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Director's Column



People and planet are highly interconnected and operate in constantly changing interwoven ways, presenting a new context to understand and act upon in order to ensure long-term human wellbeing. Work in this context is no longer solely about studying the environment with humans as an external driver or accounting for the environment in economic affairs and societal development. Rather, it is about recognising that people are embedded within, and dependent upon, favourable conditions in the biosphere as a precondition for sustainable development. It is also about capturing the dynamic and complex interplays between the local and the global on a planet influenced throughout by human actions, shaping the operation of the Earth system as a whole.

Researching the continuous interplay between the adaptive responses of the parts and the emergent properties of the whole is at the very core of complex systems thinking and the work of the Beijer Institute. In this spirit, and in dialogue with our scientific advisory board, we have modified the Beijer research programme structure to make clear that all our efforts are framed by the new global context and complexity.

Now, we are working with four exciting international programmes, with two different cuts. The first has a thematic focus on urban environments and their development, a significant issue on a highly urbanised planet, and on aquaculture and seafood production, which is decisive for the future of food, health and sustainability. The second cut is about human behaviour and its governance in a complex world, with the Behaviour, Economics and Na-

ture Network (BENN) programme unravelling social behaviour and dynamics and the new programme, Governance, Technology and Complexity, taking on the challenge of norms, institutions, finance, risk and technological change in relation to biosphere stewardship.

With Victor Galaz as director of the new programme, a most successful and inspirational inauguration workshop was held in the spring, and no doubt new discoveries will emerge. The same is true of the productive and active BENN programme, from which new important insights are starting to materialise. Similarly, the work within the Urban Social-ecological Systems programme is challenging narrow perspectives and leaving an important imprint on science, practice and policy. The progress of the Aquaculture and Sustainable Seafood programme is spectacular, placing seafood in the broader food-society-environment context and covering sustainability issues like use of freshwater and antibiotics.

The work on the Arctic Ocean and a changing climate within the ACCESS programme, beautifully orchestrated by Anne-Sophie Crépin, culminated with a seminar at the Royal Academy of Sciences and with new findings published in a special issue of *Ambio*. The urban work was complemented by the Askö meeting, which focused on the interplay between migration, urbanisation and the Anthropocene, a highly relevant area in turbulent times. New perspectives on the future of the oceans were highlighted at an inspiring half-day seminar at the Academy in honour of the Volvo Environment Prize laureate Rashid Sumaila.

The collaboration with Stockholm Resilience Centre (SRC) and the Global Economic Dynamics and the Biosphere Academy pro-

gramme GEDB received a new major grant from the Erling-Persson Family Foundation for another five years. Fantastic! The programme, with Beatrice Crona as executive director, has generated truly novel insights, for example on links between financial markets and biosphere dynamics, and it has performed amazing work at the interface of science and business.

The collaboration with Stanford University and the long legacy of working together with Beijer Fellows Gretchen Daily, Steve Polasky (who visited several times this year) and the Natural Capital group is deepened with a new five-year Wallenberg grant to SRC, in which the Beijer Institute plays an active and central part. Similarly, Beijer Fellow Simon Levin is piloting interactions with scholars at Princeton University into a solid joint research collaboration.

Our dear friend and close colleague Johan Rockström has stepped down as director of SRC and will move on to take the helm at the Potsdam Institute for Climate Impact Research (PIK) in Germany in autumn 2018. However, our close collaboration will continue and hopefully expand, not least within the European Research Council project Earth resilience in the Anthropocene. Within that project, a most significant publication 'Trajectories of the Earth System in the Anthropocene', led by Will Steffen, has just appeared in the *Proceedings of the National Academy of Sciences, USA*.

The second group of Beijer Young Scholars met again this May. What a group of future leaders! It was very impressive and exciting to experience their collaboration and professional performance. An amazing publication of theirs on a highly novel topic – Inequality and the Biosphere – will soon appear in *Annual Re-*

view of Environment and Resources.

Our initiative with SRC and GEDB, Seafood Business for Ocean Stewardship (SeaBOS), in which we are collaborating with the ten transnational companies dominating the seafood sector, is rapidly advancing. Henrik Österblom, deputy science director of SRC, is simply amazing in operating this important, complex yet inspiring space.

