and Daniel Ospina, the Beijer Institute.

Project leader
Anne-Sophie Crépin

Project members
Gustav Engström, Åsa Gren, Therese Lindahl, Nikolina Oreskovic, Daniel Ospina and Max Troell.

The edge of a glacier, Svalbard.
Photo: Martin Almqvist/Azote

Aquaculture and the resilience of global food systems

by Marika Haeggman and Fredrik Moberg

The global food system: fragile and vulnerable

More food is needed for a growing global population and there is an increasing appetite for animal protein. This poses a challenge in terms of using natural resources, fish feed, water and energy as efficiently as possible, while minimising environmental impacts. At the same time, resource scarcity and the impacts of climate change put pressure on food production systems.

What is the role of aquaculture, i.e. farming of fish, shellfish and other aquatic organisms for human consumption, in addressing this dilemma? Will aquaculture, which is the fastest growing sector in the food system, enhance or detract from the resilience of the global food system?

These questions are posed in an article published in the journal *PNAS*, authored by a group of globally renowned interdisciplinary scholars who took part in the Beijer Institute's annual Askö meeting 2011.

Enter Aquaculture

Aquaculture offers the potential to reduce the fragility of the global food system through acting as a buffer by increasing the variety of proteins available for human consumption. In the past couple of decades, the cultivation of fish and shellfish grew at an annual rate that substantially exceeded that of poultry, pork, dairy, beef and grains.

According to the study, aquaculture's contribution to global food supplies will depend on its use of food-grade crops and its ability to use agricultural residues, and also on its future use of wild fish for feeds – something that is also entangled with issues of social equity and ethics. A key example of this is the ethical trade-off between fish and crops being used directly for food, versus using them to feed farmed aquatic animals and livestock.

An innovative approach

The study used an innovative framework called portfolio theory, which enabled the authors to analyse how growth in aquaculture and diversifying food production can enhance the ability of the global food system to meet future demands under changing conditions.

"This first set of global estimates of the use of crops for feed in aquaculture indicates that the crops used are often the same as those used for terrestrial animal farming, but that the volumes used for aquaculture are still low", says lead author Max Troell, the Beijer Institute.

In a port of Guandong, China, low valued fish is put aside for fish meal production.
Photo: Patrik Henriksson

The authors concluded that the present diversity of aquaculture contributes important elements of stability to the world's food portfolio, but in the long run this will depend on how the sector develops in terms of species composition, feed inputs and system design and operation.

China's path ahead is crucial

An important element of the equation is the future development of Chinese aquaculture. China is the world's leading producer, consumer and processor of fish, contributing one-third of the global supply. Its fish production has tripled in the past 20 years, and about three-quarters of its supply now comes from fish farms, relying increasingly on fish feed made from wild-caught fish. This practice risks depleting wild fish stocks and places a strain on fragile ocean ecosystems.

A study in *Science* carried out by a research team led by Stanford University and including Max Troell and colleagues from Stockholm Resilience Centre offers the clearest picture to date of China's enormous impact on wild fisheries. It also presents a more sustainable alternative to the current practice of using wild-caught fish to feed farm-raised fish.

Seafood waste can replace wild fish

Fishing in the coastal waters of China is poorly regulated and often indiscriminate. The result is large volumes of assorted "trash fish" – low valued species – that end up in animal feeds. Many of the stocks of wild fish used for feeds have been fully exploited, but one promising solution is to recycle the waste by-products from seafood processing plants across China. The analysis showed that this waste, which can comprise 30-70% of the incoming volume could satisfy between half and two-thirds of the current volume of fishmeal demanded by Chinese fish farmers.

Quality and food safety are two potential barriers. Fish waste is lower in protein than wild-caught fish, but this can be overcome by adding plant-based protein sources, such as algae or ethanol yeast, to the fishmeal. The use of processing waste also raises concerns about contamination and disease transmission.

"The economic and regulatory incentives for such change are not yet in place, but there is a clear opportunity for positive change", says Rosamond Naylor, Stanford University.

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Keystone actors shape marine ecosystems

by Fredrik Moberg

A MERE 13 corporations control 19-40% of the world's largest and most valuable fish stocks and 11-16% of the global marine catch, according to new research published in the journal *PLOS ONE*, authored by researchers at the Beijer Institute, GEDB and Stockholm Resilience Centre. These "keystone" corporations of the global seafood industry critically shape the future of marine ecosystems.

The new study makes an analogy between the largest companies in the seafood industry and keystone species in ecological communities. Keystone species in nature have a profound effect on the structure and function of the ecosystem and disproportionately determine the prevalence and activities of other species.

"Increasing demand for seafood has contributed to a global fisheries crisis, with consequences for marine ecosystems around the world", says lead author Henrik Österblom, Stockholm Resilience Centre. However, existing analyses of global fisheries operations have so far largely focused on the role of countries, rather than industry corporations.

"Active leadership in sustainability initiatives by these corporations could result in a cascade through the entire seafood industry towards improved management of marine living resources and ecosystems", Österblom adds.

A handful of dominant corporations

The study found that the average annual revenue of the 160 largest seafood companies in 2012 exhibited a distinct keystone pattern, with the top 10% accounting for 38% of total revenue. Among these, 13 companies were analysed in more detail and found that they shape very large marine ecosystems around the world and are involved in both wild capture fisheries and aquaculture. Their combined annual revenue corresponded to 18% of the global value of seafood production in 2012 (US$ 252 billion).

This handful of corporations, representing 0.5% of 2250 registered fishing and aquaculture companies worldwide, dominates all parts of seafood production, operates through an extensive global network of subsidiaries and is profoundly involved in fisheries and aquaculture decision making. Such omnipotence represents both a challenge and an opportunity for the governance of global fisheries.

"Several of the fishing companies we investigated are larger than most nations in terms of their share of global catches. Our study illustrates that they must be included in the equation if we are to solve the global sustainability crisis in marine ecosystems," says co-author Jean-Baptiste Jouffray, a PhD student affiliated to all three institutions behind the article.

A key feature of globalisation

According to the article, such keystone actors among corporations can be defined by the following characteristics: a) They dominate global production revenues and volumes within a particular sector, b) they control globally relevant segments of production, c) they connect ecosystems globally through subsidiaries and d) they influence global governance processes and institutions.

"Similar keystone actors also exist in other sectors, like meat and grain production, and they all have high relevance for sustainable management of natural resources and the environment. Our study illustrates a key feature of globalisation that creates novel opportunities to think about ways to address current challenges", concludes co-author Carl Folke.

"Several of the fishing companies we investigated are larger than most nations in terms of their share of global catches."

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Photo: World Bank

Exploring behaviour in the face of potential disaster

by Agneta Sundin, Therese Lindahl and Caroline Schill

IF AN ECOSYSTEM, say a lake, is subjected to persistent stresses, for example a combination of nutrient pollution and overfishing, it can abrubtly change into another state, in this case a murky, eutrophicated lake. The ecosystem has undergone a regime shift, persistent change in the system's structure and function, which can be abrupt and difficult to reverse. Such shifts can have a severe impact on human wellbeing and threaten local livelihoods, especially in poorer regions where people may depend heavily on local ecosystems and the goods and services derived from them. Moreover, recent research suggests that the frequency and intensity of regime shifts increase with growing anthropogenic pressure, so understanding the underlying social-ecological dynamics is crucial if these are to be avoided. Unfortunately, these shifts are very difficult to predict.

Eutrophicated lake.
Photo: Bengt Ekberg/Azote

Do we avoid disaster?

An article in the journal *Ecology and Society* investigates by means of behavioural laboratory experiments how a group of managers of a common-pool resource (CPR) behave when faced with the risk of a regime shift threatening their livelihood: a shift induced by their own actions, such as overexploitation, and consequently within their power to avoid. The authors focused on a CPR management setting because many natural resources are managed and used collectively by a group, especially in those areas where livelihoods crucially depend on the local natural resource. Regime shifts are associated with numerous uncertainties, for example it is not always known with any certainty whether the resource dynamics entail such a latent (endogenously driven) shift or not. To determine how the risk of there actually being such a latent shift affects resource management and collective action, the researchers compared four experimental treatments in which groups were faced with different levels of risk: 100, 90, 50 or 10 per cent risk. The authors found that when the likelihood of there being a latent shift was certain or high, people appeared more prone to agreeing on a common exploitation strategy, which in turn is a predictor for averting a shift.

"By adding more pieces to the puzzle we can show patterns of behaviour."

Surprising results

What surprised the authors was that although risk appeared to have a positive effect on collective action, the magnitude of this effect was influenced by how risk and probabilities were communicated and perceived. Lead author Caroline Schill explains:

"It seems very important how risk and probabilities are communicated. For instance we found that the 50/50 chance treatment produced more cooperation than the 90 per cent risk treatment. This could be due to the way we presented the probabilities. We explained the 50/50 chance by flipping a coin, which is a procedure people are familiar with and can imagine or visualise."

Part of a bigger picture

This study builds on earlier experimental studies within the Beijer Institute's BENN research programme, showing that when managers of a CPR faced a latent regime shift with certainty, it triggered more effective communication within the groups. This led to more knowledge sharing and cooperation, which in turn led to better resource management.

"In the earlier experiments participants knew with certainty whether there was a latent shift or not; the only uncertainty was social, that they could not be sure how their fellow group members would act," says Therese Lindahl, programme coordinator and co-author. "In this study, we made it more realistic by adding ecological uncertainty (risk) to the experimental design. It is crucial for the management of CPRs to consider both the social and ecological dynamics and their inherent uncertainties, which in most cases are interdependent."

Improving chances for effective policies

The authors view their article as a piece in a bigger puzzle of knowledge valuable for resource-dependent communities and for policy makers when considering appropriate policies. Their next step is to refine these laboratory experiments and run them in the field with fishing communities in Thailand and Colombia. Therese Lindahl continues:

"In our experimental programme, by adding more pieces to the puzzle we can show patterns of behaviour of the resource users and communities facing these risks. And the clearer the picture gets, the better the chances of designing appropriate and effective policies to help local communities take care of the ecosystems they depend upon and sustain their livelihood."

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Planetary Boundaries 2.0

by Owen Gaffney and Marika Haeggman

FOUR of nine planetary boundaries have now been crossed as a result of human activity, according to an international team of 18 researchers reporting in the journal *Science*, among them Beijer Institute Director Carl Folke and colleagues from Stockholm Resilience Centre. The four are: climate change, loss of biosphere integrity, land system change and altered biogeochemical cycles (phosphorus and nitrogen).

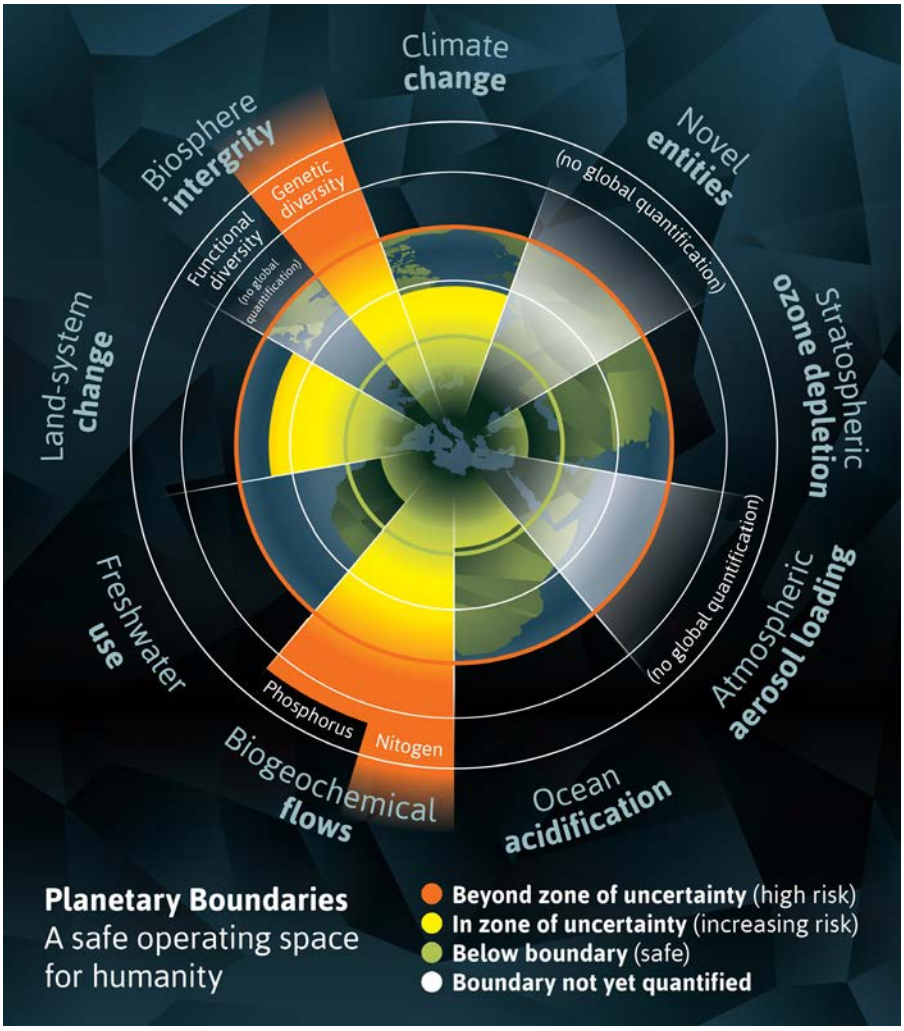
Two of these, climate change and biosphere integrity, are what the scientists call "core boundaries". Significantly altering either of these core boundaries would "drive the Earth System into a new state".

"Transgressing a boundary increases the risk that human activities could inadvertently drive the Earth System into a much less hospitable state, damaging efforts to reduce poverty and leading to a deterioration of human wellbeing in many parts of the world, including wealthy countries", says lead author, Professor Will Steffen, researcher at the Australian National University, Canberra and SRC. "In this new analysis we have improved our quantification of where these risks lie".

What's new?

The paper is a development of the Planetary Boundaries concept, which was first published in 2009, identifying nine global priorities relating to human-induced changes to the environment. The science shows that these nine processes and systems regulate the resilience of the Earth System – the interactions of land, ocean, atmosphere and life that together provide conditions upon which our societies depend.

The article builds on a large number of scientific publications critically assessing and improving the planetary boundaries research since its original publication. It confirms the original set of boundaries and provides updated analysis and quantification for several of them, including phosphorus and nitrogen cycles, land system change, freshwater use and biosphere integrity.



The silver lining

It may seem that the paper puts forward a gloomy message. However, the authors also emphasise that this knowledge provides us with a great opportunity to turn things around.

"Planetary Boundaries illustrate that humanity is an embedded part of the biosphere and needs to reconnect development to biosphere resilience and the safe operating space for humanity", says Carl Folke.

Johan Rockström, co-author and Stockholm Resilience Centre Director, presented the new findings at the World Economic Forum in Davos on 21–24 January 2015.

"In the last four years we have worked closely with policymakers, industry and organisations to explore how the planetary boundaries approach can be used as a framework for sectors of societies to reduce risk while developing sustainably," says Rockström. "It is obvious that different societies over time have contributed very differently to the current state of the earth. The world has a tremendous opportunity 2015 to address global risks, and do it more equitably, when nations agree on the UN's Sustainable Development Goals in September".

> **"This knowledge provides us with a great opportunity to turn things around."**

Reference

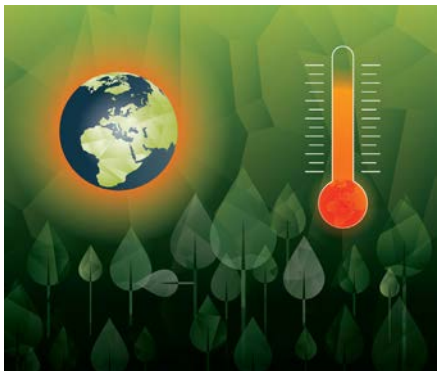
Steffen, W., K. Richardson, J. Rockström, S. Cornell, I. Fetzer, E. Bennett, R. Biggs, S.R. Carpenter, W. de Vries, C.A. de Wit, C. Folke, D. Gerten, J. Heinke, G.M. Mace, L.M. Persson, V. Ramanathan, B. Reyers and S. Sörlin. 2015. Planetary boundaries: Guiding human development on a changing planet. *Science* 347(6223) 1259855 1-10.

Global icons, local threats

by Owen Gaffney and Fredrik Moberg

WITHOUT better local management, the world's most iconic ecosystems are at risk of collapse under climate change. This is the conclusion in an article in the journal *Science* by an international team of researchers, including Beijer Institute Director Carl Folke and several Beijer Fellows.

Protecting places of global environmental importance such as the Great Barrier Reef and the Amazon rainforest from climate change will involve reducing the other pressures they face, for example overfishing, fertiliser pollution and land clearance.



The article warns that localised issues, such as declining water quality from nutrient pollution or deforestation, can exacerbate the effects of climate extremes, such as heat waves and droughts. This reduces the ability of ecosystems to cope with the impacts of climate change.

"Managing local ecosystems can help maintain and enhance their resilience in the face of global changes. It is often easier to implement incentives for stewardship of the biosphere in local commons than in global commons. Locally, the uncertainty is lower and the positive results of management may be more visible", says Carl Folke.

Unique World Heritage Sites

Three UNESCO World Heritage Sites were examined: Spain's Doñana wetlands, the Amazon rainforest and the Great Barrier Reef. While many ecosystems are crucial to their local people, these ecosystems are also of global importance—hence their designation as World Heritage Sites. For instance, the Amazon rainforest is a globally important climate regulator.

Like coral reefs, rainforests and wetlands around the world, these sites are all under increasing pressure from both climate change and local threats. For example, rising temperatures and severe dry spells are threatening the Amazon rainforest and, in combination with deforestation, could turn the ecosystem into a drier, fire-prone and species-poor woodland. Curtailing deforestation and canopy damage from logging and speeding up forest regeneration could protect the forest from fire, maintain regional rainfall and thus prevent a drastic ecosystem transformation.

Photo: Tom Hermansson Snickars/Azote

"All three sites play a critical role in maintaining global biodiversity. If these systems collapse, it could mean the irreversible extinction of species," says Beijer Fellow Marten Scheffer, professor at Wageningen University, the study's lead author.

No excuse – act locally

The authors suggest their evidence places responsibility on governments and societies to manage local threats to iconic ecosystems, as such efforts will complement the growing momentum to control global greenhouse gases. Yet, in the three cases they examined, they found that local governance trends are worrisome. The problem is one of incentives.

"These ecosystems are of value to the whole world, not only to the countries that have jurisdiction over them. It may be necessary for other countries to bring pressure to bear on these 'host' countries or to offer them assistance, to ensure that these iconic ecosystems are protected for the benefit of all of humanity," says Scott Barrett, professor at Columbia University, Beijer Fellow and former chairman of the Beijer Institute Board. Above all, the study raises awareness of the great opportunities for enhanced local action.

"Local management options are well understood and not too expensive. So there is really no excuse for countries to let this slip away, especially when it comes to ecosystems that are of vital importance for maintaining global biodiversity", concludes Marten Scheffer.

Reference

Scheffer, M., S. Barrett, S.R. Carpenter, C. Folke, A.J. Green, M. Holmgren, T.P Hughes, S. Kosten, I.A. van de Leemput, D.C. Nepstad, E.H. van Nes, E.T.H.M. Peeters and B. Walker. 2015. Creating a safe operating space for iconic ecosystems. *Science* 347 (6228), 1317-1319.

The Beijer Young Scholars

by Albert Norström and Agneta Sundin

THE BEIJER Young Scholars Programme (BYS) was founded in 2012 with the aim of creating an international network of young researchers to stimulate the emergence of new research pathways and ways of cooperating across disciplines in response to global issues facing humanity. Seventeen postdocs, young faculty members (within five years of completing their PhDs) and advanced PhD students with a background in economics, ecology, political science or related disciplines were selected and invited to meet annually for three years.