During the year, there have been many other exciting events and collaborations to read about in this report. Demand for the work that the Beijer Institute generates is strong, as demonstrated by numerous invitations for keynote speakers, for collaborations with leading scholars and universities and for engagements with major actors in practice and policy. This is made possible thanks to our network of collaborators, the Beijer Fellows, the Beijer Scientific Advisory Board and the professional support of the Academy.

We are deeply grateful to the Kjell and Märta Beijer Foundation, and in particular to its chairman Anders Wall, for its long-term commitment and trust in our work and activities. The very early and progressive investment in the Beijer Institute by this foundation, which was also instrumental for the formation of the Resilience Alliance, SRC and the GEDB programme, has helped place Sweden at the very forefront of ecological economics, resilience thinking and sustainability science, providing insights for action towards sustainable development.

Carl Folke, director
Stockholm, August 2018



“Work in this context is no longer solely about studying the environment with humans as an external driver or accounting for the environment in economic affairs and societal development.”

Research Programmes

Work at the Beijer Institute strives to create a research frontier at the interface of ecology, economics and related disciplines, in order to promote a deeper understanding of the interplay between ecological systems and social and economic development in relation to sustainability. In dialogue with the Institute's international scientific advisory board, we have concluded our research programmes Complex Systems and Global Dynamics and Resilience, and shifted their research focus into the overall framework of the four current research programmes of the Beijer Institute. These four programmes, all combining important theoretical insights with novel and grounded empirical research, and their focus and progress are presented below.

Complexity, Technology and Governance

It is becoming increasingly clear that the environmental, technological and socio-economic changes in recent decades pose a serious challenge to the problem-solving capacities of norms, institutions and legal systems worldwide. This is exacerbated by the fact that, due to globalisation, the world has become increasingly dominated by the dynamics created by the behaviour of complex systems: emergence, connectivity, surprise, non-linear changes and poorly understood feedbacks across multiple domains.

Although our understanding of the scale, connectivity and speed of the globalised world, and how it shapes the planet, is limited, there is a growing recognition that part of the solution for navigating a potentially turbulent future lies in exploring challenges and opportunities for the governance of complexity. The capacity of modern societies to stay resilient in the face of change and surprise will depend, among other things, on their ability to address expected and unexpected shocks, achieve incremental improvements and make innovations, and balance the benefits and strengths of global connections.

Exploring governance of complexity

The new Beijer programme 'Complexity, Technology and Governance' is a long-term commitment to advancing interdisciplinary insights in this intellectual space. This programme is being run in close collaboration between the Beijer Institute and Stockholm Resilience Centre. Although the emphasis is on the governance of societal complexity as part of the biosphere, our ambition is to continue to integrate and identify opportunities for cross-fertilisation with scholars from other fields, such as finance, law, economics, political economics, computer sciences, risk studies and others. As in all our previous programmes, we are striving to combine important theoretical insights with novel and grounded empirical research.

Human-machine-ecology interactions

The programme hosted its first workshop at the Royal Swedish Academy of Sciences in Stockholm on 10-12 April 2018. The purpose was to

provide inspiration and identify new research frontiers that the programme could help develop in the next few years. As part of this ambition, we invited a number of highly recognised scholars representing the complexity sciences, economics, resilience thinking, political science and other related fields.

Based on these discussions, the programme will pursue work in two interrelated fields. The first relates to governance and resilience challenges associated with the emergence of new human-machine-ecology interactions. This stream of work will focus on the ways in which rapid technological advances in artificial intelligence, robotics etc. are likely to fundamentally shape the prospects for planetary stewardship in the near future.

Facilitating rapid transformations

The second relates to the challenges of understanding and facilitating rapid transformations towards sustainability. In particular, it concerns the role of small alliances, clubs or "keystone actors" in driving cascading change that may contribute to improved biosphere stewardship and to a safe and just operating space for humanity. Understanding the importance of these actors and the dynamics of change, and relating these to the speed, scale and connectivity of the Anthropocene, will be a key issue to explore for the new Beijer programme.

AI workshop planned

On 9-10 November 2018, the programme will host a workshop entitled "Human-Machine-Ecology: Emerging Risks and Opportunities" at Princeton University, in collaboration with the Princeton PIIRS Global Systemic Risk. The workshop will explore evolving systemic risks created in the biosphere by the rapid progression and application of artificial intelligence systems in e.g. agriculture and forestry.

Programme director: Victor Galaz

Aquaculture and Sustainable Seafood

Humanity is now the dominant force for change on this planet and food production is the single largest source of environmental degradation and impact on the Earth system. There is growing recognition of the need to adopt an Earth system approach to sustainable food production, which means considering the complex system interactions that prevail from local to global scale. The role of seafood in enabling food production to stay within planetary boundaries is still uncertain, but it has the potential to contribute positively to a transition towards environmental sustainability and improved human health. However, while seafood production generally has a smaller environmental footprint than many land-based animal systems, seafood production is very diverse and different products will have different environmental and social impacts. Recent research within the Aquaculture and Sustainable Seafood programme at the Beijer Institute continues to look closely into the future role of aquaculture and how the diversity of systems relates to global sustainability.

Possibilities and limitations of aquaculture expansion

Expanding aquaculture into oceans has been suggested as a “quick fix” for the global food challenge, but studies within this programme show that, while there are plenty of suitable sea spaces for farming, there are other limitations. A study in *PLoS ONE*, co-authored by Max Troell, estimates that the marine area suitable for potential open ocean mariculture amounts to around 72,000,000 km² (roughly the combined size of Asia and Africa) and that suitable areas along the Atlantic coast of South America and West Africa appear to be most under-utilised. These findings suggest that factors other than environmental considerations are currently limiting the potential for expansion in many areas. Such factors include lack of socio-economic and technological capacity and, importantly, feed supply.

In a comment in *Nature Ecology and Evolution*, Troell and colleagues explain that feed availability and feed costs will prevent further expansion of mariculture long before any ocean space limitations are reached. Current production of fish from off-shore ocean systems is still insignificant, but the dominant species all require high-quality protein feeds

based on fish resources and, increasingly, agriculture crops such as soy. Troell and colleagues claim it is important to acknowledge that aquaculture production, through its resource requirements, is connected to both aquatic and terrestrial ecosystems. In addition, they underline that the potential for marine aquaculture is affected by climate change effects, such as temperature increases and ocean acidification.

“Feed availability and feed costs will prevent further expansion of mariculture long before ocean space becomes limited.”

The impacts of climate change are likely to be exceptionally dramatic in the Arctic. Possible future trajectories under climate change for capture fisheries and for aquaculture are outlined by Troell and colleagues in an article in *Ambio*, part of a special issue presented on page 16. It is clear that the aquaculture sector will be able to utilise space that shrinking sea ice provides, but that future development will face many challenges posed by warming conditions, forcing the aquaculture industry to adapt.

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- Gordon, L.J., V. Bignet, B. Crona, P.J. Henriksson, T. Van Holt, M. Jonell, T. Lindahl, M. Troell, S. Barthel, C. Queiroz. 2017. Rewiring food systems to enhance human health and biosphere stewardship. *Environmental Research Letters* 12(10):100201.
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Integrated farming technologies in the seascape

By establishing integrated cultivation systems, such as integrated multi-trophic aquaculture (IMTA), the sustainability of aquaculture could be increased.

With IMTA, fed species such as finfish or shrimp are co-cultivated with species that benefit from their effluents, such as mussels, oysters, sea-cucumbers and sea-urchins, but also invertebrates and kelp. Large-scale expansion of marine food production could include this technique.

An article in *Frontiers of Marine Science* describes how IMTA also has scope for integration with energy systems in offshore areas and how it can bring environmental benefits from making use of waste products and transforming these into valuable co-products. Furthermore, the article explores the implications of exposing nature at offshore and open ocean sites and the effects on the biological, technological and socio-economic performance of IMTA.

Reference:

- Buck B.H., M. Troell, G. Krause, D.L. Angel, B. Grote, T. Chopin. 2018. State of the art and challenges for offshore integrated multi-trophic aquaculture (IMTA). *Front. Mar. Sci.* 5:165.

A life cycle perspective

Expanding the role of seafood in future diets will require an in-depth understanding of how different species and production systems affect different aspects of sustainability. Work on Life Cycle Analysis (LCA) within the Aquaculture and Sustainable Seafood research programme is quite broad. For example, it includes specific analyses of aquaculture systems, as described in the articles in *PNAS* and *Frontiers in Ecology and the Environment* listed below, and studies problematising how LCA should be performed to become a useful sustainability tool, as published in the *International Journal of Life Cycle Assessment and Environmental Science & Technology*. The outcomes of this research highlight the difficulties in comparing LCA results and making generalised conclusions.