The third BYS workshop, and the last with this first group, was held on 4-7 May 2015 at the Royal Swedish Academy of Sciences and on the island of Fejan in the Stockholm Archipelago. For practical reasons it had been postponed for a year, but since the last workshop in 2013 an article by the group has been published in the journal *Ecology and Society,* as well as a short correspondence in the journal *Nature* (presented in last year's Annual Report).

Sustainable development goals in the Anthropocene

The article in *Ecology and Society* proposed three conditions that are necessary for establishing effective Sustainable Development Goals (SDGs). As a first condition the authors argued that the SDGs need to embrace the concept of social-ecological systems, seeing people and the biosphere as integrated parts of a whole rather than as separate systems.

Secondly, the SDG process needs to address and navigate the trade-offs between being ambitious and being achievable. The new goals will be composed of moral and political commitments, much like the Millennium Development Goals (MDGs), but they will not be legally binding. This means that there is a need for those setting the goals to be aware of the different constraints, biophysical, social and political, that different nations and peoples face. It also means that the SDGs need to be set in such a way that they are inspiring rather than a deterrent and that they should address issues that can be tackled at different levels in society and government.

The third condition for developing effective SDGs, according to the BYS group, is that formulating the goals should be guided by existing knowledge about social change processes on all scales, from global to individual.

What is good transdisciplinary science?

A large part of this year's workshop was spent discussing the broad overarching topic of "Interdisciplinarity and Sustainability Science", with the aim of producing a scientific paper. Building upon the philosophy promoted by the Beijer Institute for its workshops – to create interdisciplinary dialogue and come up with innovative ideas for research in a friendly environment – the group used group discussions and individual speed presentations with Q&A sessions to investigate what makes good interdisciplinary (transdisciplinary) science and how to properly assess its quality and impact. The work will continue through a broad literature review and an empirical component involving surveys to editors of leading interdisciplinary journals to understand the criteria actually used in assessing the quality of interdisciplinary efforts.

Lessons from the BYS experience

The group also spent time distilling insights and lessons learnt from the BYS process. Those discussions together with the responses to an evaluation questionnaire will be useful knowledge for the Beijer Institute when forming the next group of Beijer Young Scholars. The overall impression from BYS members is that the network and workshops have been unique in their interdisciplinary composition and with their open and trusting atmosphere. Several members professed that BYS had profoundly changed their research perspective and their willingness to work across disciplines to address global sustainability challenges.

Reference

Norström, A. V., A. Dannenberg, G. McCarney, M. Milkoreit, F. Diekert, G. Engström, R. Fishman, J. Gars, E. Kyriakopoulou, V. Manoussi, K. Meng, M. Metian, M. Sanctuary, M. Schlüter, M. Schoon, L. Schultz and M. Sjöstedt. 2014. Three necessary conditions for establishing effective sustainable development goals in the Anthropocene. *Ecology and Society* 19(3): 8.

Informal discussion at Fejan.

Above. BYS-members and Beijer staff at the island of Fejan, Stockholm Archipelago. Agneta Sundin, Beijer, Scott Barrett, Columbia University, Manjana Milkoreit, University of Arizona, Ram Fishman, George Washington University, Albert Norström, SRC, Johan Gars, GEDB, Michael Schoon, University of Arizona, Martin Sjöstedt, Gothenburg University, Florian Diekert, University of Oslo, Mark Sanctuary, Stockholm School of Economics, Maja Schlüter, SRC, Astrid Dannenberg, University of Kassel, Gustav Engström, Beijer and Christina Leijonhufvud, Beijer.

Missing BYS members: Geoff McCarney, University of Ottawa, Efthymia Kyriakopoulou, Gothenburg University, Vassiliki Manoussi, University of Athens, Marc Metian, IAEA, Kyle Meng, University of California Santa Barbara Lisen Schulz, SRC

Photo: Manjana Milkoreit.

Patterns of the Biosphere
– *an exhibition visualising Beijer research*

by Agneta Sundin

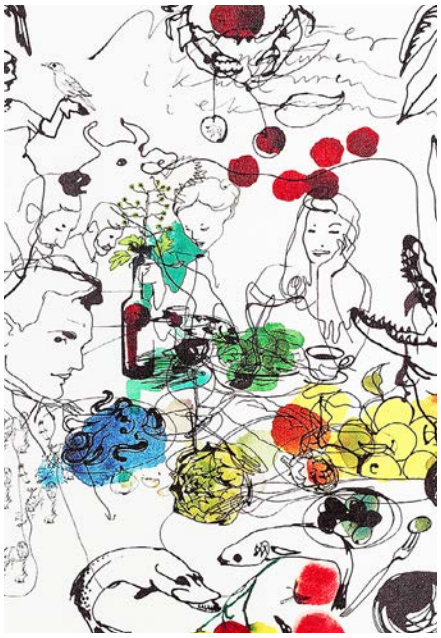
"The biosphere is the thin outer layer of this planet in which life exists. We humans are part of the biosphere and completely dependent on the air, the oceans, the forests and all other ecological systems in order to survive and thrive." So begins the text interpreted by artist Jesper Waldersten in the exhibition *Patterns of the Biosphere* at the classical Swedish design company and store Svenskt Tenn in Stockholm 15 April-15-June 2015. This was also the exhibition's overarching message and it is the basis for all research at the Beijer Institute.

Svenskt Tenn is owned by the Kjell and Märta Beijer Foundation and its profits go via the foundation to support research conducted at the Beijer Institute and a few other research institutions. The exhibition was initiated by Svenskt Tenn to make this link better known to its customers, while for the Beijer institute it was a tremendous opportunity to visualise its research to a wide audience from outside academia in the unique setting of the Svenskt Tenn store in Stockholm.

The project developed into an art-science exhibition where four Swedish artists – Eric Ericson, Jesper Waldersten, Liselotte Watkins and Stina Wirsén – interpreted Beijer research of in a series of posters. In addition, a classic cabinet by Svenskt Tenn's head designer Josef Frank (1885-1967) was transformed into a spectacular sculpture interpreting resilience dynamism, created by project partner and producer Guringo together with the craftsmen who make the original cabinet. The posters were also printed in a smaller format and more than a thousand copies of these were sold in the store.

It became evident through the process that, perhaps surprisingly, the Beijer Institute and Svenskt Tenn share a lot of common ground. Diversity and durability are core values of the company and its furniture and other goods. Josef Frank's main inspiration was nature and he brought nature's colours and forms into his designs. Teaming up with this iconic design company also resulted in coverage in media where the Beijer Institute does not normally feature, such as interior design magazines. It might also have been the first time that the Royal Swedish Academy of Sciences was mentioned in lifestyle blogs!

The hugely successful opening marked the start of a steady stream of visitors and a range of activities. Among other things, two informal talks, one on sustainable design and the other on sustainable food, were held for an invited audience in the store's Tea Salon, with Beijer researchers in the panel discussions. Furthermore, city walks taking their starting point in the exhibition and showing urban ecosystem services were arranged.



Left: Detail from Stina Wirséns poster *Welcome to the Banquet*

Below: Several hundred people from the cultural, business, science and media sectors attended the opening of the exhibitions.

In the joint opening ceremony, another exhibition of science and art, *Reflections on People and the Biosphere,* was opened outdoors at the centrally located Raol Wallenberg Square by Nybroplan, Stockholm. It displayed pictures and quotes from the book of the same name by photographer Lars Hall and Beijer director Carl Folke (presented in the previous Annual Report) and sharing the same theme: the urgent need for humanity to reconnect to the Biosphere.

Photo: Ulf Jakobsson

Upper left: The exhibition *Reflections on People and the Biosphere* shown in central Stockholm. Photo: Carl Folke

Upper right: Anders Wall, the head of the Beijer Foundation and Carl Folke opened the exhibitions. Photo: Ulf Jakobsson

The exhibition *Patterns of the Biosphere.* Photo: Svenskt Tenn

Left: Sustainable food talk in the Tea Salon at Svenskt Tenn. In the panel: Food writer Lisa Förare-Winbladh, Line Gordon, SRC, Annica Kvint (moderator) and Max Troell, the Beijer Institute. Photo: Agneta Sundin

Right: *Be a Tree and You Will See*, poster by Jesper Waldersten.

Presentation to Swedish pension fund managers

As a spin-off from the two exhibitions at Svenskt Tenn and Nybroplan, Carl Folke was invited to give a presentation for the management and staff of the Third Swedish National Pension Fund - AP3 17, June 2015. AP3 is one of five so-called buffer funds within the Swedish national pension system that are increasingly engaged in sustainability and resilience issues. Together, the buffer funds hold around 13% of total pension system assets. AP3 is tasked by the Swedish Parliament with generating the maximum possible benefit for the income pension system by managing the fund capital so as to deliver strong investment returns at a low level of risk.

Carl Folke's presentation focused on the theme "People and the Biosphere", illustrating the new dynamics of the Anthropocene and the uncertainty of living with rapidly changing systems of people and nature in a globally intertwined world. A lively discussion concerning strategies for investments followed with the forty or so participants. The need for resilience and insurance-building strategies became obvious in efforts to navigate towards sustainability.

Economics for the Environmentally Interested

Therese Lindahl has contributed a chapter on environmental economics and behavioural science in the book *Economics for the Environmentally Interested* (in Swedish), published in March 2015. It was launched with the following description:

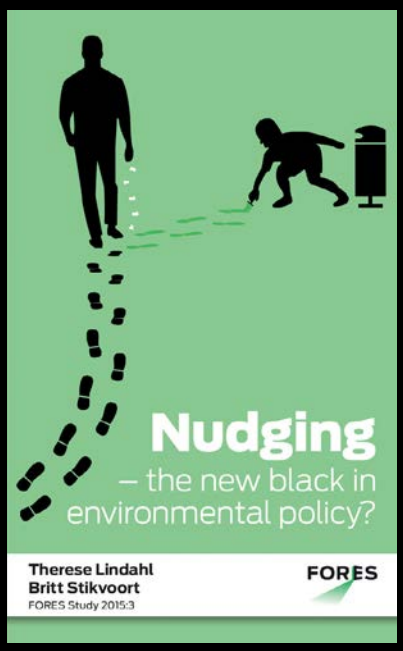
"This book tells of an emerging and fruitful cooperation between economists, natural scientists and environmentalists. It illustrates a step forward from a previously all-too-common mutual suspicion [...] A cooperation across disciplinary boundaries is now developing, which this book reflects. Ten economists offer their thoughts on environmental problems and sustainability. The publication includes chapters on economic growth, what drives technological development, GDP and other welfare dimensions of finite and renewable resources, policy instruments and climate economics, and what environmental economics can learn from behavioural science. The book is written for environmentalists interested in economics and economists interested in the environment."

Another chapter, on Renewable resources, was written by former Beijer researcher Johan Gars, now at Beijer Institute partner GEDB.

Lindahl, T. 2015. Miljöekonomi och beteendevetenskap (Environmental Economics and Behavioural Science). In: Stavlöt, U. (ed.). *Nationalekonomi för miljöintresserade.* Ivrig Förlag, Stockholm, Sweden.

Nudges: The new black in environmental policy?

Nudging – a collection of behaviour change techniques – is increasingly attracting the interest of researchers, policy makers and the media. However, despite all this attention, it is not particularly clear to many *what* exactly nudging is, what it *is not* and *why* nudges can (sometimes) be so effective in changing our behaviour. To make the issues clearer, Therese Lindahl and Britt Stikvoort wrote a report exploring them. The report was written for the Swedish think tank Fores and was launched in June 2015. The report sought to answer the following questions: Are there enough sound scientific grounds for nudging today on which policy makers can base their policies? What really is the current state of the art in nudging research, what lessons can we learn from these past experiences and what are the biggest caveats in our current knowledge about nudging? The report was presented by Therese Lindahl and discussed by a panel that included Per Bolund, Minister of Financial Markets and Consumer Affairs, during the Swedish policy week in Almedalen, Visby in July 2015.



The report can be downloaded at **www.fores.se** in English and Swedish

Joining actors for a sustainable regional development

Over the past ten years, the rapidly changing Lake Mälaren region in Sweden, which includes Stockholm, has become an increasingly interesting region for research on urban-rural issues and is now also one of the regional case studies within the PECS research programme. On 7 November 2014 the Urban Research group of the Beijer Institute and SRC organised a conference at Stockholm University, bringing together a group of 70 actors from the Lake Mälaren region, including municipal planners, NGOs, grassroots activists and representatives from associations and state agencies. Åsa Gren from the Beijer Institute was part of the organising team. The purpose was to share research findings and discuss the future of the region and indeed it became a day for joint learning, developing an inventory of knowledge and identifying future challenges.

As a follow-up to the conference, Åsa Gren and her colleagues from SRC were invited by Stockholm County Council (SCC) to a meeting on 17 April 2015 to discuss future potential co-operations. Through a potential partnership with the provincial government, the Beijer Institute/SRC Urban Research Group hope to become more closely involved in the operational development of the Stockholm County area.

Conference organisers: Stockholm Resilience Centre and The Beijer Institute. Head of organisation team: Sara Borgström, SRC.

Host Femi Oke with HRH Crown Princess Mette-Marit of Norway who was one of the speakers at the EAT Stockholm Forum 2015 Photo: EAT 2015 Johan Lygrell

EAT – the essential interplay of food, health and sustainability

The second EAT Stockholm Forum took place in early June 2015. This is an annual high-level forum with presentations and workshops, gathering international stakeholders, partners and experts across sectors and scientific disciplines, to integrate knowledge and action in the interwoven areas of food, health and sustainability. They met to address one of the greatest challenges facing humanity today: providing the growing global population with a healthy and nutritious diet within safe environmental limits.

EAT was initiated by the Stordalen Foundation together with Stockholm Resilience Centre as main academic partner. It stimulates interdisciplinary research by fostering collaboration across the multiple scientific disciplines interfacing with food issues. The aim is to improve nutrition and food safety, as well as tackling global health and environmental challenges such as the epidemics of obesity and non-communicable diseases, climate change and degradation of ecosystems. The initiative focuses on seven themes and the Beijer Institute is deeply engaged in two of these: "Consumer behaviour and choices" with links to the BENN programme and with engagement by Therese Lindahl, and "Multifunctional landscapes and seascapes" chaired by Carl Folke and Frank Rijsberman (CEO, CGIAR), with Line Gordon of the SRC as a central driver of the theme.

The scientific content and output of EAT are steered by an Advisory Board consisting of thirty of the leading experts in the fields of food science and policy, nutrition, public health, environmental sustainability, veterinary sciences and economics. Johan Rockström of SRC is Chairman of the Advisory Board and Carl Folke, serves on the EAT board.

Read more and see presentations at:
http://eatforum.org/

Stockholm Summit on Natural Capital

The Beijer Institute, together with the Academy programme Global Economic Dynamics and the Biosphere (GEDB), have had the great privilege of hosting Professor Gretchen Daily, Stanford University, for a two-year period. One of her key efforts was to set in motion a *Stockholm Summit on Natural Capital* as a platform for long-term collaboration. On 19-20 May 2015, at Steningevik outside Stockholm, a select group was convened under Chatham House rules of some fifty business executives and scientists representing institutions situated in contrasting, high-leverage contexts for driving innovation and systemic change.

The overall aim of the summit was to synthesise and find ways to step up the innovation and impact of natural capital approaches to promote social, economic and environmental resilience. Modern economies have evolved sophisticated systems for safeguarding capital assets, including built, financial and human capital. However, while nature is the foundation of all economies, systems for capturing the significance and value of natural capital remain in their infancy. Yet the world is on the cusp of dramatic change. A decade ago, the Millennium Ecosystem Assessment provided the first global account of conditions and trends in vital natural assets. Since then, leading governments, corporations and human development and conservation organisations have invented new ways of factoring natural capital into smart investment and operation and risk management decisions.

Today, the rapidly increasing risks of eroding natural capital and resilience have converged with the access to enhanced geospatial information, cloud computing, big data analytics and new science, making it possible to accelerate, standardise and scale these practices. This creates an opportunity to transform decision making on resource and land use.

Time for informal conversations and fishing during the Stockholm Summit on Natural Capital. Photo: Gretchen Daily

At the summit, successful examples were presented of how natural capital and resilience approaches have been used for the mutual benefit of stakeholders, shareholders and nature in projects led by such diverse institutions as the Inter-American Development Bank, the Council on Ethics for the Norwegian Government Pension Fund, IUCN, Dow Chemical, Unilever, and the Government of China. The examples included a tool to help implement broad forest restoration goals within on-the-ground action, developed by the IUCN, WRI and partners. Another example was software developed by Unilever which can enhance decisions on where agricultural expansion would have the lowest impact on carbon sequestration, biodiversity and water quality and other ecosystem services.

A joint action plan was agreed to scale up efforts and pave the way for new projects, as well as to support an array of global initiatives now underway, such as Future Earth, the Natural Capital Coalition and the World Business Council for Sustainable Development's (WBCSD) Natural Infrastructure Group.

Conveners

The Beijer Institute, The Natural Capital Project (with core partners Stanford University, The Nature Conservancy, University of Minnesota and World Wildlife Fund), The Global Economic Dynamics and the Biosphere Programme (GEDB) and Stockholm Resilience Centre.

Core funding

The MAVA Foundation. Additional funding: Peter and Helen Bing, Future Earth, Google.org, Gordon and Betty Moore Foundation, Kjell and Mårta Beijer Foundation, Natural Capital Coalition, Packard Foundation, Rockefeller Foundation, Vicki and Roger Sant, Winslow Foundation and the World Business Council on Sustainable Development.

In synergy with the *Stockholm Summit on Natural Capital,* Beijer Fellows Steve Polasky and Jane Lubchenco edited a special issue of *Proceedings of the National Academy of Sciences* (PNAS), USA, as part of the 100th anniversary of the journal. The special feature *"Nature as Capital"*, released in June 2015, includes twelve contributions, of which five by Beijer researchers and fellows.

Guerry, A.D., S. Polasky, J. Lubchenco, R. Chaplin-Kramer, G.C. Daily, R. Griffin, M.H. Ruckelshaus, I. Bateman, A. Duraiappah, T. Elmqvist, C. Folke, J. Hoekstra, P. Kareiva, B. Keeler, S. Li, E. McKenzie, Z. Ouyang, T. Ricketts, B. Reyers, J. Rockström, H. Tallis and B. Vira. 2015. Natural capital and ecosystem services informing decisions: From promise to practice. *Proceedings of the National Academy of Sciences* 112(24):7348-7355

Environmental Economics – Pathways to a sustainable future

On 5 May 2015, the Swedish International Development Cooperation Agency (Sida) organised a half-day seminar in its Development Talks series that focused on environmental economics in development cooperations. The aim was to address the following questions: how can the integration of research and policy recognise and address the interlinkages between the environment, society and the economy? How can it create green development opportunities and solutions at a local, national and international level? And what is needed to tackle the systemic barriers to progress that we face today?

In the first session, Beijer Fellow Partha Dasgupta set the stage and explained why environmental considerations are critical to economic development and how best to address this integration. Beijer Director Carl Folke explained earth system resilience and planetary sustainability. He discussed what a sustainable future actually looks like and proposed reconnecting development to the biosphere in the Anthropocene. He was followed by Beijer Fellow Thomas Sterner who talked about how to design economic policies that allow us to develop our societies, alleviate poverty and still make sure we stay within a safe operating space for the globe.

The second session focused on environmental and development economics. The directors of regional networks in environmental economics – Francisco Alpízar (LACEEP), Herminia Francisco (EEPSEA), Rashid Hassan (CEEPA) and Priya Shyamsundar (SANDEE) – presented their perspectives, followed by a presentation from Gunnar Köhlin of the Environment for Development Initiative and a panel discussion with the above speakers, joined by Anders Granlund from Sida and Anne-Sophie Crépin from the Beijer Institute.

The Stockholm Seminars: Frontiers in Sustainability Science and Policy

The Stockholm Seminars are organised by the Beijer Institute, the Stockholm Environment Institute, the IGBP and the Stockholm Resilience Centre, along with Albaeco. They cover a broad range of perspectives on sustainability issues

and focus on the need for a sound scientific basis for sustainable development policy. The seminar series was launched in 2000 as a way of taking advantage of the opportunities presented when world leading scientists visit the organising institutions, and over the years speakers have included Nobel Peace Prize winner Wangari Maathai, father of resilience theory Buzz Holling and Economics laureates Ken Arrow and Elinor Ostrom.

Between July 2014 and June 2015 the diverse topics covered ranged from *Rethinking economics in the age of abrupt climate change* (Stuart Scott) to *Urban densification, contact with nature and psychological restoration: Issues of conflict and compensation* (Terry Hartig). A full list of seminars in this period can be found in the Appendix to this report.

The seminars, which are free of charge, are held at the Royal Swedish Academy of Sciences and are attended by a large audience, including scientists, students, the media and policymakers in the public and private sectors. Most seminars are filmed and can be viewed on the SRC website.

www.stockholmresilience.su.se

Green transformations – a major opportunity for the entrepreneur

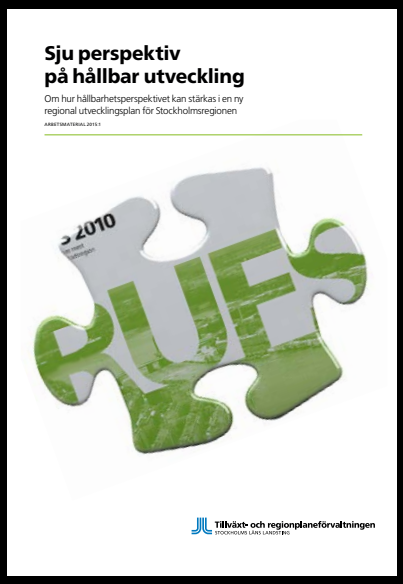
The Wallumni network consists of more than 350 people who, as young talents, have received a scholarship from the Anders Wall Foundation in either the natural sciences, countryside development, young entrepreneurship, international studies or music.

The Foundation's main aim is to promote Swedish business, primarily in the areas of trade, industry and agriculture, but also to promote environmental protection, culture and scientific research in the above as well as in other areas. One specific aim is to promote and encourage efforts undertaken in the spirit of entrepreneurship and creative thinking.

The annual scholarship award takes place at the Academy of Music in Stockholm on Anders Wall's birthday on 10 March. At a gathering of the Wallumni network on the morning of that day, environmental challenges were discussed on the theme of *Green transformations – A major opportunity for the entrepreneur.* Carl Folke and Lisen Schultz of SRC were invited to give a lecture on environment and development in synergy.

Perspectives on sustainability for regional development

In preparation for a new regional development plan for Stockholm County, the report *Seven Perspectives on Sustainable* has been released (in Swedish) by Stockholm County Council. Johan Colding contributed with a chapter entitled 'Increased sustainability'. The regional authorities are acknowledging that they might need to transform their view of what sustainable development really is and what the concepts of resilience and robustness mean for the Stockholm region. To do this they asked seven researchers and experts to produce their own memorandum, independently of one another, to elaborate on these terms and on what they see as the major challenges faced by the region in terms of sustainable development.



Download the report: http://www.trf.sll.se/Global/Dokument/publ/2015/PM-samling_lowres.pdf

Left: Stockholm Seminar with Professor William Laurance.

Bottom: Attentive audience at a Stockholm Seminar with Simon Levin.

Photos: Agneta Sundin

Challenges of Environmental Decision-Making

During the spring of 2015, Beijer Institute researchers organised and taught the *Challenges of Environmental Decision-Making* course for students taking the Master's programme in Social-Ecological Resilience for Sustainable Development at the Stockholm Resilience Centre, for the third year in a row. As in previous years, the objective was to help the students understand a broad spectrum of the challenges associated with decision-making and how these are typically tackled within the field of economics. New for this year was the lecture given by Chandra Kiran Krishnamurthy that encompassed in more detail some specif ic challenges related to environmental valuation, and in particular how choice experiments could be used to help bridge them. The class consisted of 13 students and the course ended with a written examination, which all students passed. Based on these examination results as well as personal interaction, the course leader believes that the participants acquired considerable knowledge about the many challenges involved in economic and environmental decision-making.

Course leader
Gustav Engström
Lecturers
Anne-Sophie Crépin, Chandra Kiran Krishnamurthy and Therese LIndahl, the Beijer Institute, Johan Gars, GEDB and Mark Sanctuary, Stockholm School of Economics.

Ecology and Economic Management

This course aims to provide students in Environmental Economics with an understanding of the complexity and functions of interlinked social-ecological systems, and the implications this has for governance. It is aimed at PhD students participating in the SIDA-funded PhD programme in Environmental Economics at Gothenburg University and is held at the Beijer Institute every other year. The latest course was featured in the previous annual report. The PhD programme was established by the Beijer Institute and the Environmental Economics unit at Gothenburg University in 1997. The purpose of the programme is to strengthen the capacity in developing countries to teach environmental economics at university level, and to establish a firm basis for research that can be used for policy advice pertaining to environmental economics and sustainable development.

ACCESS and Arctic Resilience Report Summer School

The ACCESS and Arctic Resilience Report Summer School took place from 22 to 26 September 2014 at the Royal Swedish Academy of Sciences and SRC. Fifteen students from a diverse set of scientific disciplines were accepted and attended the lectures. Thirteen of these completed the course and received ETCS PhD level credits. The aim was to provide the students with an opportunity to learn about different aspects of Arctic resilience, with the focus on Arctic climate change and its impacts on geophysical and ecological systems, as well as on the economic sectors of shipping, fisheries, aquaculture and oil and gas exploitation. They also learned about approaches and useful analysis tools, including resilience assessment, ecosystem services and marine spatial planning.

Course organisers
Anne-Sophie Crépin and Daniel Ospina
Read more about the ACCESS research project earlier in this report.

Stockholm Resilience Centre (and Stanford University)

The collaboration with Stockholm Resilience Centre (SRC) continues to be intense, exciting and very productive, with many joint projects, grants, workshops and publications. SRC was established in 2007 with core funds from Mistra through 2018. The communication, outreach and policy engagements of the Beijer Institute are substantially magnified through the close collaboration with SRC and its communication team, as well as with communication strategists at our partner Albaeco.

New funding

Two recent significant grants will help strengthen and extend the collaboration between the Beijer Institute, SRC and Stanford University.

Advancing Fundamental Knowledge of Natural Capital, Resilience and Biosphere Stewardship

This five-year programme comprises a research exchange between Stanford University and SRC, with the Marianne and Marcus Wallenberg Foundation providing 9.5 million SEK in funding. It will be a research platform for the development of new theory, analysis and synthesis on stewardship of natural capital and the biosphere, for social-ecological resilience, human wellbeing and sustainability. Carl Folke and Gretchen Daily serve as project leaders. The exchange programme will engage top young scientists, who will gain experience in problem-orientated, interdisciplinary collaboration in sustainability science and become key individuals in this field for the future. The programme draws on the legacy of science developed jointly by Stanford and the Beijer Institute, and more recently, SRC.

GRAID - Guidance for Resilience in the Anthropocene: Investments for Development

Funded by the Swedish International Development Agency (Sida) with a start-up grant of 107 million SEK over four years.

GRAID aims to contribute to a world where resilience forms an integral part of sustainable development for poverty alleviation and human wellbeing. Resilience thinking grew out of the Beijer Institute's research programmes leading to the formation of the Resilience Alliance and later to the founding of SRC. Beijer Institute researchers play an active role as theme leaders and contribute to the scientific content and research direction of SRC, and will be engaged within GRAID. The collaboration takes an integrated view of people and nature, aiming at a deeper understanding of human-environment interactions, wellbeing, resilience and stewardship of social-ecological systems as part of the biosphere from local to global levels. GRAID has three strategic goals:

- To provide strategic support and capacity building and operate as a knowledge contributor to the Global Resilience Partnership (GRP) of the Rockefeller Foundation, USAID and Sida.
- To further develop methods, practices and tools for integrating resilience into development planning at local to global scale.
- To further develop the resilience framework, including its underlying principles, theories, practices and empirical evidence.

MOOC: Planetary Boundaries and Human Opportunities

A MOOC is a massive, open, online course: a course that is free of charge and open to everyone with access to the internet. The first MOOC from Stockholm University was organised by SRC together with the Sustainable Development Solutions Network-Education. *Planetary Boundaries and Human Opportunities: The Quest for Safe and Just Development on a Resilient Planet* ran from 17 November 2014 to 2 February 2015. The course was designed to help students explore and apply a range of emerging concepts within sustainability science, including the Anthropocene, planetary boundaries, social-ecological systems approach and resilience thinking. Lisa Deutsch of SRC was course coordinator, Johan Rockström of SRC was the main instructor and Carl Folke and several SRC researchers gave lectures. An amazing 5,600 students signed up to take the course, and over 15% of them received a course completion certificate, which is more than double the average rate of MOOC completion according to The Times in 2013.

"An amazing 5,600 students signed up to take the course"

SRC staff and management at the annual staff retreat on the island of Stora Karlsö in the Baltic, where the island museum serves as meeting room. Photo: SRC.

Future Earth, PECS and STIAS – Research on global sustainability

Future Earth is an international research initiative aimed at developing knowledge for responding effectively to the risks and opportunities presented by global environmental change. The Academy has played a central role in the development of a decentralised Future Earth Secretariat with a strong Swedish presence. The Beijer Institute and GEDB are central in the Academy's profile on issues of global sustainability and collaboration with SRC. The Beijer Institute is active in the Future Earth core project, the Programme on Ecosystem Change and Society (PECS), chaired by Beijer fellow Steve Carpenter, with the International Programme Office hosted by the SRC. PECS aims to integrate research on the stewardship of social-ecological systems, the services they generate and the relationships between natural capital, human wellbeing, livelihoods, inequality and poverty. Albert Norström, SRC, is executive director and Carl Folke is programme director of PECS. During his two-month stay at the Stellenbosch Institute for Advanced Study (STIAS), Carl Folke worked with the Southern African PECS (SAPECS), a case study area that will serve as a central link between the new Wallenberg grant, the new GRAID-Sida grant and the Beijer Institute, SRC, GEDB and Stanford collaboration

www.futureearth.org
www.pecs-science.org
www.stias.ac.za

SARAS - The South American Institute for Resilience and Sustainability Studies

The Beijer Institute is engaged in the South American Institute for Resilience and Sustainability Studies (SARAS). SARAS is an interdisciplinary research institute based in Maldonado, Uruguay, designed to catalyse high-impact science that serves to enhance South America's long-term resilience and sustainable development. SARAS is working towards becoming a regional centre cooperating closely with the scientific community and relevant funding agencies in several South American countries and with an established set of international key scientists. Last year's workshop focused on the art-science interface (see Annual Report 2013/2014) with a special feature on the topic in progress in *Ecology and Society*. The Science Board includes Carl Folke and Beijer fellows Steve Carpenter and Marten Scheffer.

www.saras-institute.org

Ebba and Sven Schwartz Foundation

The Swedish foundation Ebba och Sven Schwartz Stiftelse has supported the Beijer Institute and Stockholm Resilience Centre through a career grant to three skilled researchers during 2011-2013 and the good news is that it has decided to continue its support at least until the end of 2015. The overall focus of the grant is to find ways to allow people to take account of ecosystem support and ecosystem services in decision making. The projects concern economic theory, regime shifts and wellbeing; freshwater, agriculture and ecosystem services; and adaptive governance of social-ecological systems in dynamic landscapes and seascapes.

www.schwartzstiftelse.com

NorMER – Nordic Centre of Excellence and the GreenMAR programme

Through collaboration with SRC, Beijer Institute researchers contribute to a Nordic Centre of Excellence on Climate Change Effects on Marine Ecosystems and Resource Economics (NorMER). Carl Folke serves as co-chair of the programme, with Professor Nils Christian Stenseth, University of Oslo as the other co-chair. The five-year programme is exploring the biological, economic and societal risks and opportunities of global climate change related to fisheries resources across the Nordic region. Through post-doc posts and PhD projects, there are international collaborations between the participating partners in the Nordic countries. The top-level research initiative Nordforsk is funding the programme. NorMER has also generated a spin-off project, GreenMAR also funded by Nordforsk. The GreenMAR network aims at understanding to what extent the ecological and social components of complex marine systems are capable of adapting to growing stress factors, such as fishing or climate change, and to provide corresponding management recommendations than can ensure green growth. Beijer Fellow Simon Levin serves on the Advisory Panel for NorMER and participates in GreenMAR, representing the Princeton node, Beijer Fellows Jim Wilen and Partha Dasgupta are members of the advisory board of GreenMAR and Carl Folke leads the Stockholm node.

www.normer.uio.no
www.greenmar.uio.no

Nereus – Predicting the Future Ocean

Over-exploitation of the world's fish resources has caused serious declines in fish populations and there is widespread concern that the world's oceans will be unable to supply fish products for future generations. Given the importance of marine fisheries for food security throughout the world, this poses a serious threat for coming generations. The Nereus programme was launched to provide scientific advice on these issues. It is an international research and outreach network with five leading academic institutions as partners. The focus is on understanding the status of the global ocean and how we can ensure that there will continue to be fish products and a healthy ocean for future generations to enjoy. The researchers in the programme are based at the University of British Columbia, Princeton University, Duke University, WCMC/Cambridge University, Stockholm Resilience Centre and the Beijer Institute. Henrik Österblom, SRC, coordinates the Swedish efforts and he and Carl Folke serve as principal investigators in the programme. The Nippon Foundation is providing financial support for a nine-year period.

www.nereusprogram.org

Global Economic Dynamics and the Biosphere

The Erling-Persson Family Academy Programme on Global Economic Dynamics and the Biosphere (GEBD) is in full bloom. Beatrice Crona, executive director of the programme, has performed excellent work in building up this programme. The same is true of Victor Galaz, who served as executive director when Beatrice was on maternity leave. Gretchen Daily, Stanford University and Beijer fellow, has been visiting professor for two years. Beijer fellow James Wilen, Professor of Economics at the University of California Davis, visits Stockholm a few times a year to take part in research, guide and mentor young scholars within GEBD and provide senior academic expertise in economics. GEDB is structured into three parts: *Macroeconomic models that explicitly consider and integrate the biosphere; Trade in, and consumption of, marine resources and the effects on social-ecological systems;* and *Interactions between financial markets and the biosphere*. There is an advisory board with several Beijer researchers involved and with Beijer fellows providing synergies. As we envisioned, GEBD has become a significant channel for research, synthesis and synergies between the Beijer Institute and SRC, with strong ties especially with the Beijer programmes Global Dynamics and Resilience, and Aquaculture and Sustainable Seafood.

Read more in the GEDB annual reports available at www.kva.se/gedb

The Resilience Alliance

A central network for collaboration is the Resilience Alliance (RA), an international consortium of leading research groups and their organisations that are collaborating to explore the dynamics of social-ecological systems and seek novel ways to integrate science and policy in order to discover foundations for sustainability. RA and the focus on social-ecological systems emerged out of research programmes at the Beijer Institute in the 1990s and the Beijer Institute is an active member. The Beijer Institute works with RA on central issues such as the Arctic resilience assessment and other relevant resilience assessments. Researchers in the Resilience Alliance Young Scholars (RAYS) are also engaged in the Beijer Young Scholars (BYS). RAYS produced a major book on resilience this spring, entitled *Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems* (Cambridge University Press), edited by Oonsie Biggs, Maja Schlüter and Michael Schoon. The journal *Ecology and Society* is owned by RA, with Carl Folke the editor-in-chief together with Lance Gunderson.

www.resalliance.org

Supporting environmental economics networks

by Anne-Sophie Crépin, Eswaran Somanathan, Agneta Sundin and Jeffrey Vincent

THE BEIJER Institute cooperates with four regional networks on environmental economics in Africa (CEEPA/RANESA), Asia (EEPSEA and SANDEE) and Latin America (LACEEP). The networks strive to strengthen the local capacity for economic analysis of environmental problems and conduct research on the interlinkages between economic development, poverty and environmental change, with the aim of providing sound advice to policymakers. With financial support from the Swedish International Development Cooperation Agency (Sida), researchers connected to the Beijer Institute support the networks with various activities, including participating in workshops organised in the network regions, evaluating research proposals, tutoring in research and teaching short courses. In addition we provide support to the Environmental and Development Economics (EDE) journal and offer mobility grants in the form of the Mäler scholarship.

Given the substantial scope for synergies between our different activities, during the past year we have continued discussions on a joint collaboration with two actors in Sweden with similar and complementary activities around capacity building: the Environmental Economics Unit with the Environment for Development Initiative, Gothenburg University, Sweden (GU) and the Stockholm Resilience Centre, Stockholm University, Sweden (SRC). These discussions resulted in a grant application to Sida, which is now under review.

Activities

As part of the collaboration with GU and SRC on a new interdisciplinary research programme in developing countries, a workshop was held in Dar es Salaam, Tanzania on 20-21 October 2014. Anne-Sophie Crépin and Jeffrey Vincent contributed to the planning process and participated in the workshop along with representatives from GU and SRC and from the regional networks. The proposal was delivered to Sida in April 2015. If funded, the programme will strengthen collaboration between economists in the regional networks, economists in GU's Environment for Development (EfD) centres and ecologists from local institutions in the network regions.

Anne-Sophie Crépin gave a plenary presentation entitled *Regime shifts, planetary boundaries and behaviour* at the EfD annual conference in Dar es Salaam on 23–26 October 2014. In her presentation she offered a definition and overview of recent research related to regime shifts and economics. In addition she addressed upcoming topics in economics such as planetary boundaries, behavioural aspects of regime shifts and the need to better quantify the impacts of regime shifts on human wellbeing.

Participants of the workshop in Dar es Salaam. Photo: Gunnar Köhlin.

Jeffrey Vincent participated in SANDEE's biannual research and training workshops in Kathmandu, Nepal in December 2014 and in Colombo, Sri Lanka in June 2015 as lead discussant on multiple proposals, progress reports and final reports. He also served as an advisor on SANDEE research projects in six countries (Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) and attended EEPSEA's annual conference in Ho Chi Minh City, Vietnam in May 2014. As at the SANDEE workshops, he served as a lead discussant on proposals for new projects and reports on projects already funded. Also for EEPSEA, he organised and taught a four-day short course on *The Valuation of Regulating Ecosystem Services,* held in Putrajaya, Malaysia in January 2014. The course was very well received and spawned proposals for new research projects that were presented at the Ho Chi Minh City conference.

Carl Folke, along with Beijer fellows Partha Dasgupta and Thomas Sterner and directors of the regional networks, took part in a Sida-organised development talk focusing on environmental economics in development cooperations, which is featured in the Science in Society section of this Annual Report.

Mäler scholars

In order to use our limited resources more effectively after the end of our latest Sida funding in 2014, we decided to focus fully on the new application and defer the call for next Mäler Scholar to autumn 2015. However we have continued our collaboration with former Mäler scholars. Therese Lindahl performed a series of field experiments in a fishing community in Thailand that were jointly organised with former Mäler Scholar Rawadee Jarungrattanapong. Matías Piaggio and Saudamini Das participated in the workshop in Dar es Salaam and Sebastian Villasante is cooperating with Li Chuan-Zhong on

the project *Threshold and resilience in fisheries,* described under research programmes, Complex Systems.

Environment and Development Economics

The Environment and Development Economics (EDE) journal was founded by, and is published in association with, the Beijer Institute. EDE is positioned at the intersection of environmental, resource and development economics and encourages submissions from researchers in the field in both developed and developing countries.

Leadership changes

There has been a change of guard this year with Eswaran Somanathan, Professor at the Indian Statistical Institute and new Director of SANDEE, taking over from Beijer fellow Tasos Xepapadeas as Editor of the journal and Renuka Rao taking over from Joan Stefan as Assistant Editor. Both Tasos Xepapadeas and Joan Stefan have put in a lot of high-quality hard work for ten long years and have greatly increased the journal's influence and visibility.