Seafood market in Malaysia. Photo: Max Troell

Several studies within this programme explore the possibilities and limitations for aquaculture expansion into oceans. Photo: Alamy

One sustainability aspect of global concern is the increased use of antibiotics in animal husbandry, due to the accelerating effects it might have on development of antimicrobial resistant bacteria. Several antibiotic compounds are used for aquaculture production globally and some of these are listed as critically important to cure human diseases. An article in *Sustainability Science* led by Beijer researcher Patrik Henriksson presents a framework for identification of mechanisms triggering antibiotic use in aquaculture that can enable mitigation efforts to be re-targeted.

References:

- Avadi, A., P.J.G. Henriksson, I. Vázquez-Rowe, F. Ziegler. 2018. Towards improved practices in Life Cycle Assessment of seafood and other aquatic products. *The International Journal of Life Cycle Assessment* 23(5):979–981.
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Programme activities - a brief update

The programme continues to be involved in activities with Seafood Business for Ocean Stewardship (SeaBOS), providing insights to the seafood sustainability dialogues held in Stockholm in 2017 and in Amersfoort in 2018. The involvement is mainly focused on regulation and best practices for antimicrobial use in aquaculture.

Partners in the research project Seawin, have mapped Swedish seafood consumption and the data are now being analysed from an environmental sustainability and health perspective by Beijer researchers. One study is focusing on how the ASC ecocertification system compares with national regulations in main salmon farming countries. Another study is reviewing data taken from key international databases on the nutritional composition of different types of seafood. An international workshop was held at Askö Marine Laboratory, Sweden, in 2017, with the aim of structuring a paper on how LCA results need to be considered in larger meta-analysis studies.

Read more at www.seawin.earth

Mendoza Beltran, A., V. Prado, D. Font Vivanco, P.J.G. Henriksson, J.B. Guinée, and R. Heijungs. 2018. Quantified Uncertainties in Comparative Life Cycle Assessment: What Can Be Concluded? *Environmental Science & Technology* 52(4):2152–2161.

The programme also held an international workshop on future seafood production, entitled Doubling aquaculture by 2050, on 13-15 February 2018 at the Worldfish Centre in Penang, Indonesia. The workshop discussions will form the basis for an article and will also serve as an entry point for a panel discussion at the World Aquaculture Symposium in Montpellier in autumn 2018.

An international workshop organised by the Global Economic Dynamics and the Biosphere programme that analysed the role of China in future seafood production was held at the Royal Swedish Academy of Sciences in December 2017. Workshop outcomes will form the basis for a joint paper on the subject.

The EAT Lancet report on how food systems can be developed within planetary boundaries and lead to improved human health will be launched in September 2018. It will include contributions from this research programme on seafood production.

Read more about the Lancet report at www.foodplanethealth.org

Programme director: Max Troell

Behaviour, Economics and Nature Network - BENN

The mission of BENN is to develop a richer understanding of human behaviour that can enable us to identify possible leverage points for interventions and to design more robust institutions for environmental protection and sustainable development. BENN research seeks to understand fundamental drivers of individual behaviour, while also recognising that people take decisions embedded in and affected by a social, economic and ecological context. BENN research covers behaviour and the underlying motivations at different levels of society, which is reflected in our various research topics, our multi-method approach and the interdisciplinary expertise we convene. Some recent and upcoming research and activities are summarised below.

Rewiring food systems

Food production is now a major driver of global environmental change, and food consumption is a key determinant of human health, wellbeing and social-economic development. In a recent study co-authored by several Beijer Institute researchers, a social-ecological framework was used to illustrate changes in food systems since the 1960s. The results show how these changes have affected human health and the biosphere, and how a more globalised food system has disconnected consumers from the producers of food. The authors present a set of solutions to improve human and planetary health where behavioural change plays a major part, e.g. when it comes to cutting food waste and changing diets. Read more about this study on page 14.



Photo: Ulf Jakobsson

Reference:

Gordon, L., V. Bignet, V. Crona, P.J.G. Henriksson, T. Van Holt, M. Jonell, T. Lindahl, M. Troell, S. Barthel, L. Deutsch, C. Folke, J. Haider, J. Rockström and J.C. Queiroz. 2017. Rewiring food systems to enhance human health and biosphere stewardship. *Environmental Research Letters* 12:100201

Improving food waste recycling

Approximately one-third of all the food produced in the world is lost or wasted. Production of this food is responsible for 8% of global greenhouse gas emissions, consumes one-quarter of all water used by agriculture and generates more than \$900 billion in economic losses globally every year. In a study in *Frontiers in Psychology*, BENN programme director

Using behavioural science to change diets

Within the Seawin project in the Aquaculture and Sustainable Seafood programme (see pages 8 and 9), which aims to increase production and consumption of sustainable seafood in Sweden, Therese Lindahl and colleagues are seeking to identify factors that can lead to people eating more sustainable and healthier seafood. During spring 2018, they

Therese Lindahl, together with her former Master's student Noah Linder and Sara Borgström from the Royal Institute of Technology in Stockholm, showed that an information leaflet designed using insights from psychology and behavioural economics can help promote recycling of food waste. To test the efficiency of the leaflet, it was sent to a treatment group of 264 households in a Stockholm suburb, while 210 households in a control group did not receive it. The amount of food waste was then measured over the eight months after the leaflet was sent out and compared with the amount produced in the previous year. The results showed a statistically significant increase in food waste recycling, in both the short and long term, by the group that received the leaflet compared with the control group. Insights from this study can be used to guide development of similar pro-environmental behaviour interventions for other urban areas in Sweden and abroad, improving the chances of achieving environmental policy goals.

teamed up with one of Sweden's largest food retailers, ICA, to design an in-store experiment to study the potential and limitations of using insights from behavioural science to change diets. A pilot study has been conducted and analysed and the full experiment will begin in autumn 2018.

BENN project members:

Therese Lindahl, the Beijer Institute and Mimi Diego Nou, Stockholm Resilience Centre.

Read more at www.seawin.earth

Exploring contextual factors affecting small-scale fisheries

Small-scale coastal fisheries are central to local societies in terms of poverty alleviation and food security, affecting millions of people around the world. However, many of these fisheries are severely threatened by chronic overfishing and climate change impacts, while demand for local marine resources continues to increase as coastal populations grow. These combined pressures call for better management but solutions can be difficult to find, since they depend on the social, ecological and historical context. In a new project, we are systematically exploring the role of these contextual factors for individual and collective resource extraction when fishers face increasing resource scarcity and variability. Laboratory experiments have been conducted in a first phase, and more will follow. The next step will be to initiate field research in fishing villages in Colombia and Thailand, building partly on previous BENN field work in these areas.

Project members:

Therese Lindahl and Caroline Schill, the Beijer Institute, Rawadee Jarungrattanapong, Sukthothai Thammathirat, Open University, Thailand, and Lina Maria Saavedra-Diaz, University of Magdalena, Colombia.

Funding: Swedish Research Council

Reference:

Lindahl, T. and R. Jarungrattanapong. 2018. Beijer Discussion Paper 263: Avoiding catastrophic collapse in small-scale fisheries through inefficient cooperation: Evidence from a framed field experiment. *Beijer Discussion Paper Series*.

“Combined pressures call for better management but solutions depend on the social, ecological and historical context.”

Neuroscience collaboration

In a unique project collaboration between behavioural economists and neuroscientists, we are applying tools and insights from cognitive sciences to develop a better understanding of how resource users, such as fishers and cattle farmers, individually and in groups, respond to various types of natural resource dynamics and to social interactions. The team has developed an experimental design where several users share a dynamic resource and behavioural indicators and neuroscience indicators (such as heart rate, skin conductance and eye movement) are measured and matched. The design has been tested in pilot studies in Stockholm and Bogotá, Colombia, and is now being evaluated and revised. During autumn 2018, the first full-scale experiment will be conducted, with the aim of identifying critical factors that can explain observed behaviour, e.g. to tease out the role emotions play for behaviour in different types of resource-sharing settings. We are also seeking to understand how people adapt to and learn about a changing resource environment while sharing resources. Our intention is for the data generated

and lessons learnt from this project to be used to improve formal models of natural resource management.

Project leaders:

Marty Anderies and Therese Lindahl.

Other project members:

Juan Camilo Cardenas, University de los Andes, Colombia, Marco Janssen, Arizona State University, USA, Andreas Olsson, Karolinska Institutet, Sweden, Sara Bengtsson, University of East Anglia, UK, Allen Lee, Arizona State University, USA, and Philip Pärnamets, Karolinska Institutet and New York University.