The journal's team of associate editors provide an invaluable service to the journal. They, along with the editor, carefully scrutinise each submission and assess not only its value to the journal, but its scientific potential. Their reviews and helpful comments go a long way in the publication of papers by authors who need these inputs in order to get published. The assistant editor works to process the manuscripts from submission to publication.

Submissions

Year on year, submissions of manuscripts to the journal have increased gradually and substantially. The number peaked in 2012 with 232 submissions, partly due to the fact that there were a number of special issues that year. The number of submissions in 2014 was "normal" while submissions in 2015 are projected to exceed the 2012 peak. This projection is based on submissions made in the first six months of 2015. The number of papers submitted each year from 1995 to 2015 is shown in Figure 1.

Geographical distribution

Figure 2 shows the geographical distribution of papers submitted in 2014 and the first six months of 2015, while the breakdown of the geographical origin of accepted papers in the past three years is represented in Figure 3.

Submissions from developing areas are about 60% and are continuing to increase. The figures indicate the effectiveness of the journal in addressing one of its primary objectives: capacity building in developing areas of the world.

Impact

At the board meeting in Helsinki in June 2015, Patrick McCartan of Cambridge University Press presented the 2015 publishing report for EDE, which mentioned that downloads and institutional access (mainly in the form of consortia subscriptions) increased in 2014. He presented details about the impact factor, which increased to 1.169 in 2014 (from 0.985 in 2013), while several related journals experienced a decrease in their impact factor.

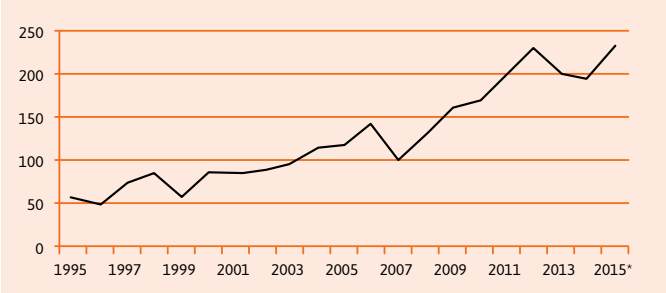


Figure 1. Annual submissions, 1995–2015

*projected.

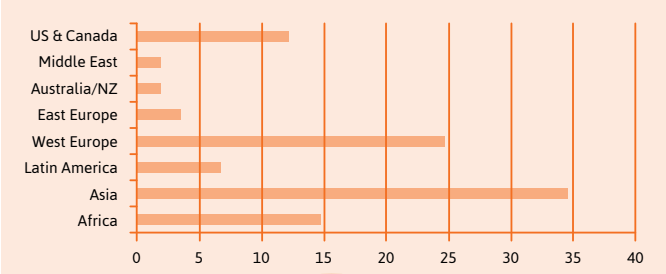


Figure 2. Geographical breakdown of submissions of papers from January 2014 to June 2015 (% of the total)

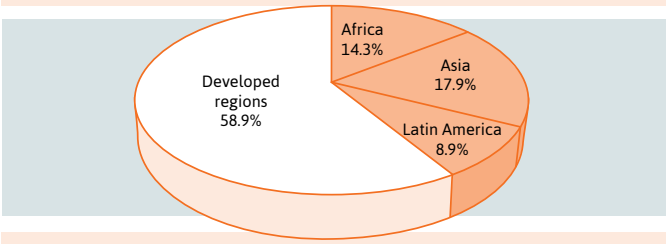


Figure 3. Geographical origin of accepted papers in the last three years

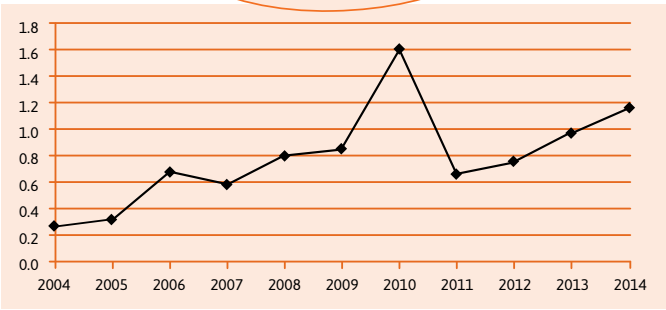


Figure 4. The journal's impact factor development over the last decade

Figure 4 EDE Impact factor 2004–2014

Future targets

The journal will continue to focus on encouraging and giving maximum support to authors for high-quality theoretical and empirical research in environmental and development economics. Special attention will be paid to papers submitted from developing areas and to publishing special issues that focus on specific areas of policy interest. The December 2014 issue of EDE was a special issue on *"The impacts and acceptance of agricultural biotechnology"* (guest editors David Zilberman and Justus Wesseler), and another special issue *"Adaptation to climate change in developing and transition countries"* (guest editors Katrin Millock, Johanna Choumert and Pascale Combes) is due in August 2015.

A microbiologist with a mission

by Agneta Sundin

ON 30 JUNE this year, Staffan Normark stepped down as the Academy's Permanent Secretary after five successful years in the post. Staffan has been an immense support to the Beijer Institute in many diverse ways. He has enthusiastically promoted the Beijer Institute's research and issues concerning global development and sustainability in different contexts. He has also played a decisive role in obtaining funding for future research and activities within the area, for example the Academy's Global Economic Dynamics and the Biosphere (GEDB) programme and the Swedish Secretariat for Future Earth.

Before departing, he shared his experiences and thoughts on his time at the Academy in a conversation in the attractive offices of the Permanent Secretary. Not least, what it meant for his own development.

Staffan Normark in the Permanent Secretary's office at the Academy. The 18th century paintings from the Academy's collection are Staffan's personal favourites. Photo: Agneta Sundin

"The most exciting part was being confronted with subjects and concepts outside my own area of expertise, particularly ideas and aspects relating to global development challenges. I acquired a greater range of knowledge during these five years and also had my eyes opened to where the actual problems lie. This resulted in my opting to engage with just those issues, with sustainability questions as central."

Both mouthpiece and midwife

The Royal Swedish Academy of Sciences was founded in 1739 as an independent scientific body and as such Staffan Normark strongly believes it can make a difference for global sustainability in a multifaceted way.

"Several of the Academy members are influential voices in Sweden, and indeed around the world, on the environment, sustainability and issues relating to these, and the Academy can act as a mouthpiece for their competence and ideas. This may involve issuing statements on climate issues and biodiversity matters or organising events to publicise the IPCC report.

Another aspect is what I call the 'midwifery role', where we try to see how we can activate or initiate activities within these important areas and then allow them to stand on their own legs. GEDB is a good example."

The output is key

Staffan has been very supportive of the Beijer Institute's work and mission. How then does he view the Institute's role as an independent body within the Academy? He explains it as a trust game, with advantages for both institutions.

"The Academy has gained added value through the Beijer Institute. It was incredibly foresighted to establish this type of institute at such an early stage. It is actually a rather unique creation. I see it as an institute for advanced studies and a network with many committed researchers around the world. The Beijer Institute works with research and results that affect a great many people and are published in the best journals, which gives great power to the findings. And I am a concrete person, not one for squares, spheres and diagrams. I want to see results based on evidence, and that is what emerges from the Beijer Institute.

Organisations such as the Beijer Institute and GEDB also reinforce the image of the Academy as an evidence-based organisation with important publications, ground-breaking work and external research funding. At the same time, they create an intellectual environment at the Academy with their workshops, seminars and prominent guest researchers.

In turn, the Beijer Institute thrives on being in this environment and being allowed to be freestanding, while at the same time benefiting from the Academy as a brand. There is a type of trust game where the achievements are critical. If the output were trivial, I as Permanent Secretary would not make any effort to support it. But when it is important, I would do anything!"

On microbes and men

Staffan Normark is Professor of Medical Microbiology and his research over the years has centred on the pathological characteristics of bacteria. He believes that this has links to sustainable development issues, for example with regard to the use of antibiotics, and points out that the Beijer Institute has been involved in publications on antibiotic use in aquaculture and cattle rearing. However, even though there are points of intersection, it is still not an obvious task for a microbiologist to devote his attention to global sustainability issues. Staffan laughed when asked why he is so fired up about this.

"These questions are the most important things you can think about. For humanity, everything else is secondary. My microbes, on the other hand, will thrive with or without humans. The great shortcoming in our society and in our politics is that we have difficulty imagining the processes that are underway and how to reverse them. This is absolutely essential. Of course it is important to take responsibility as an individual, for example with recycling, but it is for the major systems that we must find solutions and produce scientific evidence to show the way forward – nothing is more important."

Reflections of a retiring chairman

MY ASSOCIATION with the Beijer Institute goes back to 1991, when my mentors, Karl-Göran Mäler and Partha Dasgupta, became Director and Chairman respectively. It was a special place then. It remains special today.

Karl-Göran and Partha pointed the Beijer Institute in a new and exciting direction. Until that time, economists and ecologists had advanced their own disciplines, without interacting much with each other. Economists ignored Nature, or represented it in naïve and simplistic ways. Ecologists looked at ecosystems as if they existed outside of human influence. The truth, Karl-Göran and Partha knew, was that humans depended on Nature, and yet were depleting and degrading it without much regard for the consequences. Nature was the worse for this, but so were humans. Individuals may have gained by using the environment in this way, but society as a whole was losing big time.

Ecologists knew better than anyone the consequences of this behavior, but I think they were puzzled as to why people were behaving in this way. I'm guessing they may have thought that people were ignorant or simply had the wrong values. To see that people may also have been responding to incentives is an important insight. It means that the situation can be changed through policies and institutions.

For their part, economists tended to believe that Nature was predictable, whereas ecologists emphasized again and again that this wasn't so. Nature is full of surprises and can respond abruptly even to tiny disturbances. In my own work, which has been heavily influenced by my association with the Beijer Institute, I have come to see things this way: Individual human "units" (individuals, households, communities, and nation states) are engaged in games with one another; collectively they are engaged in games with Nature, and Nature is unpredictable. At my first Askö meeting, I had trouble seeing this. I learned then about "resilience" and "robustness", but I wasn't sure why and how these properties really mattered. Now I get it.

In science, we care about outputs—mainly, publications. But outputs come from processes, and the most special thing about the Beijer Institute is its way of working. This is particularly evident in the Askö meetings. The formula goes something like this. First, gather together a group of smart people from the two disciplines. Second, take them to an island on which there are few distractions. Third, keep the agenda simple. Actually, forget an agenda. Just start with a topic; let the agenda emerge from the process of interaction. Fourth, add in some fun. Finally, repeat. I found my first Askö meeting somewhat perplexing, but as I went to more and more of them I came to appreciate that my own thinking had been changed by these interactions. I also became attached to a lot of the regulars. For me, coming to an Askö meeting in September is like coming home for Thanksgiving dinner, only more fun.

The consequence of the Beijer doing this year after year is something I would call the Beijer gestalt. The Merriam-Webster online dictionary defines gestalt as "a structure, configuration, or pattern of physical, biological, or psychological phenomena so integrated as to constitute a functional unit with properties not derivable by summation of its parts". This, I think, sums up the Askö regulars perfectly. It's why the meetings are so productive.

I mentioned the Beijer Institute's publication record, but its output, or impact, is much greater than this. Ecologist Simon Levin is now writing articles on economics. Perhaps that would have happened without the Beijer Institute's influence, but I doubt it. Marten Scheffer recently asked me, (and several other Askö regulars) to contribute to an article he had drafted on safe operating spaces for iconic ecosystems. Would that have happened without the Beijer? Again, I doubt it. I've been doing work on "regime shifts". Where did I first hear about these? At the Beijer Institute, of course. I could go on and on. The problem is I wouldn't know where to stop. The Beijer Institute is like a small pebble thrown into the Great Lake of Science. It has a ripple effect.

Photo: Agneta Sundin

"The Beijer Institute is like a small pebble thrown into the Great Lake of Science. It has a ripple effect."

I started by attributing the institute's success to its rebirth under the leadership of Karl-Göran and Partha, but its continued success is due to the people who have nurtured it along all this time. Carl Folke joined the Beijer as Associate Director in 1991. Later, when Karl-Göran retired, Calle shared the directorship with Aart de Zeeuw. Later still, when Aart stepped down, Calle took over as Director. Since then, Calle has brought some important changes to the Beijer. He has strengthened its capabilities by linking it, when appropriate, to the Stockholm Resilience Centre. He has launched new initiatives, such as the Beijer Young Scholars program. One of the best things he did, however, was not to change the things that weren't broken. Under his leadership, the Askö meetings continue to be held every September. The Beijer gestalt continues to thrive.

Cape Cod, 18 August 2015

Scott Barrett *Professor, Columbia University, USA*

Member of the Board 2003–2014
Chairman of the Board 2012–2014

Board of Directors

Board members of the Beijer Institute of Ecological Economics are appointed by the Royal Swedish Academy of Sciences for a three-year period, and should not be re-elected more than once, according to the standing instructions for the Beijer Institute approved by the Royal Swedish Academy of Sciences on 5 June 1991. The first Board of Directors for the new Institute was elected on 5 June 1991. The 24th annual board meeting was held at the Royal Swedish Academy of Sciences on 12 September 2014.

At this meeting, Professor Scott Barrett, Professor Stephen Carpenter and Professor Anastasios Xepapadeas reached the end of their term. They have all been on the board since 2003, which is an unusually long time and was made possible by an exception to the rules at the transition time when the institute changed leadership. The Beijer Institute wishes to express its warmest gratitude for their great efforts on behalf of the institute over the years.

This meeting was the first for Professor Neil Adger, University of Exeter, UK, who was welcomed as a new member of the board.

BOARD OF DIRECTORS

Chairman

Scott Barrett
Professor, Columbia University, USA

Ex-officio members

Carl Folke*
Director, the Beijer Institute, Sweden

Staffan Normark*
Professor, Permanent Secretary of the Royal Swedish Academy of Sciences, Sweden

Anne-Sophie Crépin
Deputy Director, the Beijer Institute, Sweden

Board meeting 12 September 2014: BOARD: Karine Nyborg, Stephen Carpenter, Anastasios Xepapadeas, Carl Folke, Neil Adger, Terry Chapin, Marty Anderies, Anne-Sophie Crépin, Scott Taylor, Aart de Zeeuw, Scott Barrett. Photo: Agneta Sundin

Members

Neil Adger
Professor, University of Exeter, UK

J. Marty Anderies
Professor, Arizona State University, USA

Stephen Carpenter*
Professor, University of Wisconsin, USA

Stuart "Terry" Chapin
Professor, University of Alaska, USA

Eric Lambin
Professor, University of Louvain, Belgium

Rosamond Naylor
Professor, Stanford University, USA

Karine Nyborg
Professor, University of Oslo, Norway

M. Scott Taylor
Professor, University of Calgary, Canada

Aart de Zeeuw
Professor, Tilburg University, the Netherlands

Anastasios Xepapadeas
Professor, University of Athens, Greece

*Member of the Royal Swedish Academy of Sciences

Staff news

Honorary doctorate in Belgium for Carl Folke

Every year as part of its Patron Saint's Day celebrations, Belgium's largest university, KU Leuven, recognises individuals for their exceptional scientific, societal or cultural achievement. One of the recipients of this year's honorary doctorates on 2 February was Beijer Institute Director Carl Folke. The others were Philippe Claudel (multifaceted artist and humanist), Rakesh Jain (engineer and cancer research pioneer), Brainard Guy Peters (leading political scientist) and Chilean president Michelle Bachelet (who received her honorary doctorate at a later event). In a press release announcing the event, Carl Folke's research on the resilience of integrated social-ecological systems was recognised as being both exceptional and novel:

"Folke's work adds a new dimension to our thinking on sustainability: he conceives of societies as living systems that are continually changing in interaction with their biophysical surroundings. His research on the resilience of these ecosystems is particularly pertinent for policy frameworks aimed at addressing climate change."

Five million SEK economics grant from the Ragnar Söderberg Foundation

Gustav Engström and Chandra Kiran, along with Johan Gars of the Academy programme Global Economic Dynamics and the Biosphere (GEDB), have received SEK five million in project funding from the Ragnar Söderberg Foundation to investigate the links between the macroeconomy and

biophysical processes. One objective is to study the importance of these links for the use of economic policy instruments in relation to global environmental problems.

In addition to this research group, the Ragnar Söderberg Foundation has granted SEK five million each to three other project groups in economics at Uppsala University, the Stockholm School of Economics and Lund University.

"The four research groups receiving funding this year have all clearly demonstrated how increased added value can arise through close co-operation. The interdisciplinary content is also apparent in all four groups," said Kjell Blückert, MD of the Ragnar Söderberg Foundation.

The researchers want to create an overall picture of how different biophysical processes relate to each other and interact with the socioeconomy in general.

Jean-Baptiste Jouffray

In September 2014, Jean-Baptiste Jouffray joined the Beijer Institute as a PhD candidate, jointly with the Global Economic Dynamics and Biosphere programme (GEDB) at the Royal Swedish Academy of Sciences, and also affiliated with Stockholm Resilience Centre. Jean-Baptiste has a background in natural science, with an undergraduate degree in Biology of Organisms, Populations and Ecosystems from University Paul-Sabatier, France, and an MSc in Ecology from Stockholm University. Most recently, he was employed within GEDB as a research assistant, during which time he widened his expertise to also encompass socio-economic aspects into his work.

As a PhD candidate in Sustainability Science, his primary interest lies in exploring the intertwined relationship between humans and marine ecosystems, as illustrated in two recently published papers "Transnational corporations as 'keystone actors' in marine ecosystems", in *PLOS ONE*, and "Identifying multiple coral reef regimes and their drivers across the Hawaiian archipelago", in *Philosophical Transactions*. "The pressures on marine ecosystems are unprecedented and are expected to rise as more and more people are depending on them. In order to come up with sustainable solutions for the marine environment, you first have to understand the underlying social-ecological dynamics," explains Jean-Baptiste. "In the long term my ambition is to provide empirical novel approaches and analytical methods of general value for understanding social-ecological system dynamics around the world."

Chandra Kiran Krishnamurthy

Chandra Kiran Krishnamurthy joined the Beijer Institute in August 2014 and prior to that was a Browaldh Fellow at the Centre for Environmental and Resource Economics and the Department of Economics at Umeå University, Sweden. He moved to Sweden after finishing his PhD in Sustainable Development at Columbia University's School of International and Public Affairs. Chandra has a Bachelor's degree in Engineering from Bangalore University, India, and an M. Phil in Economics, from IGIDR, Mumbai, India.

Although his research interests are broad, Chandra is primarily interested in issues related to managing natural resources, quantifying and dealing with the impacts of climate change, understanding key issues involving energy consumption, and exploring the interplay between industrial development, economic growth and environmental degradation. He uses both empirical and theoretical methods in his research.

Given his focus on issues related to the environment and the reputation of the Beijer Institute for excellence on related topics and for its openness to eclectic approaches, Chandra's move to Beijer was a natural next step in the progression of his research career. He explains why:

"I was particularly drawn to the relatively open approach to research at the Beijer, in terms of both the choice of disciplinary projects and the potential to naturally interact with researchers in other, environment-related fields. It certainly helped that, in my prior interactions, I found the Beijer researchers and staff fun to be with!"

Together with Gustav Engström and Johan Gars, he will begin work on understanding how the inclusion of other earth system processes, such as ocean

Top left: Gustav Engström and Johan Gars, photo: Johan Miderberg. Top right: Jean-Baptiste Jouffray. Bottom left: Carl Folke with fellow recipients of the honorary doctorates, photo: KU Leuven. Bottom right: Chandra Kiran Krishnamurthy.

BEIJER FELLOW PRIZES, HONOURS AND AWARDS

Jane Lubchenco
2015 Tyler Prize, together with Madhav Gadgil

Eric Lambin
2014 Volvo Environment Prize

Thomas Sterner
2015 guest professor at Collège de France

Fikret Berkes
2015 Elinor Ostrom Award

Simon Levin
2014 Luca Pacioli Prize

acidification and land use change, affects climate and environmental policy. In addition, he is exploring alternate ways of modelling regime shifts and thresholds in dynamic systems, to explore whether different ways of managing thresholds lead to very different outcomes for natural systems such as the climate system.

Daniel Ospina-Medina

Daniel Ospina-Medina joined the Beijer Institute in May 2014 as a research assistant, and since November he has been a PhD candidate in the Global Dynamics and Resilience programme at Beijer and the Regime Shifts theme of Stockholm Resilience Centre. He has an undergraduate degree in Ecology and an MSc from Stockholm Resilience Centre at Stockholm University.

Daniel's main research interests revolve broadly around the changes in rural landscapes and livelihoods in the context of increasing global connectivity and urbanisation, particularly in Latin America. More specifically, he is interested in forest transition and its dynamic relationship with human migration and remittances. Ultimately, his objective is to identify ways of harnessing these processes to enhance the viability of rural economies and sustainable flows of ecosystem services.

According to Daniel, the Beijer Institute and Stockholm Resilience Centre offer an ideal setting to develop this research, given the interdisciplinary nature of these issues and the need for building on foundations from various fields of economics.

"The broader Beijer network of researchers is a wonderful asset in this regard, including scholars with expertise on land use change, agricultural and labour economics, as well as advanced approaches for modelling complex social-ecological dynamics."

Staff members

Carl Folke
Professor, Director

Anne-Sophie Crépin
PhD, Deputy Director

Marty Anderies
Professor, Programme Director

Johan Colding
Associate Professor, Researcher, Programme Director

Gretchen Daily
Professor, Researcher

Gustav Engström
PhD, Researcher

Åsa Gren,
PhD, Researcher

Jean-Baptiste Jouffray
PhD Candidate

Chandra Kiran Krishnamurthy
PhD, Researcher

Sofia-Kristin Kokinelis
MSc, Finance and HR Administrator

Efthymia Kyriakopoulou
PhD, Researcher

Christina Leijonhufvud
BA, Administrator

Linda Lindström
Research Assistant

Chuan-Zhong Li
Professor, Programme Director

Therese Lindahl
PhD, Researcher, Programme Co-ordinator

Nikolina Oreskovic
MSc, Research Assistant

Daniel Ospina-Medina
PhD Candidate

Stephen Polasky
Professor, Programme Director

Caroline Schill
PhD Candidate

Britt Stikvoort
MSc, Research Assistant

Agneta Sundin
Communications Officer

Max Troell
Associate Professor, Researcher, Programme Director

Jeffrey Vincent
Professor, Senior Advisor

Brian Walker
PhD, Programme Director

Aart de Zeeuw
Professor, Programme Director

Visiting scientists

Patrik Henriksson
PhD candidate, University of Leiden, 14 August 2014 –

Jim Wilen
Professor, University of California, Davis, 8-18 September 2014, 5-13 February 2015, 4-13 May 2015.

Scott Barrett
Professor, Columbia University, 2–8 May 2015

Aart de Zeeuw
Tilburg University, 15–23 May 2015

Jessica Gephart
PhD candidate, University of Virginia, 8–30 June 2015

Rawadee Jarungrattanapong
PhD, Sukhothai Thammathirat Open University, 28 June–5 July 2015

Administration

Office location

The Beijer Institute is located in a wing of the early 20th century building of the Royal Swedish Academy of Sciences at Frescati, a science and university area about 2 km north of Stockholm City. The area is situated in one of Stockholm's green belts, Ekoparken, which also includes some of the inlets of the Baltic Sea. Ekoparken has been declared a 'national city park' by the Swedish parliament. The Institute's visiting address is Lilla Frescativägen 4, Stockholm.

Organisation

The Institute's administration is partly carried out by, or coordinated with, the Royal Swedish Academy of Sciences, for example accounting and maintenance of premises and computers. Other administrative procedures are performed independently by the Beijer Institute.

Sofia-Kristin Kokinelis

Sofia-Kristin is Finance and HR Administrator for both the Beijer Institute and the Family Erling Persson Academy Programme, GEDB. More specifically, she is responsible for accounting issues and budgeting and provides support and financial information to researchers about their projects. She also prepares staff contracts and assists staff members with different issues.

Christina Leijonhufvud

Christina was responsible for the administration of the Board and Askö meetings in September 2014. She helped with the organisation of the second workshop on *"Natural Capital & Resilience: Frontiers in Research, Tools, Policy and Practice"* 2–3 October 2014 and spent a great part of the spring preparing for the *Stockholm Summit on Natural Capital,* which took place in Steningevik 18-30 May 2015. In May she also co-ordinated the Beijer Young Scholars meeting (4-7 May) and in June the *Behaviour, Economics and Nature Network workshop* (8-10 June). She is responsible for the administration of guest research posts and deals with various office tasks.

Agneta Sundin

Agneta is communications officer, dividing her time between the Beijer Institute and its partner, the Global Economic Dynamics and the Biosphere Programme (GEDB) of the Academy. Agneta's responsibilities include developing and editing the website, the annual report and administering the Beijer publication series, as well as taking part in organising workshops and other events. A member of Stockholm Resilience Centre Communications team, Agneta is involved in activities arranged jointly by SRC, Beijer and Albaeco, for example the Stockholm Seminars series. She was project leader and co-creator of the exhibition *Patterns of the Biosphere* shown in Stockholm 15 April-15 June 2015, her main project during the period. She was also involved in the preparation and execution of the *Stockholm Summit on Natural Capital* at Steningevik 18–30 May, 2015, as well as the *Beijer Young Scholars meeting* 4–7 May and the workshop *Planning for healthy and sustainable cities: Unpacking the urban green box* 8–9 June.

Funding

Core funding for the Beijer Institute is provided by the Kjell and Märta Beijer Foundation, founded in 1974 through a donation from Kjell and Märta Beijer. The Foundation's purpose is to support research and education, as well as supporting culture, especially design and interior decoration, but also music and literature. The Beijer Institute is its single largest beneficiary, but the Kjell and Märta Beijer Foundation also makes large donations to research in genetic science, neuroscience and pharmaceutical research at Uppsala University and dairy cattle research at the Swedish University of Agricultural Studies

Kjell Beijer was a Swedish businessman who met his wife Märta when she was working in the furniture and design store Svenskt Tenn in Stockholm, which is renowned for classical designs and high quality. This store was later bought by the Kjell and Märta Beijer Foundation and the profits go to the Foundation.

Funding for the Beijer Institute's research activities between 1 July 2014 and 30 June 2015 was also provided by:

- The Brothers Jacob and Marcus Wallenberg Memory Foundation
- The Canadian International Development Research Centre, IDRC
- The Crafoord Foundation
- The European Association of Environmental and Resource Economics, EAERE
- The European Commission
- The Ebba and Sven Schwartz Foundation
- The Foundation for Strategic Environmental Research, MISTRA
- The Alba Langeskiöld Foundation
- The Riksbankens Jubileumsfond, The Swedish Foundation for Humanities and Social Sciences
- The Swedish International Development Cooperation Agency, Sida
- The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, FORMAS
- Swedish Governmental Agency for innovation systems, VINNOVA
- Western Indian Ocean Marine Science Association, WIOMSA

Teaching and training

The Beijer Institute serves as a link between university departments and institutions working with ecological economics issues, and PhD students are involved in its research programmes and projects. The Institute organises training workshops and international research seminars on the environment and development and international training programmes.

Challenges of Environmental Decision-making – Master's course

Beijer Institute researchers organise and teach the course *Challenges of Environmental Decision-making* to students taking the Master's programme Social-Ecological Resilience for Sustainable Development at Stockholm Resilience Centre. The objective of the course is to help students understand a broad spectrum of challenges associated with decision making and how these are typically tackled within the field of economics. Read more about under the Education section of this report.

Ecology and Economic Management - PhD Course

This course aims to provide students in Environmental Economics with an understanding of the complexity and functions of interlinked socio-ecological systems, and the implications this has for governance. It is aimed at PhD students participating in the SIDA-funded PhD programme in Environmental Economics at Gothenburg University and it is held at the Beijer Institute every second year. The latest course was featured in the previous annual report. The PhD programme was established by the Beijer Institute and the Environmental Economics unit at Gothenburg University in 1997. The purpose of the programme is to strengthen the capacity in developing countries to teach environmental economics at university level, and to establish a firm basis for research that can be used for policy advice pertaining to environmental economics and sustainable development.

The Stockholm Seminars: Frontiers in Sustainability Science and Policy

The Stockholm Seminars are arranged by the Beijer Institute, Stockholm Environment Institute, IGBP and Stockholm Resilience Centre, along with Albaeco. They cover a broad range of perspectives on sustainability issues and focus on the need for a sound scientific basis for sustainable development policy.

The seminars are given at the Royal Swedish Academy of Sciences and attended by a large audience, including scientists, students, media and policymakers in the public and private sector.

Between July 2014 and June 2015, the following seminars were held:

2014

» **15 September:** Prof. Simon Levin *Obstacles and opportunities in environmental management*
» **19 September:** Dr. Günter Pauli *Designing new competitive business models*
» **24 September:** Prof. William Laurance *Ecosystem decay of a fragmented Amazonian rainforest*
» **20 October:** Prof. Xuemei Bai *Urban system dynamics, experiments, and sustainability transition*
» **18 November:** Seminar and launch of the new report *"Connected Risks, Connected Solutions"* at the IVA conference, hosted by the Centre and Global Challenges Foundation.
» **15 December:** Prof. Gerge Sugihara *Correlation and causation*

2015

» **13 January:** Mr. Stuart Scott *Rethinking economics in the age of abrupt climate change*
» **30 January:** Prof. Terry Hartig *Urban densification, contact with nature and psychological restoration: Issues of conflict and compensation*
» **21 May:** Prof. Jianguo Liu *Promises and perils of telecouplings for global sustainability*
» **4 June:** Prof: Kazuhiko Takeuchi *Science and innovation for a sustainable future*
» **17 June:** Prof. Katherine Richardson and Jorgen Randers *Are we likely to hit planetary boundaries before 2050?*

Brown Bag Lunch Seminars

The Brown Bag Lunch Seminars are a joint initiative between the Beijer Institute and Stockholm Resilience Centre, held at Stockholm Resilience Centre. The seminars aim to provide a platform for staff, students and visitors at the institutions, to share their work in an informal manner with ample time for discussion. The Brown Bag Seminars have proved to be a success and often attract a large audience.

The Askö Meeting

Since 1993, the Beijer Institute has organised an annual meeting in September for informal discussions between ecologists and economists at the Stockholm Centre for Marine Research at Askö, a Swedish island in the Baltic Sea. The Askö meetings have generated unique cooperation between these disciplines and each meeting has resulted in a consensus document, often published in a leading scientific journal.

The theme of Askö 2014 was *Social Norms, Multiple Equilibria and the Environment*. This meeting is described more closely in the BENN section of this report.

Staff members' publications and activities

Johan Colding
Associate Professor, Researcher

Research focus

Urban social-ecological systems.

Publications during the period

» Marcus, L. and J. Colding. 2014. Towards an integrated theory of spatial morphology and resilient urban systems. *Ecology and Society* 19(4):55.

Reports

» Colding, J. 2015. Stärkt hållbarhet (Improved sustainable development). In: Tillväxt- och regionalplaneförvaltningen (Stockholm county council). *Sju perspektiv på hållbar utveckling (Seven perspectives on sustainable development)*. Arbetsmaterial 2015:1. Pp. 25-32.
» Colding, J., S. Barthel and L. Marcus. 2015. *SURF: Stockholm Urban Mistra Futures. Stockholm Resilience Centre.*

Conferences, workshops and presentations

» Associate Professor appointment, The ABE School, KTH, Stockholm, October 2014. Lecture: *Sustainable Urban Development: A brief summary of research and teaching themes.*
» Workshop 1: Improved Sustainable Development (Stärkt hållbarhet), TMR, Office of Regional Planning, Stockholm County Council, November 2014. Invited speaker: *Resiliens: Insikter från forskning om social-ekologiska system (Resilience: Insights from social-ecological research)*.
» Conference, Social- och Regionalfonden i ett regionalt utvecklingsperspektiv (European Social and European Regional Development Fund in a regional development perspective), TMR, Office of Regional Planning, Stockholm County Council, December 2014. Invited speaker: *Resiliens: Insikter från forskning om social-ekologiska system (Resilience: Insights from social-ecological research)*.
» Workshop 2: Improved Sustainable Development (Stärkt hållbarhet), TMR, Office of Regional Planning, Stockholm County Council, January 2015. Participant.
» Seminar on Culture-driven growth and societal planning (Kulturdriven tillväxt och samhällsplanering) – part 2, Stockholm County Board, May 2015. Presentation: *Resiliens och hållbarhet (Resilience and sustainability)*.

Teaching and training

» Co-supervisor of PhD candidate Caroline Schill (Stockholm Resilience Centre, Stockholm University).

Commissions

» Member of the city planning group for Albano sustainable campus.

» Member of the international working group within The Scandinavian Turfgrass Research Foundation for sustainable development of golf courses.

Other

» Appointed lecturer in Sustainable Urban Development Stockholm, Department of Environmental Strategies Research, ABE School, KTH, Stockholm, October 2014.
» Popular science communication: Dags att ta stadsbonden på allvar (Time to take city farmers seriously), 21 October 2014, *EXTRAKT*, Formas, Stockholm, Sweden.

Anne-Sophie Crépin
PhD, Deputy Director

Research focus

Modelling social ecological systems, regime shifts and economics, risk modelling, global dynamics and resilience, economic consequences of climate change in the Arctic Ocean, behavioural responses to regime shifts.

Publications during the period

» Crépin, A.-S. and C. Folke. 2015. The Economy, the biosphere and planetary boundaries: Towards biosphere economics. International Review of *Environmental and Resource Economics 8:57-100*.
» Homer-Dixon, T., B. Walker, R. Biggs, A.-S. Crépin, C. Folke, E. Lambin, G. Peterson, J. Rockström, M. Scheffer, W. Steffen and M. Troell. 2015. Synchronous failure: The emerging causal architecture of global crisis. *Ecology and Society. In press.*
» Schill, C., T. Lindahl and A.-S. Crépin. 2015. Collective action and the risk of ecosystem regime shifts: insights from a laboratory experiment. *Ecology and Society* 20(1):48.
» Troell, M., R.L. Naylor, M. Metian, M. Beveridge, P.H. Tyedmers, C. Folke, K.J. Arrow, S. Barrett, A.-S. Crépin, P.R. Ehrlich, Å. Gren, N. Kautsky, S.A. Levin, K. Nyborg, H. Österblom, S. Polasky, M. Scheffer, B.H. Walker, T. Xepapadeas and A. de Zeeuw. 2014. Does aquaculture add resilience to the global food system? *Proceedings of the National Academy of Sciences* 111(37):13257–13263.

Reports

» Crépin, A.-S., G. Engström, Å. Gren and D. Ospina. 2015. *Conditions for Integrated Ecosystem Based Management in the Arctic*. Deliverable D5.71 of the European Union FP7 (project no. 265863) Arctic Climate Change. Economy and Society.
» Lindahl, T., A.-S. Crépin and N. Oreskovic. 2015. *Results from field experiments in the Arctic*. Deliverable D3.51 of the European Union FP7 (project no. 265863), Arctic Climate Change, Economy and Society.

Conferences, workshops and presentations

» Askö 2014 meeting on Social norms, multiple equilibria and the environment, Askö and Royal Swedish Academy of Sciences (RSAS), Stockholm, September 2014. Participant.
» 2014 Annual Meeting of the Environment for Development (EfD) initiative, Dar es Salaam, Tanzania, October 2014. Plenary keynote Speaker: *Regime shifts, planetary boundaries and behaviour.*
» 2015 Annual workshop of Luleå Technical University, Sigtuna, January 2015. Invited lecturer: *Regime shifts, planetary boundaries and behaviour.*
» ACCESS final general assembly, Universitat Politècnica de Catalunya, Villanova, Spain, February 2015. Speaker: *WP 5 Highlights: ACCESS management tools and ACCESS synthesis report*.
» 2015 Annual conference of the Association of Environmental and Resource Economists, Helsinki, Finland, June 2015. Presentation of paper: *Inertia in risk; improving economic models of catastrophes.*

Teaching and training

» Course organiser, Master's and PhD level course *The Arctic Climate Change, Economy and Society (ACCESS) and Arctic Resilience Report (ARR) Summer school,* Beijer Institute and Stockholm Resilience Centre, September 2014.
» Lecturer, Master's level course *Governance and Management of Social-Ecological Systems: Principles of Economic Decision-making,* Stockholm Resilience Centre, Stockholm University, spring 2015.
» Co-supervisor of PhD candidates Daniel Ospina-Medina and Caroline Schill (Stockholm Resilience Centre, Stockholm University).

Commissions

» Steering committee member, Arctic Climate Change Economy and Society (ACCESS), FP 7 EU project within the call Ocean of Tomorrow, 2011-2015.
» Reviewer for [to be inserted]

Gretchen Cara Daily
Visiting Professor

Research focus

Work orientated around three broad questions: The kinds of species and ecosystems that will exist over the coming decades and centuries, given the projected intensification of human impacts on the biosphere; the important species and ecosystems that most merit protection, from scientific and societal standpoints; and strategies to effect the deep, global transformation needed to bring human impacts into balance with what the biosphere can sustain.

At the Royal Swedish Academy of Sciences: integrating the tremendous knowledge foundation in system dynamics and resilience into the Natural Capital Project's tools and approaches, from biophysical, social and governance perspectives.

Publications during the year

» Bratman, G.N., G.C. Daily, B.J. Levy and J.J. Gross. 2015. The benefits of nature experience: Improved affect and

cognition. *Landscape and Urban Planning* 138: 41-50.
» Bratman, G.N., J.P. Hamilton, K. Hahn, G.C. Daily and J.J. Gross. 2015. Nature experience reduces rumination and subgenual prefrontal cortex activation. P*roceedings of the National Academy of Sciences*. In press.
» Brauman, K.A., D.L. Freyberg and G.C. Daily. 2014. Impacts of land-use change on groundwater supply: Ecosystem services assessment in Kona, Hawaii. *Journal of Water Resources Planning and Management* A4014001-1-11.
» Daily, G.C. Securing nature and people: Can we replicate and scale success? In: M. Potschin, R. Haines-Young, R. Fish, and R.K. Turner (eds.). *Routledge Handbook of Ecosystem Services*. Taylor & Francis. In press.
» Daily, G.C. and C.J. Katz, Jr. 2014. *The Power of Trees*. Fubaisha Press, Japan (in Japanese).
» Frishkoff, L.O., D.S. Karp, L.K. M'Gonigle, C.D. Mendenhall, J. Zook, C. Kremen, E.A. Hadly and G.C. Daily. 2014. Loss of avian phylogenetic diversity in neotropical agricultural systems. *Science* 345:1343-1346.
» Frishkoff, L.O., E.A. Hadly and G.C. Daily. 2015. Thermal niche predicts tolerance to habitat conversion in tropical amphibians and reptiles. *Global Change Biology*. In press.
» Gould, R.K, S. Klain, N.M. Ardoin, T. Satterfield, U. Woodside, N. Hannahs, G.C. Daily and K.M. Chan. 2015. A protocol for eliciting nonmaterial values using a cultural services frame. *Conservation Biology* 29(2):575-586.
» Gould, R.K., N.M. Ardoin, U. Woodside, T. Satterfield, N. Hannahs and G.C. Daily. 2014. The forest has a story: cultural ecosystem services in Kona, Hawai'i. *Ecology and Society* 19(3):55.
» Guerry, A.D., S. Polasky, J. Lubchenco, R. Chaplin-Kramer, G.C. Daily, R. Griffin, M.H. Ruckelshaus, I. Bateman, A. Duraiappah, T. Elmqvist, C. Folke, J. Hoekstra, P. Kareiva, B. Keeler, S. Li, E. McKenzie, Z. Ouyang, T. Ricketts, B. Reyers, J. Rockström, H. Tallis and B. Vira. 2015. Natural capital and ecosystem services informing decisions: From promise to practice. *Proceedings of the National Academy of Sciences* 112(24):7348-7355.
» Karp, D.S., S. Judson, G.C. Daily, and E.A. Hadly. 2014. Molecular diagnosis of bird-mediated pest control in tropical farmland. *SpringerPlus* 3:630.
» Pejchar, L., M. Hooten and G.C. Daily. Using effects of large-scale forest restoration on native and exotic birds in Hawaii. *Ecosphere*. In press.