The role of values and culture for human behaviour

BENN research focusing on human behaviour at individual and community scale has been advancing social-ecological systems research by building on expertise and insights primarily from behavioural sciences (e.g., social and cognitive psychology, behavioural economics and environmental psychology). While nurturing these projects and collaborations, BENN is also currently building capacity to address behavioural questions on larger scales. To this end, BENN hosted a workshop on 30 May-2 June 2018 at the Royal Swedish Academy of Sciences on the topic *Understanding Humans as Encultured Actors in the Governance of Shared Resources*. The workshop was organised around presentations, panel discussions and group exercises and gathered 15 leading international scientists from different disciplines, including e.g. philosophy and his-

tory. Together, we explored how we can use data and understanding of human values, world views and social identities to advance our research on social-ecological systems. In summary, the workshop was extremely productive, with several interesting ideas and potential long-term collaborations emerging. There were three concrete outputs from the workshop: i) A draft of a position paper that articulates design principles for governing the global problems facing humanity was developed. These design principles emerged from workshop discussions on the role of values and culture for human behaviour. ii) A collaborative project for thinking about how to connect cultural elements with biophysical systems in formal models was initiated. iii) A project aiming to synthesise insights from natural resource games played in the field was designed.

Programme directors:

Marty J. Anderies and Therese Lindahl

BENN workshop participants June 2018: Back-row: Olivier Barreteau, Jon Norberg, Therese Lindahl, Marco Janssen, Steve Polasky, Caroline Schill, Carl Folke, Maja Schlüter, Bi Puranen, Jean Camilo Cardenas, Christina Leijonhufvud, Jean-Denis Mathias. Sitting down: Marty Anderies, Gert Jan Hofstede and Anne-Sophie Crépin. Photo: Agneta Sundin



Urban social-ecological systems

The world is urbanising at an unprecedented rate, with the urban population predicted to reach 6 billion by 2050, resulting in the urban land-cover area almost tripling from the year 2000. This calls for improved urban models that can promote urban resilience building. For one, cities need to be better prepared to deal with climate change, biodiversity loss and challenges connected to increased digitalisation and new migration patterns. C.S. Holling was among the first to recognise the notable similarities between urban and ecological systems. Managing such systems requires a focus on the properties and processes that nurture resilience, i.e. the capacity to survive disturbance and adapt to change in ways that do not disrupt critical social and ecological services that create pleasant cities.

Within this programme, research is conducted on urban sustainability, with particular focus on how physical layout and structures, together with institutions and world views, can shape and sustain human welfare within and outside cities and reconnect humans more closely to the biosphere. This involves research on the interplay between ecosystems, the built environment, institu-

tions, digitalisation and cognitive resilience building (see below).

'Smart growth' and 'Smart Cities'

Urban theorists and planners have long advocated building smarter cities through 'Smart Growth', e.g. building compact cities to provide social and environmental benefits. More recently, however, the notion of 'Smart Cities' has become somewhat of a new buzzword for achieving sustainable development. It is an urban development concept using information and communication technology to manage and control services and responsibilities of cities.

"Cities need to be better prepared to deal with climate change, biodiversity loss and challenges connected to increased digitalisation and new migration patterns"

Over the course of this year, the Beijer urban programme has strengthened

its research on these influential concepts. Steps have been taken to link the Beijer Institute research on smart cities with world-leading environmental psychology scholars at the University of Gävle in Sweden. With this collaboration, we aim to improve understanding of how the Smart City framework affects human cognition, pro-environmental behaviour and ways for humans to reconnect to the biosphere. In addition, we want to look into how well-prepared digitalised cities are for various climate change effects. An international seminar on smart cities and digitalization will be held in October 2018, co-organised by the Beijer Institute and University of Gävle.

Another collaboration with environmental psychologists at the University of Gävle (HiG) is devoted to the notion of 'cognitive resilience building', launched by the Beijer Institute urban group in 2013. This refers to the mental processes of human perception, memory and reasoning that people acquire from interacting frequently with local ecosystems, shaping people's experiences, world views and values towards local ecosystems and ultimately towards the biosphere. In the first seminar on cognitive resilience building, which was held at HiG in May 2018, we worked towards redefining the concept of cognitive development – a work still in progress.