Reports

» Daily, G.C. 2014. Preface. In: J. O. Kenter, M. S. Reed, M. Everard, K. N. Irvine, E. O'Brien, E. C. Molloy, R. Bryce, E. Brady, M. Christie, A. Church, T. Collins, N. Cooper, A. Davies, D. Edwards, A. Evely, I. Fazey, R. Goto, N. Hockley, N. Jobstvogt, J. Orchard-Webb, N. Ravenscroft, M. Ryan and V. Watson. 2014. *Shared, Plural and Cultural Values:* A Handbook for Decision-makers. UK National Ecosystem Assessment follow-on phase. Cambridge, UNEP-WCMC. P. 3.
» Daily, G.C. Mainstreaming the values of nature for people into decision-making. Paper prepared for the Pontifical Academy of Sciences and the Pontifical Academy of Social Sciences Joint Workshop on *Sustainable Humanity, Sustainable Nature: Our Responsibility,* May 2014, Vatican City. In press.

Conferences, workshops and presentations

» Xi'an Jiaotong University, Xi'an, China, July 2014. Speaker: *Bringing China's dream to the world.*
» World Water Week Symposium, Stockholm, September 2014. Speaker: *Targeting watershed investments for multiple benefits.*
» Stockholm Resilience Centre and Natural Capital Workshop II, Stockholm, October 2014. Organiser of workshop Integrating Natural Capital and Resilience Approaches into Decision-making.
» Natural Capital Project Advisory and Governing Committee Meetings, Stanford, USA, October 2014. Organiser.
» Cambridge University, Cambridge, UK, October 2014. Presentation: *Methods for modelling ecosystem services.*
» Stockholm Resilience Centre and Natural Capital Workshop II, Stockholm, November 2014. Participant and co-organiser.
» Joint Seminar of Leipzig Research Community, Leipzig, Germany, November 2014. Speaker: *Science frontiers in natural capital.*
» Inter-Departmental Seminar, Yale University, USA, January 2015. Invited speaker by webex: *The history and future of ecosystem service approaches.*
» Inter-Departmental Seminar, Uppsala Agricultural University, January 2015. Invited speaker: *Integrating biodiversity and ecosystem services into decisions.*
» Natural Capital Symposium, Stanford, USA, March 2015. Primary organiser and keynote speaker: *Key frontiers in ecosystem service science.*
» Modeling Ecosystem Services, Leipzig, Germany, April 2015. Primary organiser and keynote speaker in a related event: *Challenges and opportunities for women in science.*
» Conference on environment and sustainable development (Tillståndet i miljön 2015), Stockholm, May 2015. Keynote speaker: *Valuing nature in business and policy.*
» Stockholm Summit on Natural Capital, Stockholm, May 2015. Primary organizer and presentation: *A shared action plan for driving innovation and uptake of natural capital and resilience approaches.*
» Stockholm City Urban Planning Conference, Stockholm, June 2015. Keynote speaker: *Ecosystem services in city planning.*

Teaching and training

» Main supervisor of PhD candidate Luke Frishkoff (Biology, Stanford University, USA) and post-docs Chase Mendenhall, Lisa Mandle, Shan Ma, Becky Chaplin-Kramer, Anne Guerry (Woods Institute, Stanford University, USA)
» Co-supervisor of PhD candidates Greg Bratman (Interdisciplinary Program in Environment and Resources, Stanford University, USA) and Maike Hamman and Master's student Matilda Lenell (Stockholm Resilience Centre, Stockholm University).

Commissions

» Scientific Advisory Council member of Peninsula Open Space Trust, Palo Alto, CA, USA, since 2012.
» Committee member of CGIAR, Research Program on Water, Land and Ecosystems, since 2012.
» Board member of Stockholm Resilience Centre, since 2010.
» Advisor for *Acta Ecologica Sinica*, Chinese Academy of Sciences, since 2010.

- Editorial Advisory Board member, *The Year in Ecology and Conservation Biology,* since 2007.
- Faculty Director, *The Natural Capital Project* (a partnership among Stanford University, The Nature Conservancy, World Wildlife Fund and University of Minnesota), since 2006.
- Board of Trustees (Global) of The Nature Conservancy, since 2006.
- Advisory Board member of The Sustainable Land Fund, since 2005.
- Section Head of Faculty of 1000, since 2004.

Gustav Engström
PhD, Researcher

Research focus

Macroeconomic models of climate change, especially integrating climate models developed by climate scientist with models of optimal economic growth. Recent interests include the tipping points of the climate system and aspects of income distribution related to climate policy. Other research activities involve urban economic and ecological issues and how these can be addressed using house sales.

Publications during the period

- Brock W. A., G. Engström and A. Xepapadeas. 2015. Energy balance climate models, damage reservoirs and the time profile of climate change policy. In: Bernard, L., and W. Semmler (eds.). The Oxford Handbook of the Macroeconomics of Global Warming. *Oxford University Press*, New York, USA.
- Engström, G. and J. Gars. 2015. Optimal taxation in the macroeconomics of climate change *Annual Review of Resource Economics*. In press.
- Norström, A. V., A. Dannenberg, G. McCarney, M. Milkoreit, F. Diekert, G. Engström, R. Fishman, J. Gars, E. Kyriakopoolou, V. Manoussi, K. Meng, M. Metian, M. Sanctuary, M. Schlüter, M. Schoon, L. Schultz, and M. Sjöstedt. 2014. Three necessary conditions for establishing effective sustainable development goals in the Anthropocene. *Ecology and Society*. 19(3): 8.

Teaching and training

- Lecturer, Master's level course *Social-ecological systems: challenges & approaches. Economic approaches to analyse ecosystem support of humanity,* Stockholm Resilience Centre, Stockholm University, autumn 2014.
- Course organiser and lecturer, Master's level course *Governance and Management of Social-Ecological Systems: Principles of Economic Decision-making,* Stockholm Resilience Centre, Stockholm University, spring 2015.

Conferences, workshops and presentations

- ACCESS final general assembly, Universitat Politècnica de Catalunya, Villanova, Spain, February 2015. Participant.

Carl Folke
Professor, Director

Research focus

Social-ecological systems and stewardship of ecosystem services from local to global contexts, resilience thinking, ecological economics, transformations reconnecting development to the biosphere.

Publications during the period

- Bennett, E.M., S.R. Carpenter, L.J. Gordon, N. Ramankutty, P. Balvanera, B. Campbell, W. Cramer, J. Foley, C. Folke, L. Karlberg, J. Liu, H. Lotze-Campen, N.D. Mueller, G.D. Peterson, S. Polasky, J. Rockström, R.J. Scholes and M. Spirenburg. 2014. Toward a more resilient agriculture. *Solutions* 5 (5):65-75.
- Blenckner, T., M. Llope, C. Möllman, R. Voss, M. Quass, M. Casini, M. Lindegren, C. Folke and N.C. Stenseth. 2015. Climate and fishing steer ecosystem regeneration to uncertain economic futures. *Proceedings of the Royal Society of London B: Biological Sciences* 282(1803):20142809.
- Conversi, A., V. Dakos, A. Gårdmark, S. Ling, C. Folke, P. Mumby, C. Greene, M. Edwards, T. Blenckner, M. Casini, A. Pershing and C. Möllmann. 2015. A holistic view of marine regime shifts. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 370(1659):20130279.
- Crépin, A.-S. and C. Folke. 2015. The economy, the biosphere and planetary boundaries: Towards biosphere economics. *International Review of Environmental and Resource Economics* 8:57-100.
- Crona, B.I., T. Daw, W. Swartz, A. Norström, M. Nyström, M. Thyresson. C. Folke, J. Hentati-Sundberg, H. Österblom, L. Deutsch and M. Troell. 2015. Masked, diluted and drowned out: how global seafood trade weakens signals from marine ecosystems. *Fish and Fisheries.* doi: 10.1111/faf.12109.
- Defeo, O., M. Castrejón, R. Pérez-Castañeda, J.-C. Castilla, N.L. Gutiérrez, T. Essington and C. Folke. 2015. Co-management in Latin American small-scale shellfisheries: Assessment from long-term case studies. *Fish and Fisheries.* DOI: 10.1111/faf.12101.
- Eriksson, H., H. Österblom, B. Crona, M. Troell, N. Andrew, J. Wilen and C. Folke. 2015. Contagious exploitation of marine resources. *Frontiers in Ecology and the Environment*. In press.
- Fischer, J., T.A. Gardner, E.B. Bennett, P. Balvanera, R. Biggs, S. R. Carpenter, T. Daw, C. Folke, R. Hill, T. Hughes, T. Luthe, M. Maass, M. Meacham, A. V. Norström, G. Peterson, C. Queiroz, R. Seppelt, M. Spierenburg and J. Tenhunen. 2015. Advancing sustainability through mainstreaming a social-ecological systems perspective. *Current Opinion in Environmental Sustainability.* In press.
- Folke, C. 2015. Foreword. In: Biggs, R., M. Schlüter and M.L. Schoon (eds.). *Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems.* Cambridge University Press, Cambridge, UK. Pp. xix-xxii.

» Guerry, A.D., S. Polasky, J. Lubchenco, R. Chaplin-Kramer, G.C. Daily, R. Griffin, M.H. Ruckelshaus, I. Bateman, A. Duraiappah, T. Elmqvist, C. Folke, J. Hoekstra, P. Kareiva, B. Keeler, S. Li, E. McKenzie, Z. Ouyang, T. Ricketts, B. Reyers, J. Rockström, H. Tallis and B. Vira. 2015. Natural capital and ecosystem services informing decisions: From promise to practice. *Proceedings of the National Academy of Sciences* 112(24):7348-7355.
» Homer-Dixon, T., B. Walker, R. Biggs, A.-S. Crépin, C. Folke, E. Lambin, G. Peterson, J. Rockström, M. Scheffer, W. Steffen and M. Troell. 2015. Synchronous failure: The emerging causal architecture of global crisis. *Ecology and Society.* In press.
» Kotschy, K., R. Biggs, T. Daw, C. Folke and P. West. 2015. Maintain diversity and redundancy. In: Biggs, R., M. Schlüter and M.L. Schoon (eds.). *Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems.* Cambridge University Press, Cambridge, UK. Pp. 50-79.
» Mathevet, R., J. D. Thompson, C. Folke and S. Chapin III. 2015. Protected areas and their surrounding territory: Social-ecological systems in the context of ecological solidarity. *Ecological Applications.* In press.
» Möllman, C., C. Folke, M. Edwards and A. Conversi. 2015. Marine regime shifts around the globe: Theory, drivers and impacts. *Philosophical Transactions of the Royal Society of London B: Biological Sciences 370(1659): 20130260.*
» Österblom, H. and C. Folke. 2015. Globalization, marine regime shifts and the Soviet Union. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 370(1659):20130278.
» Österblom, H., J.-B. Jouffray, C. Folke, B. Crona, M. Troell, A. Merrie and J. Rockström. 2015. Transnational corporations as 'keystone actors' in marine ecosystems. *PLoS ONE* 10(5): e0127533.
» Rockström, J., M. Falkenmark, T. Allan, C. Folke, L. Gordon, A. Jägerskog, M. Kummu, M. Lannerstad, M. Meybeck, D. Molden, S. Postel, H.H.G. Savenije, U. Svedin, A. Turton and O. Varis. 2014. The unfolding water drama in the Anthropocene: towards a resilience-based perspective on water for sustainability. *Ecohydrology* 7:1249-1261.
» Scheffer, M., J. Bascompte, T.K. Bjorndam, S.R. Carpenter, L.B. Clark, C. Folke, P. Marquet, N. Mazzeo, M. Meerhoff, O. Sala and F. Westley. 2015. Dual thinking for scientists. *Ecology and Society* 20(2):3.
» Scheffer, M., S. Barrett, S. Carpenter, C. Folke, A.J. Greene, M. Holmgren, T.P. Hughes, S. Kosten, I. van de Leemput, D. Nepstad, E.H. van Nes, E.T.H.M. Peeters and B. Walker. 2015. Creating a safe operating space for the world's iconic ecosystems. *Science* 347:1317-1319.
» Schultz, L., C. Folke, H. Österblom and P. Olsson. 2015. Adaptive governance, ecosystem management, and natural capital. *Proceedings of the National Academy of Sciences* 112(24):201406493.
» Steffen, W., K. Richardson, J. Rockström, S. Cornell, I. Fetzer, E. Bennett, R. Biggs, S.R. Carpenter, W. de Vries, C.A. de Wit, C. Folke, D. Gerten, J. Heinke, G.M. Mace, L.M. Persson, V. Ramanathan, B. Reyers and S. Sörlin. 2015. Planetary boundaries: Guiding human development on a changing planet. *Science* 347(6223) 1259855 1-10.
» Troell, M., R.L. Naylor, M. Metian, M. Beveridge, P.H. Tyedmers, C. Folke, K.J. Arrow, S. Barrett, A.-S. Crépin, P.R. Ehrlich, Å. Gren, N. Kautsky, S.A. Levin, K. Nyborg, H. Österblom, S. Polasky, M. Scheffer, B.H. Walker, T. Xepapadeas and A. de Zeeuw. 2014. Does aquaculture add resilience to the global food system? *Proceedings of the National Academy of Sciences* 111(37):13257–13263.
» Van den Bergh, J., C. Folke, S. Polasky, M. Scheffer and W. Steffen. Environmental problem shifting: An illustration and framework for analysis. *Current Opinion in Environmental Sustainability.* In press.

Conferences, workshops and presentations

» Askö 2014 meeting. Social norms, multiple equilibria and the environment, Askö and KVA, Stockholm, September 2014.
» Dialogue at Mistra's twenty year celebration, September 2014.
» Natural Capital and Resilience Workshop, Stockholm, October 2014. Participant.
» Towards an ecosystem-based legal framework for the Baltic Sea symposium, Stockholm University, October 2014. Invited speaker.
» University of Cape Town, South Africa, October 2014. Invited lecture.
» Nelson Mandela University, George Campus, South Africa, October 2014. Invited lecture.
» STIAS – Stellenbosch Institute for Advanced Study, South Africa, October 2014. Fellow lecture.
» Seeds of the Good Anthropocene workshop, SAPECS, Stockholm Resilience Centre and STIAS, South Africa, November 2014. Keynote speaker.
» Rhodes University, Grahamstown, South Africa, December 2014. Invited lecture.
» South American Institute for Resilience and Sustainability Studies (SARAS), Board meeting and Symposium on Imagining Resilience: Art-science Collaboration for Sustainability, December 2014. Presentation (with T. Bjordam and M. Scheffer).
» Insurance Value of Ecosystems, UNU, Tokyo, Japan, January 2015. Invited presentation.
» Investing in natural capital as a means to enable a society in harmony with nature: Insights from Sustainability Science, International Conference on Sustainability Science, UNU, Tokyo, Japan, January 2015. Keynote presentation.
» Policy Dialogue on Science and Technology for Sustainability, UNU, Tokyo, Japan, January 2015.
» Honorary Doctor Lecture, KU Leuven, Belgium, February 2015.
» Wellcome Trust visit, Stockholm Resilience Centre, Stockholm, February 2015. Presenter.
» Anders Wall's Foundation symposium "Gröna omställningar – jordens chans för entreprenörer", Stockholm, March 2015. Invited speaker.
» Environmental Economics – Pathways to a Sustainable Future, Sida Development Talks, Sida, Stockholm, May 2015. Invited presentation.
» Stockholm Summit on Natural Capital, Stanford, Beijer Institute/RSAS, Stockholm Resilience Centre, Steningevik, Stockholm, May 2015. Co-organizer.
» Rockefeller Global Fellowship Programme on Social Innovation, Stockholm, May 2015. Invited speaker.

» Ebba and Sven Schwartz Foundation, September 2014, March and May 2015.
» EAT Food Forum, Stockholm, chair of competence forum EAT Science, Jury of EAT Award, June 2015.
» Behavior, Economics, and Nature Network Workshop: Living with Homo Economicus? Beijer Institute, June 2015. Participant.

Teaching and training

» Lecturer, Massive Open Online Course (MOOC) *Planetary Boundaries and Human Opportunities,* Stockholm Resilience Centre, Stockholm University, autumn 2014.
» Lecturer in undergraduate, Master's and PhD level courses at Stockholm University.
» Co-supervisor of two PhD candidates in *Sustainability Science* (Stockholm Resilience Centre, Stockholm University).

Commissions

» Director of Science and Founder, Stockholm Resilience Centre, since 2007.
» Director of The Erling-Persson Family Academy Programme on Global Economic Dynamics and the Biosphere, since 2012.
» Member of the Royal Swedish Academy of Sciences, since 2002.
» Director of Programme on Ecosystem Change and Society (PECS), Future Earth/ICSU, since 2013.
» Founding and Board Member of the Resilience Alliance, since 1999.
» Member of the Environmental Research Committee of the Royal Swedish Academy of Sciences, since 2003.
» Editor-in-Chief of Ecology and Society, since 2002.
» Advisory and Editorial board member of *Ambio, Ecological Economics, Environmental Conservation, Environment and Development Economics, Environmental Innovation and Societal Transitions, Frontiers in Ecology and the Environment, Resilience: International Policies, Practices and Discourses, Reviews in Ecological Economics and Sustainability Science.*
» Fellow of The Synergy programme on resilience and critical transitionS (SparcS), Wageningen, The Netherlands, since 2012.
» Fellow of STIAS – Stellenbosch Institute for Advanced Study, since 2014.
» Senior Fellow of IHOPE, Integrated History and future of People on Earth, since 2015.
» Scientific Advisory Board member of SARAS (South American Institute for Resilience and Sustainability Studies), Montevideo, Uruguay, since 2007.
» Board member of UNU Institute for the Advanced Study of Sustainability, Tokyo, Japan, since 2014.
» Scientific Advisory Board member of STEPS, University of Sussex, Brighton, UK, since 2010.
» Member of The International Scientific Advisory Council, The Waterloo Institute for Complexity and Innovation (WICI), University of Waterloo, since 2012.
» Advisory Board member of EAT and EAT Forum, since 2013.
» Advisory Board member of The International Network of Research on Coupled Human and Natural Systems (CHANS-Net), since 2009.
» Associate Faculty member of Earth System Governance Project, Future Earth, since 2009.
» Scientific Committee member of Volvo Environment Prize, since 2008, chair since 2012.
» Selection Committee member of The Kenneth Boulding Award, International Society for Ecological Economics, since 2013.
» Member of the Ralph Yorque Society, since 1997.
» Principal investigator (with Gretchen Daily) for *Advancing Fundamental Knowledge of Natural Capital, Resilience and Biosphere Stewardship - A Research Exchange Program between Stanford University and Stockholm Resilience Centre, Stockholm University,* funded by the Marianne and Marcus Wallenberg Foundation.
» Co-principal investigator of the Centre of Excellence: *Nordic Centre for the Study of Climate Change Effects on Marine Ecosystems and Resource Economics* (NorMER) of The Top-level Research Initiative (TRI), a joint Nordic research and innovation initiative (NC Stenseth PI).
» Partner investigator of Nereus Program – Predicting the Future Ocean, UBC, Canada, since 2010.
» Steering Committee member of BEAM (Baltic Ecosystem Adaptive Management), Stockholm University.
» Partner investigator, The ARC Centre of Excellence for Coral Reef Studies, JCU, Australia 2005-2014

Other

» Honorary Doctorate from KU Leuven, Belgium, February 2015.
» Outreach publication: Folke, C. 2014. The most obvious thing in a complex world: We are nature. In *Atmosphere,* Hackholmssund. Pp. 28-35.
» Exhibition *Reflections on People and the Biosphere* at the gallery Artipelag, Värmdö, Sweden, July-August 2014.
» Outdoor exhibition of *Reflections on People and the Biosphere* at Raoul Wallenberg Square, Nybroplan, Stockholm, April-May 2015, including several presentations.
» *Patterns of the Biosphere (Biosfärens Mönster)* exhibition, including several lectures and presentations, Svenskt Tenn, Stockholm, April to June 2015.
» Publications in relation to exhibitions: Folke, C. 2015. Om Biosfären, Människan, och Konsten (About the Biosphere, People, and Art), *Sapir Magazine*, 16 April 2015; Sundin, A., C. Folke, F. Moberg and A. Wall. 2015. Catalogue for the exhibition *Patterns of the Biosphere (Biosfärens Mönster)*, Svenskt Tenn and the Beijer Institute, Royal Swedish Academy of Sciences.
» Recognized as highly cited researcher by Thompson Reuters and by Google Scholar Citations and listed in Thompson Reuters 2014 report *The World's Most Influential Scientific Minds.*

Åsa Gren
PhD, Researcher

Research focus

Valuation of resilience using response diversity as a proxy and the unpacking of urban green areas in a health/human

wellbeing/sustainable planning/cultural ecosystem service perspective.

Conferences, workshops and presentations

» Workshop on urban systems in a global context, Royal Institute of Technology, Stockholm, October 2014. Keynote speaker: *Sustainable urban systems.*
» Conference: Research and practice for the future of the Stockholm-Lake Mälaren region for Stakeholders in the Stockholm County (Forskning och praktik kring Stockholm-Mälarregionens framtid), Urban Theme, Stockholm Resilience Centre, November 2014. Organiser and presentation: *Urban ecosystem services in the Stockholm region.*
» Swedish urban network conference, Urban Theme, Stockholm Resilience Centre, November 2014. Organiser and presenter.
» ACCESS final general assembly, Universitat Politècnica de Catalunya, Villanova, Spain, February 2015. Participant.
» Sustainable Markets and the Biosphere, collaboration workshop of Beijer Institute, Global Economic Dynamics and the Biosphere Programme and the Stockholm School of Economics (MISUM), Sigtuna, June 2015. Presentation: *Urban systems and actors.*
» Planning for Healthy Cities, Unpacking the Green In Urban Green Areas, workshop, Beijer Institute, June 2015. Organiser, moderator and presenter.

Teaching and training

» Lecturer, undergraduate course *Världens Eko (Urban Ecosystem Services),* Stockholm Resilience Centre, Stockholm University, September 2014.
» Lecturer, Master's and PhD level course *The Arctic Climate Change, Economy and Society (ACCESS) and Arctic Resilience Report (ARR) Summer school,* Beijer Institute and Stockholm Resilience Centre, September 2014.

Commissions

» Reviewer for *Ecological Indicators.*

Jean-Baptiste Jouffray
PhD candidate, Researcher

Research focus

Marine social-ecological systems, studies on coral reefs at local and regional scales, the global sustainability of fisheries and marine social-ecological resilience in general.

Publications during the year

» Jouffray, J.-B., M. Nyström, A.V. Norström, I.D. Williams, L.M. Wedding, J.N. Kittinger and G.J. Williams. 2015. Identifying multiple coral reef regimes and their drivers across the Hawaiian archipelago. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 370(1659):20130268.
» Österblom, H., J.-B. Jouffray, C. Folke, B. Crona, M. Troell, A. Merrie and J. Rockström. 2015. Transnational corporations as 'keystone actors' in marine ecosystems. *PLoS ONE* 10(5): e0127533.

Conferences, workshops and presentations

» Workshop, Leibniz Center for Tropical Marine Ecology (ZMT), Bremen, Germany, September 2014. Presentation of paper: *Identifying multiple coral reef regimes and their drivers across the Hawaiian archipelago.*
» NCEAS Ocean Tipping Points – All Hands Meeting, Honolulu, Hawaii, USA, December 2014. Presentation of paper: *Identifying multiple coral reef regimes and their drivers across the Hawaiian archipelago.*
» Sustainable Markets and the Biosphere, collaboration workshop of Beijer Institute, Global Economic Dynamics and the Biosphere Programme and the Stockholm School of Economics (MISUM), Sigtuna, June 2015. Presentation of paper: *Transnational Corporations as 'Keystone Actors' in Marine Ecosystems.*

Commissions

» Reviewer for *Philosophical Transactions of the Royal Society of London B: Biological Sciences and Coral Reefs.*

Other

» Newspaper articles on publications in the period: Study reveals good, bad news about algae on coral communities, 25 November 2014, *West Hawaii Today*, Hawaii, USA; 13 'keystone' companies control 11-16% of global marine catch, 28 May 2015, *Undercurrent News;* A handful of corporations could hold the answer to crisis in the seafood industry, 28 May 2015, *The Guardian,* UK.
» Interview for a documentary on Hawaiian coral reefs; to be featured in a video documentary as part of a 'Coral Guardians' project (http://www.coralguardians.org/).
» PhD candidate since September 2014.

Chandra Kiran Krishnamurthy
PhD, Researcher

Research focus

A wide range of issues in environmental and resource economics, including the economics of climate change, energy economics, management of renewable resources, and empirical methods applied, and pertaining, to environment-related issues. Focus at Beijer: environmental problems at a larger scale (global and regional), and research on understanding and modelling the economics of planetary boundaries.

Publications during the period

» Krishnamurthy, C.K.B. 2015. Beijer Discussion Paper 252: Distributional Implications of Electricity Taxation: An Assessment using Household Survey Data from 11 OECD countries. *Beijer Discussion Paper Series.*
» Krishnamurthy, C.K.B. and B. Kriström. 2015. A cross-country analysis of residential electricity demand in 11 OECD-countries *Resource and Energy Economics* 39:68-88.

- Krishnamurthy, C.K.B. and B. Kriström. 2015. How large is the Owner-Renter Divide in Energy Efficient Technology? Evidence from an OECD cross-section *The Energy Journal* 36(4):63-82.
- Krishnamurthy, C.K.B. and B. Kriström. 2015. Determinants of the price-premium for green energy: Evidence from an OECD cross-section. *Environmental and Resource Economics*. In press.

Conferences, workshops and presentations

- Occasional ENE seminar series, Norwegian School of Economics (NHH), Bergen, Norway, April 2014. Invited presentation of paper: *Residential end-use electricity demand and the implications for real-time pricing in Sweden*.

Teaching and training

- Lecturer, Master's and PhD level course *Environmental Economics,* Umeå University, autumn 2014.
- Lecturer, short course *An R Crash course,* Beijer Institute, March 2015.

Commissions

- Member of the programme committee of the EAERE.
- Reviewer for *American Journal of Agricultural Economics (AJAE), Annals of Operations Research, Climate Change, Energy Journal, Journal of the Association of Environmental and Resource Economists (JAERE)*.

Efthymia Kyriakopoulou

PhD, Researcher

Research focus

Urban economics, environmental policy in IO and trade models, spatiotemporal analysis of economic models.

Publications during the period

- Antoniou, F. and E. Kyriakopoulou. 2015. On the strategic effect of international permits trading on local pollution: The case of multiple pollutants. *Working Papers in Economics* No 610, University of Gothenburg.
- Coria, J. and E. Kyriakopoulou. 2015. Environmental policy and the size distribution of firms. *Working Papers in Economics* No 614, University of Gothenburg.
- Kyriakopoulou, E. and A. Xepapadeas. 2014. Atmospheric pollution in rapidly growing urban centers: Spatial policies and land use patterns. *Working Papers in Economics* No 601, University of Gothenburg.
- Norström, A. V., A. Dannenberg, G. McCarney, M. Milkoreit, F. Diekert, G. Engström, R. Fishman, J. Gars, E. Kyriakopoolou, V. Manoussi, K. Meng, M. Metian, M. Sanctuary, M. Schlüter, M. Schoon, L. Schultz, and M. Sjöstedt. 2014. Three necessary conditions for establishing effective sustainable development goals in the Anthropocene. *Ecology and Society*. 19(3): 8.

Conferences, workshops and presentations

- 5th World Congress of Environmental and Resource Economists, Istanbul, Turkey, July 2014. Presentation of paper (by a co-author) and organiser of a Sida meeting: *On the Strategic Effect of International Permits Trading on Local Pollution: The Case of Multiple Pollutants*.
- Workshop: Policies for Resilience and Development in the Anthropocene, Dar es Salaam, Tanzania, October 2014. Organiser and presentation.
- General Economics Workshop, Department of Economics, University of Gothenburg, January 2015. Presentation of paper: *Urban spatial structures*.
- 2nd Thales Research Workshop: Optimal Management of Dynamic Systems of the Economy and the Environment, Athens University of Economics and Business, Athens, Greece, March 2015. Presentation of paper: *Atmospheric pollution in rapidly growing industrial cities: Spatial policies and land use patterns*.

Teaching and training

- Lecturer, Master's level course *Environmental and Resource Economics* (for non-economists), Department of Economics, University of Gothenburg, autumn 2014.
- Lecturer and course coordinator, Master's Course *Environmental Policy Instruments,* Chalmers University of Technology, Gothenburg, spring 2015.

Commissions

- Reviewer for *Energy Journal, Environmental and Resource Economics, Journal of Public Economic Theory, Journal of Environmental Management, Regional Science and Urban Economics,* and *Resource and Energy Economics*.

Other

- Co-coordinator of a joint research proposal (Beijer Institute, Environmental Economics Unit of University of Gothenburg and Stockholm Resilience Centre) submitted to Sida and entitled *Policies for Resilience and Development in the Anthropocene*.

Chuan-Zhong Li

Professor, Researcher

Research focus

Environmental valuation, growth with environmental assets, resilience studies.

Publications during the period

- Li, C.Z. and R. Bali Swain. 2015. Beijer Discussion Paper 251: Growth, water resilience, and sustainability: A DSGE model applied to South Africa. *Beijer Discussion Paper Series*.
- Li, C.Z. and K.G. Löfgren. 2015. A dynamic price index theory for deflating green NNP: An illustrative application using data from the United States. *Environmental Economics*. In press.

Teaching and training

» Course leader, lecturer and examiner, Master's level course *Microeconomic Theory,* Uppsala University, autumn 2014.

Commissions

» Editorial board member, *Journal of Environmental Economics and Policy Studies,* since 2011.
» Member of the board of directors, Professional Association of China's Environment, Beijing, China, since 2012.

Therese Lindahl
PhD, Researcher

Research focus

Human behaviour as it relates to the biosphere, in the intersection of economics, psychology and systems ecology. Influence of complex ecosystem dynamics (e.g. threshold effects, uncertainty and resources interdependencies) on resource users' strategies for exploitation and cooperation and implications for the management of common resources. Alternative approaches to environmental policy based on psychological insights.

Publications during the period

» Lindahl, T. 2015. Miljöekonomi och beteendevetenskap (Environmental economics and behavioural science). In: Stavlöt, U. (ed.). *Nationalekonomi för miljöintresserade (Economics for the Environmentally Interested)*. Ivrig Förlag, Stockholm, Sweden.
» Lindahl, T., Ö. Bodin, and M. Tengö. 2015. Governing complex commons: The role of communication for experimental learning and coordinated management. *Ecological Economics* 11:111-120.
» Schill, C., T. Lindahl and A-S. Crepin. 2015. Collective action and the risk of ecosystem regime shifts: insights from a laboratory experiment. *Ecology and Society* 20(1):48.

Report

» Lindahl, T., A.-S. Crépin and N. Oreskovic. 2015. *Results from Field Experiments in the Arctic*. Deliverable D3.51 of the European Union FP7 (project no. 265863) Arctic Climate Change, Economy and Society.
» Lindahl, T., and B. Stikvoort. 2015. *Nudging – The New Black in Environmental Policy?* FORES Study 2015:3. Stockholm, Sweden.

Conferences, workshops and presentations

» Seminar series in Economics, Department of Agricultural and Resource Economics, Faculty of Economics, Kasetsart University, Bangkok, Thailand, December 2014. Invited speaker: *Dealing with abrupt ecosystem changes in common pool resource systems: Evidence from laboratory experiments.*
» Evaluating interventions that encourage healthy and sustainable diets, Chatham House, London, England, April 2015. Participant.
» ACCESS final general assembly, Universitat Politècnica de Catalunya, Villanova, Spain, February 2015. Participant as task leader in working group on fisheries.
» EAT Stockholm Food Forum, June 2015. *Participant in Competence Forums # 3 (Reviewing Interventions for Healthy and Sustainable Diets: A Run-Through of Progress and Outline of Next Steps) and # 10 (Theme Committee Meeting on Consumer Behaviour and Choices)*.
» Towards Healthy and Sustainable Diets in the Nordic Countries, workshop, Karolinska Institutet, Stockholm, June 2015. Participant.
» Behaviour, Economics, and Nature Network Workshop: Living with Homo Economicus? Beijer Institute, Stockholm, June 2015. Organiser.
» Behaviour, Economics, and Nature Network Workshop: Exploring the Role of the Limbic System in CPR Management, Beijer Institute, Stockholm, June 2015. Organizer.
Symposium on Religion, Values and Sustainability, KVA, Stockholm, June 2015. Organiser.
» Workshop: Governing Boundary-spanning Ecosystems, Stockholm Resilience Centre, June 2015. Presentation: *Informal solutions to environmental problems: Dealing with complex humans and complex environments. The value added of using experiments.*

Teaching and training

» Lecturer, Master's level course *Social-ecological systems: challenges & approaches. Economic approaches to analyse ecosystem support of humanity,* Stockholm Resilience Centre, Stockholm University, autumn 2014.
» Lecturer, PhD level course How 2B a *Scientist,* Stockholm Resilience Centre, Stockholm University, autumn 2014.
» Lecturer, Master's level course *Governance and Management of Social-Ecological Systems: Principles of Economic Decision-making,* Stockholm Resilience Centre, Stockholm University, spring 2015.
» Lecturer, Master's level course *Governance and Management of Social-Ecological Systems: Drama of the Commons,* Stockholm Resilience Centre, Stockholm University, spring 2015.
» Lecturer, undergraduate course *Ekologisk Ekonomi* (Ecological Economics), Department of Physical Geography and Stockholm Resilience Centre, Stockholm University, spring 2015.
» Main supervisor of PhD candidate Caroline Schill and Master's students Linda Lindström (Stockholm Resilience Centre, Stockholm University) and Lea Schulz (Department of Biology, Stockholm University).

Commissions

» Scientific council member, Fores, Stockholm, since 2010.
» Scientific advisor, EAT forum, Stockholm, since 2015.
» Guest editor for Ecology and Society on special issue: *Advancing the Understanding of Behavior in Social-Ecological Systems: Results from Lab and Field Experiments.*
» Reviewer for Chatham House (London, UK), *Journal of Economic Behavior and Organization (JEBO), Journal of Environmental Economics and Management (JEEM), Environment and Behavior, Ecology and Society and Nature Climate Change.*

Nikolina Oreskovic
MSc, Research Assistant

Research focus
Exploring linkages between ecological characteristics and human behaviour among common-pool resource users managing resources facing potential abrupt, drastic and persistent changes.

Reports
» Lindahl, T., A.-S. Crépin and N. Oreskovic. 2015. *Results from Field Experiments in the Arctic*. Deliverable D3.51 of the European Union FP7 (project nr 265863) Arctic Climate Change, Economy and Society.

Conferences, workshops and presentations
» Planning for healthy cities, unpacking the green in urban green areas, workshop, Beijer Institute, June 2015. Participant.

Other
» Finished laboratory experiments and started developing the field part of the study, which will be carried out with Swedish fishermen.

Daniel Ospina-Medina
PhD candidate, Researcher

Research focus
Changes in rural landscapes and livelihoods in the context of increasing global connectivity and urbanization, particularly in Latin America. More specifically, the role of human migration and remittances in forest transitions.

Reports
» Crépin, A.-S., G. Engström, Å. Gren and D. Ospina. 2015. *Conditions for Integrated Ecosystem-based Management in the Arctic*. Deliverable D5.71 of the European Union FP7 (project no. 265863) Arctic Climate Change. Economy and Society.

Conferences, workshops and presentations
» Workshop: Emerging Methods for Empirical Analyses of Social-Ecological Systems, Ekskäret, Stockholm archipelago, December 2014. Participant.

Teaching and training
» Teaching assistant, Master's course *Regime Shifts,* Stockholm Resilience Centre, Stockholm University, autumn 2014.

Other
» Research assistant for the ACCESS project, tasks include coordination of WP meeting, synthesis workshop and Master's and PhD level course *The Arctic Climate Change, Economy and Society (ACCESS) and Arctic Resilience Report (ARR) Summer school.*
» PhD candidate since November 2014.

Caroline Schill
PhD candidate, Researcher

Research focus
Collective action, ecological complexity and social-ecological dynamics in social dilemmas. In particular, implications of abrupt ecosystem changes, and social and environmental uncertainties for sustainable commons management.

Publications during the period
» Schill, C., T. Lindahl and A.-S. Crepin. 2015. Collective action and the risk of ecosystem regime shifts: insights from a laboratory experiment. *Ecology and Society* 20(1):48.

Conferences, workshops and presentations
» Askö 2014 meeting on Social norms, multiple equilibria and the environment, Askö and KVA, Stockholm, September 2014. Participant.
» Behaviour, Economics, and Nature Network Workshop: Living with Homo Economicus? Beijer Institute, Stockholm, June 2015. Participant.

Teaching and training
» Teaching assistant, Master's level course *Social-ecological systems: challenges & approaches. Economic approaches to analyse ecosystem support of humanity,* Stockholm Resilience Centre, Stockholm University, autumn 2014.

Other
» Vice-chair (March 2013 to September 2014) and Education Team (Lärarkollegiet) representative (since September 2014), PhD student council, Stockholm Resilience Centre, Stockholm University.

Britt Stikvoort
MSc, Research Assistant

Research focus
Social psychological and behavioural economics perspective of the way human behaviour affects, and is affected by, the environment.

Reports

» Lindahl, T. and B. Stikvoort. 2015. *Nudging, The New Black in Policy?* Fores Report, Stockholm, Sweden.

Conferences, workshops and presentations

» Behaviour, Economics, and Nature Network Workshop: Exploring the role of the Limbic System in CPR Management, Beijer Institute, Stockholm, June 2015. Participant.

Max Troell
Associate Professor, Researcher

Research focus

Environmental impacts and sustainability of aquaculture, governance of coastal and marine ecosystems, ecosystem services, ecosystem functions, biodiversity, resilience, regime shifts, food security, integrated aquaculture, LCA, eco-certification.