City densification in a resilience perspective

The Beijer Institute has received a research grant from the Swedish Research Council for Sustainable Development (Formas) for the project Analysing city densification from an ecological resilience perspective. This three-year study will explore the environmental rationale behind city densification through conducting the first large-scale literature review of the Smart Growth concept. Smart Growth is an approach that strives for compact, walkable, bicycle-friendly land use, with development concentrated along the transit lines of trains, buses etc. The funding complements a previous grant from Stockholm County Council for research on city densification in the Stockholm region, with special attention to green structure. With the new funding, we will also study multifunctional use of park land, to reveal tradeoffs among ecosystem services. This work will partly be carried out in collab-



With a new grant the multifunctional use of park land will be studied, to reveal tradeoffs between ecosystem services. Photo: Agneta Sundin



Visualisation of the Albano Campus project by BSK Arkitekter, from the book "Dreams and Seeds".

oration with this year's Mäler Scholar, economist Yana Jin.

Another aspect of this project is how dense city environments could be improved in terms of their resilience capacity to meet an increasingly uncertain future of climate change with potential loss of ecosystem services. We envision the results to be highly valuable for improving global knowledge about city densification and of immediate value in promoting more sustainable urban growth in the Stockholm region.

Project members:

Johan Colding, The Beijer Institute and SRC, Åsa Gren, The Beijer Institute, and Yana Jin, College of William & Mary, USA.

How university campuses can promote sustainable development

In an article recently published in the journal *Sustainability*, Johan Colding and Stephan Barthel (SRC and HiG) looked at the potential for making university campuses more integrated in a global sustainability agenda, concluding that they have an untapped potential for recon-

necting humans to the biosphere.

Universities can be important actors in promoting sustainable development goals, since they provide expertise and knowhow and contribute to regional development. They can therefore play a role in promoting these goals through education, research, policy formation and information exchange. Yet despite their potential, universities are still lagging behind in helping societies become more sustainable. Between 1999 and 2011, only 15 out of 14,000 universities world-wide had published sustainability reports. Universities engaged in attempts to identify sustainability goals and best practice are still focused on limited indicators, such as how to become more energy efficient. To speed up their ambitions, Colding and Barthel make a variety of recommendations for universities to become ambassadors for sustainable development by making use of university campuses or surrounding natural areas. These often cover large tracts of land, providing excellent starting points for authentic learning about nature and biodiversity.

The study was part of the Live Baltic Campus project within the EU Interreg

Central Baltic programme, which had the objective of improving urban planning and the urban space by designing and building more sustainable universities in the Baltic region. The Albano Campus project, described in earlier annual reports, was part of this project. The end of the Live Baltic Campus project was marked by the book "Dreams and Seeds: The Role of Campuses in Sustainable Urban Development", representing a compilation of all the insights, perspectives and practical examples developed during this two-year joint exploration of sustainable urban campuses.

Reference:

Colding, J. and S. Barthel. 2017. The role of university campuses in reconnecting humans to the biosphere. *Sustainability* 9(12):2349.

Project members:

Stephan Barthel, SRC and HiG, and Johan Colding, The Beijer Institute and SRC.

[Read more: livebalticcampus.eu](http://livebalticcampus.eu)

Programme director: Johan Colding

Eight ways to rewire the world's food systems

In recent decades, major changes in what people eat and in food production systems all around the world have impacted human health and the state of the environment. Although more food is now being produced to feed a growing population, our plates are filled unequally and nutrition and food safety are not always guaranteed. That has imposed strain on our planet and has resulted in a growing number of people suffering from overweight, obesity and micronutrient deficiency. Food production is the single largest driver of environmental degradation and a major contributor to greenhouse gas emissions.

In a study published in *Environmental Research Letters*, Beijer Institute researchers, together with colleagues at the Global Economic Dynamics and the Biosphere programme (GEDB), Stockholm Resilience Centre (SRC), University of Gävle and the WorldFish Center in Malaysia, teamed up to identify ways in which the global food system can be 'rewired'. To do that, they looked at how food production has influenced human health and the biosphere since the 1960s until today.

Implications for human and environmental health

In the study, led by Line Gordon, SRC, the researchers looked at how the total volume of food production and the nutritional value of the food have changed. They also looked at safety aspects of food production and how farming and fishing have affected crucial earth system processes. The latter part of the study uses the planetary boundaries framework. The authors argue that the overall increase in the volume of food production has mixed implications for human and environmental health. Fewer people are undernourished today than in the 1960s and more varied and convenient food choices are available, but the proportion of overweight and obese people has increased. Malnutrition, in all its forms directly affects one in three people and is responsible for serious public health problems, including nutrient deficiency (such as anaemia and vitamin A deficiencies) and cardiovascular and other circulatory heart diseases. At the same time, four out of the six planetary boundaries most affected by food systems have crossed the safe operating space of the biosphere.