Publications during the period

» Cao, L., R. Naylor, P. Henriksson, D. Leadbitter, M. Metian, M. Troell and W. Zhang. 2015. China's aquaculture and the world's wild fisheries. *Science* 347(6218):133-135.
» Crona, B.I., T. Daw, W. Swartz, A. Norström, M. Nyström, M. Thyresson. C. Folke, J. Hentati-Sundberg, H. Österblom, L. Deutsch and M. Troell. 2015. Masked, diluted and drowned out: how global seafood trade weakens signals from marine ecosystems. *Fish and Fisheries* (Ghoti paper).
» Eriksson, H., H. Österblom, B. Crona, M. Troell, N. Andrew, J. Wilen and C. Folke. 2015. Contagious exploitation of marine resources. *Frontiers in Ecology and the Environment*. In press.
» Henriksson, P.J.G., M. Troell and A. Rico. 2015. Antimicrobial use in aquaculture: Some complementing facts. Letter. *Proceedings of the National Academy of Sciences,* 112(26):E3317 doi:10.1073/pnas.1508952112.
» Homer-Dixon, T., B. Walker, R. Biggs, A.-S. Crépin, C. Folke, E. Lambin, G. Peterson, J. Rockström, M. Scheffer, W. Steffen and M. Troell. 2015. Synchronous failure: The emerging causal architecture of global crisis. *Ecology and Society*. In press.
» Krause, G., C. Brugere, A. Diedrich, M.W. Ebeling, S.C.A. Ferse, E. Mikkelsen, J.A. Pérez Agúndez, S.M. Stead, N. Stybel and M. Troell. 2015. A revolution without people? Closing the people-policy gap in aquaculture development. *Aquaculture*. In press.
» Österblom, H., J.-B. Jouffray, C. Folke, B. Crona, M. Troell, A. Merrie and J. Rockström. 2015. Transnational corporations as 'keystone actors' in marine ecosystems. *PLoS ONE* 10(5): e0127533.
» Thi Da, C., L.H., Phuoc, H.N. Duc, M. Troell and H. Berg. 2015. Use of Wastewater from Striped Catfish (Pangasianodon hypophthalmus) Pond Culture for Integrated Rice–Fish–Vegetable Farming Systems in the Mekong Delta, Vietnam. *Agroecology and Sustainable Food Systems* 39(5):580-597.
» Troell, M., R.L. Naylor, M. Metian, M. Beveridge, P.H. Tyedmers, C. Folke, K.J. Arrow, S. Barrett, A.-S. Crépin, P.R. Ehrlich, Å. Gren, N. Kautsky, S.A. Levin, K. Nyborg, H. Österblom, S. Polasky, M. Scheffer, B. H. Walker, T. Xepapadeas and A. de Zeeuw. 2014. Does aquaculture add resilience to the global food system? *Proceedings of the National Academy of Sciences* 111(37):13257-13263.

Conferences, workshops and presentations

» Natural Capital and Resilience workshop, Stockholm, October 2014. Participant.
» Aquaculture and Climate Change, International Atomic Energy Agency Monaco, Monaco, October 2014. Presenter.
» Aquaculture Water Footprinting, Beijer Institute, November 2014. Organiser and Presenter.
» MASMA Grantees Meeting: Monitoring the Performance, Mombasa, Kenya, October/November 2014. Evaluator.
» MyFish - Improving Research & Development of Myanmar's Inland and Coastal Fisheries, Department of Fisheries (Yangon, Myanmar) and FRND, NayPyiTaw, Myanmar, November/December 2014. Evaluator and Participant.
» Minister Meeting for Fisherie s Management, Department of Fisheries (Yangon, Myanmar), NayPyiTaw, Myanmar, November/December 2014. Participant.
» ACCESS final general assembly, Universitat Politècnica de Catalunya, Villanova, Spain, February 2015. Participant.
» Framtidsakademien (Future academy), CEMUS, Uppsala University, Uppsala Library, February 2015. Presenter: Hav i förändring - *hur möter vi det växande behovet av fisk och skaldjur (The changing sea – how to meet the growing demand for fish and shellfish)*.
» Nordic workshop: Shrimp Fisheries and Management, SP Food and Bioscience, Gothenburg, March 2015. Participant.
» Farm Foundation Forum: Nexus of Technology, Agricultural Productivity & the Environment, National Press Club, Washington, D.C., USA, March 2015. Participant.
» Agricultural Productivity and the Environment, U.S. Department of Agriculture, Washington, D.C., USA, March 2015. Invited speaker: *Environmental implications of the growth of aquaculture*.
» Sustainable Food, Svenskt Tenn, Stockholm, May 2015. Invited speaker/discussant.
» Sustainable Markets and the Biosphere, collaboration workshop of Beijer Institute, Global Economic Dynamics and the Biosphere Programme and the Stockholm School of Economics (MISUM), Sigtuna, June 2015. Participant.

Teaching and Training

» Lecturer, Master's course *Management of Aquatic Resources in the Tropics,* Stockholm University, March 2015.
» Opponent of Master's student Kate Williman (Stockholm Resilience Centre, Stockholm University), June 2015.
» Supervisor of PhD candidate Malin Jonell (Department of Ecology, Environment and Plant Sciences, Stockholm University) and Master's students Lara Mateos (Stockholm Resilience Centre, Stockholm University) and Daniel Johnson (Department of Ecology, Environment and Plant Sciences, Stockholm University).

Commissions

» Member of ICES working group, ICES: The Working Group on Social and Economic Dimensions of Aquaculture (WGSEDA), since 2011.

- Advisory Board Member of IDREEM, FP7 EU Project, since 2012.
- Member of the MASMA Programme Committee, Western Indian Ocean Marine Science Association, since 2007.
- Reviewer, United Nations Environmental Programme (UNEP) / Nairobi Convention and the Western Indian Ocean Marine Science Association, Regional State of the Coast Report (RSOCR) for the Western Indian Ocean: Chapter 23, Mariculture, October 2014.
- External Reviewer for the National Aquaculture Master plan, Seychelles Fishing Authority, Mahé Island, Seychelles, April-May 2015.
- Reviewer IFS Grants, International Foundation for Science, Sweden, since May 2015.
- External reviewer for senior lecture in Environmental Science, Uppsala University, May-June 2015.
- Review Editor for *Journal of Aquaculture Environment Interactions* (AEI), since 2009.
- Journal Reviewer for *Aquaculture research, Aquaculture, Journal of Applied Phycology, AMBIO, Environmental Interactions, International Journal of Sustainable Development (IJSD), Society & Natural Resources, Frontiers in Marine Science, Ecosystem Services, Journal of Shellfish Research and Ecology and Society.*

The Beijer Publication Series

SCIENTIFIC papers by Beijer staff or Beijer fellows, published in refereed journals or in books that have undergone review, are published in the BEIJER E-PRINT SERIES in order to facilitate the dissemination of research results. Some of the E-prints may have appeared earlier as discussion papers. The total number of E-prints since 1991 is at present 434, of which 34 were published on our website between July 2014 and June 2015. The BEIJER DISCUSSION PAPER SERIES constitutes a forum for unpublished scientific papers with content that should be subject to discussion and comments. They can be downloaded from the Beijer website. 253 discussion papers have been produced since 1991.

E-Print Series

2015

- **434.** The forest has a story: cultural ecosystem services in Kona, Hawai'i. Gould, R.K., N.M. Ardoin, U. Woodside, T. Satterfield, N. Hannahs and G.C. Daily (2014). Ecology and Society 19(3):55.
- **433.** The benefits of nature experience: Improved affect and cognition. Bratman, G.N., G.C. Daily, B.J. Levy and J.J. Gross (2015). Landscape and Urban Planning 138:41-50.
- **432.** Impacts of land-use change on groundwater supply: Ecosystem services assessment in Kona, Hawaii. Brauman, K.A., D.L. Freyberg and G.C. Daily (2014). Journal of Water Resources Planning and Management A4014001-1-11.
- **431.** Impacts of conservation and human development policy across stakeholders and scales. Li, C., H. Zheng, S. Li, X. Chen, J. Li, W. Zeng, Y. Liang, S. Polasky, M.W. Feldman, M. Ruckelshaus, Z. Ouyang, and G.C. Daily (2015). Proceedings of the National Academy of Sciences 112(24):7396–7401.
- **430.** A Protocol for eliciting nonmaterial values through a cultural ecosystem services frame. Gould, R.K, S. Klain, N.M. Ardoin, T. Satterfield, U. Woodside, N. Hannahs, G.C. Daily and K.M. Chan (2015). Conservation Biology 29(2):575-586.
- **429.** Loss of avian phylogenetic diversity in neotropical agricultural systems. Frishkoff, L.O., D.S. Karp, L.K. M'Gonigle, C.D. Mendenhall, J. Zook, C. Kremen, E.A. Hadly and G.C. Daily (2014). Science 345:1343-1346.
- **428.** Energy Balance Climate Models, Damage Reservoirs and the Time Profile of Climate Change Policy. Brock, W., G. Engström and A. Xepapadeas (2015). In: Bernard, L. and W. Semmler (eds.). The Oxford Handbook of the Macroeconomics of Global Warming. Oxford University Press, New York, USA. Pp.19-52.
- **427.** Maintain diversity and redundancy. Kotschy, K., R. Biggs, T. Daw, C. Folke and P. West (2015). In: Biggs, R., M. Schlüter and M. L. Schoon (eds.). Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems. Cambridge University Press, Cambridge, UK. Pp.50-79.
- **426.** Antimicrobial use in aquaculture: Some complementing facts. Henriksson, P.J.G., M. Troell and A. Rico (2015). Letter. Proceedings of the National Academy of Sciences 112(26):E3317.
- **425.** Use of Wastewater from Striped Catfish (Pangasianodon hypophthalmus) Pond Culture for Integrated Rice–Fish–Vegetable Farming Systems in the Mekong Delta, Vietnam. Thi Da, C., L.H., Phuoc, H.N. Duc, M. Troell and H. Berg (2015). Agroecology and Sustainable Food Systems 39(5):580-597.
- **424.** Governing complex commons – The role of communication for experimental learning and coordinated management. Lindahl, T., Ö. Bodin and M. Tengö (2015). Ecological Economics 11:111-120.
- **423.** Marine regime shifts around the globe: theory, drivers and impacts. Möllman, C., C. Folke, M. Edwards and A. Conversi (2015). Philosophical Transactions of the Royal Society of London B: Biological Sciences 370(1659): 20130260.
- **422.** Climate and fishing steer ecosystem regeneration to uncertain economic futures. Blenckner, T., M. Llope, C. Möllman, R. Voss, M. Quass, M. Casini, M. Lindegren, C. Folke and N.C. Stenseth (2015). Proceedings of the Royal Society of London B: Biological Sciences 282(1803):20142809.
- **421.** A holistic view of marine regime shifts. Conversi, A., V. Dakos, A. Gårdmark, S. Ling, C. Folke, P. Mumby, C. Greene, M. Edwards, T. Blenckner, M. Casini, A. Pershing and C. Möllmann (2015). Philosophical Transactions of the Royal Society of London B: Biological Sciences 370(1659):20130279.
- **420.** Globalization, marine regime shifts and the Soviet Union. Österblom, H. and C. Folke (2015). Philosophical Transactions of the Royal Society of London B: Biological Sciences 370(1659):20130278.
- **419.** Dual thinking for scientists. Scheffer, M., J. Bascompte, T.K. Bjorndam, S.R. Carpenter, L.B. Clark, C. Folke, P. Marquet, N. Mazzeo, M. Meerhoff, O. Sala and F. Westley (2015). Ecology and Society 20(2):3.
- **418.** Identifying multiple coral reef regimes and their drivers across the Hawaiian archipelago. Jouffray, J.-B., M. Nyström, A.V. Norström, I.D. Williams, L.M. Wedding, J.N. Kittinger and G.J. Williams (2015). Philosophical

Transactions of the Royal Society of London B: Biological Sciences 370(1659):20130268.

» **417.** Adaptive governance, ecosystem management, and natural capital. Schultz, L., C. Folke, H. Österblom and P. Olsson (2015). Proceedings of the National Academy of Sciences 112(24):201406493.

» **416.** Creating a safe operating space for iconic ecosystems. Scheffer, M., S. Barrett, S.R. Carpenter, C. Folke, A.J. Green, M. Holmgren, T.P. Hughes, S. Kosten, I.A. van de Leemput, D.C. Nepstad, E. H. van Nes, E.T.H.M. Peeters, B. Walker (2015). Science 347:1317-1319.

» **415.** Transnational Corporations as 'Keystone Actors' in Marine Ecosystems. Österblom, H., J.-B. Jouffray, C. Folke, B. Crona, M. Troell, A. Merrie and J. Rockström (2015). PLoS ONE 10(5):e0127533.

» **414.** A cross-country analysis of residential electricity demand in 11 OECD-countries. Krishnamurthy, C.K.B. and B. Kriström (2015). Resource and Energy Economics 39:68-88.

» **413.** Natural capital and ecosystem services informing decisions: From promise to practice. Guerry, A.D., S. Polasky, J. Lubchenco, R. Chaplin-Kramer, G.C. Daily, R. Griffin, M.H. Ruckelshaus, I. Bateman, A. Duraiappah, T. Elmqvist, C. Folke, J. Hoekstra, P. Kareiva, B. Keeler, S. Li, E. McKenzie, Z. Ouyang, T. Ricketts, B. Reyers, J. Rockström, H. Tallis and B. Vira (2015). Proceedings of the National Academy of Sciences 112(24):7348-7355.

» **412.** Co-management in Latin American small-scale shellfisheries: assessment from long-term case studies. Defeo, O., M. Castrejón, R. Pérez-Castañeda, J.-C. Castilla, N. L. Gutiérrez, T. Essington and C. Folke (2014). Fish and Fisheries. doi: 10.1111/faf.12101.

» **411.** Masked, diluted and drowned out: how global seafood trade weakens signals from marine ecosystems. Crona, B.I., T. Daw, W. Swartz, A. Norström, M. Nyström, M. Thyresson. C. Folke, J. Hentati-Sundberg, H. Österblom, L. Deutsch and M. Troell (2015). Fish and Fisheries. doi: 10.1111/faf.12109.

» **410.** Toward an integrated theory of spatial morphology and resilient urban systems. Marcus, L. and J. Colding (2014). Ecology and Society 19(4):55.

» **409.** The Economy, The Biosphere and Planetary Boundaries: Towards Biosphere Economics. Crépin, A-S. and C. Folke (2015). International Review of Environmental and Resource Economics 8:57–100.

» **408.** Collective action and the risk of ecosystem regime shifts: insights from a laboratory experiment. Schill, C., T. Lindahl and A.-S. Crépin (2015) Ecology and Society 20(1):48.

» **407.** Does aquaculture add resilience to the global food system? Troell M., R.L. Naylor, M. Metian, M. Beveridge, P.H. Tyedmers, C. Folke, K.J. Arrow, S. Barrett, A.-S. Crépin, P.R. Ehrlich, Å. Gren, N. Kautsky, S.A. Levin, K. Nyborg, H. Österblom, S. Polasky, M. Scheffer, B.H. Walker, T. Xepapadeas and A. de Zeeuw (2014). Proceedings of the National Academy of Sciences 111(37):13257-13263.

» **406.** Planetary boundaries: Guiding human development on a changing planet. Steffen, W., K. Richardson, J. Rockström, S.E. Cornell, I. Fetzer, E.M. Bennett, R. Biggs, S.R. Carpenter, W. de Vries, C.A. de Wit, C. Folke, D. Gerten, J. Heinke, G.M. Mace, L.M. Persson, V. Ramanathan, B. Reyers, S. Sörlin (2015). Science 347(6223):1259855 1-10.

» **405.** China's aquaculture and the world's wild fisheries. Ling Cao, L., R. Naylor, P. Henriksson, D. Leadbitter, M. Metian, M. Troell and W. Zhang (2015). Science 347(6218):133-135.

2014

» **404.** The unfolding water drama in the Anthropocene: towards a resilience-based perspective on water for global sustainability. Rockström, J., M. Falkenmark, T. Allan, C. Folke, L. Gordon, A. Jägerskog, M. Kummu, M. Lannerstad, M. Meybeck, D. Molden, S. Postel, H.H.G. Savenije, U. Svedin, A. Turton and O. Varis (2014). Ecohydrology 7:1249-1261.

» **403.** Toward a More Resilient Agriculture. Bennett, E.M., S.R. Carpenter, L.J. Gordon, N. Ramankutty, P. Balvanera, B. Campbell, W. Cramer, J. Foley, C. Folke, L. Karlberg, J. Liu, H. Lotze-Campen, N.D. Mueller, G.D. Peterson, S. Polasky, J. Rockström, R.J. Scholes and M. Spirenburg (2014). Solutions 5(5):65-75.

» **402.** Three necessary conditions for establishing effective Sustainable Development Goals in the Anthropocene. Norström, A.V., A. Dannenberg, G. McCarney, M. Milkoreit, F. Diekert, G. Engström, R. Fishman, J. Gars, E. Kyriakopoolou, V. Manoussi, K. Meng, M. Metian, M. Sanctuary, M. Schlüter, M. Schoon, L. Schultz and M. Sjöstedt (2014). Ecology and Society 19(3):8.

» **401.** Pursuit of the common good. Dasgupta, P. and V. Ramanathan (2014). Science 345(6203):1457-1458.

Discussion Papers

» **253.** Transboundary Capital and Pollution Flows and the Emergence of Regional Inequalities. Simon Levin and Anastasios Xepapadeas. 2015.

» **252.** Distributional Implications of Electricity Taxation: An Assessment using Household Survey Data from 11 OECD countries. Chandra Kiran B. Krishnamurthy. 2015.

» **251.** Growth, Water Resilience, and Sustainability: A DSGE Model Applied to South Africa. Chuan-Zhong Li and Ranjula Bali Swain. 2015.

» **250.** Climatic tipping points and optimal fossil fuel use. Gustav Engström and Johan Gars. 2015.

» **249.** Indicators for sustainable seafood production. Anne-Sophie Crépin, Sebastian Petrick, Edgar Morgenroth, Michel André, Arne Eide, Øystein Hermansen, John Isaksen, Therese Lindahl, Anna Stammler-Gossman and Max Troell. 2014.

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ANNUAL REPORT 2014/2015

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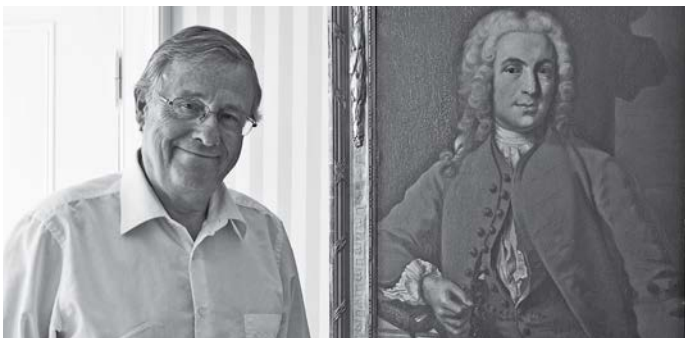

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1. Karine Nyborg and Caroline Schill on the boat to Askö. **2.** Participants of the BENN workshop in June 2015. **3.** Staffan Normark, retiring Permanent Secretary and Carl von Linné (Carl Linneaus) one of the founders of the Royal Swedish Academy of Sciences. **4.** Marten Scheffer and Terry Chapin entertaining Carl Folke and Maja Schlüter on the boat from Askö. **5.** Scott Barrett and Ram Fishman at BYS workhop on the island Fejan. **6.** Anne-Sophie Crépin, Jeff Vincent with fellow participants at the EfD conference in Dar es Salaam. **7.** KU Leuven Honorary Doctor Carl Folke. **8.** Mary Ruckelshaus and Gretchen Daily, co-organisers of the Stockholm Summit on Natural Capital. **9.** Ken Arrow and Marten Scheffer on the boat to Askö.

All photos by Agneta Sundin except 6 Gunnar Köhlin, 7 KU Leuven and 8 Gretchen Daily.

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THE BEIJER INSTITUTE OF ECOLOGICAL ECONOMICS

KUNGL. VETENSKAPS-AKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES

THE BEIJER INSTITUTE of Ecological Economics is an international research institute under the auspices of the Royal Swedish Academy of Sciences. Since 1991, the Beijer Institute has been an institute of ecological economics.

Humanity is embedded in the Biosphere and shape it from local to global scales, from the past to the future. At the same time humanity is fundamentally dependent on the capacity of the Biosphere to sustain development.

The major objectives of the Beijer Institute are to carry out research and stimulate scientific cooperation to promote a deeper understanding of the interplay between ecological systems and social and economic development. Cooperation efforts include collaborative research between economists and ecologists and related disciplines on fundamental and applied problems in relation to sustainability, as well as teaching and training on those issues nationally and internationally.

The Beijer Institute's major activities are international research programmes, synthesis workshops, a broad set of research projects, teaching and training programmes, dissemination of results, the science-policy interface and collaborative communication.

Core funding is provided by Kjell och Märta Beijer Foundation. Funding is also provided by Swedish and international research councils, foundations and other organisations.

This Annual Report covers the period 1 July 2014 – 30 June 2015.

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