Moreover, a more globalised food system has disconnected consumers from

the producers of food. This in turn has reduced the transparency in how food is produced.

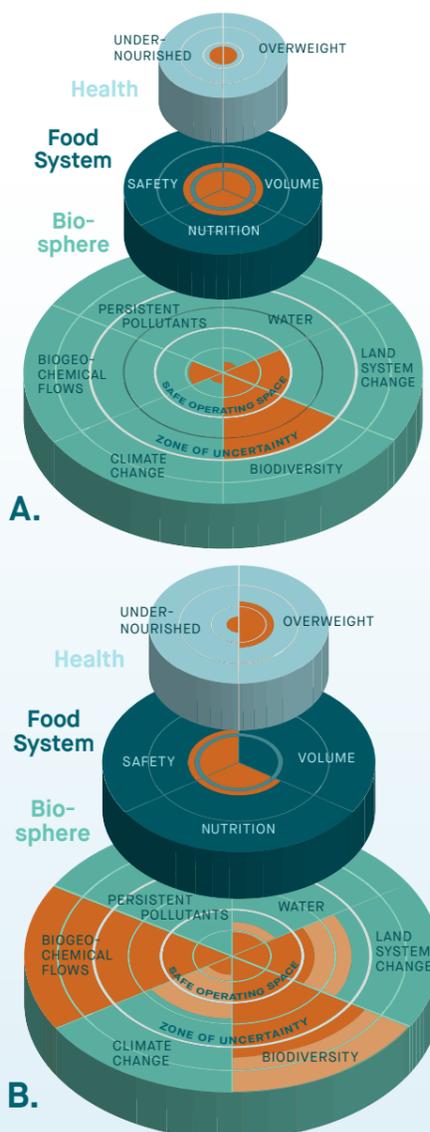
"Throughout the past decades, supply chains have become consolidated to a few actors that exert disproportionate power over the production methods and the supply of food at a large scale, constraining individual food choices at the local scale," co-author Beatrice Crona, GEDB Executive director argue.

Eight action points

The authors identify eight "entry points" for a more healthy and sustainable food system:

- 1. Create nutrient-rich landscapes:** This includes selecting crop varieties, fish and livestock based on their nutritional content.
- 2. Cut waste and change diets:** Solutions such as cutting post-harvest losses and shifting dietary patterns can reduce pressure on natural resources.
- 3. Reduce antimicrobial use:** Intensification is a general trend in animal farming and it is critically important to find means that limit excessive use of antibiotics within the animal food production sector.
- 4. Strengthen biodiversity and multi-functional landscapes:** We should better acknowledge and account for the many ecosystem services and social benefits that food-producing systems deliver beyond food itself, such as pollination, water filtration and recreation.
- 5. Reconnect people to the biosphere:** The disconnect between the food production system and consumers calls for initiatives that can reconnect individuals and communities to food, facilitating broader engagement with food systems in healthy and sustainable ways.
- 6. Enhance transparency between producers and consumers:** It is necessary to improve the capacity to trace the impacts of food production across the supply chain.
- 7. Influence consumer decisions:** Better knowledge is needed about what enables people to adopt healthy and sustainable dietary patterns.
- 8. Mobilise key actors to become biosphere stewards:** Even though key actors have the power to create strong incentives for local action to reconnect development to the biosphere, they are sometimes unaware of their own potential to foster positive change.

Based on these action points, the authors conclude:



The food system and its impact on health and the biosphere comparing 1961 (a) and today (b).

"We need to rewire different parts of food systems, to enhance information flows between consumers and producers at different scales, influence food-system decision makers, foster the biosphere stewardship of key actors in food systems, and re-connect people to the biosphere through the culture of food."

Reference:

Gordon, L., V. Bignet, V. Crona, P. Henriksson, T. Van Holt, M. Jonell, T. Lindahl, M. Troell, S. Barthel, L. Deutsch, C. Folke, J. Haider, J. Rockström, J.C. Queiroz. 2017. Rewiring food systems to enhance human health and biosphere stewardship. *Environmental Research Letters* 12:100201.

Healthy fish, healthy people

– reducing antimicrobial use in aquaculture

Global seafood provides almost 20% of all animal protein in diets and aquaculture is the fastest growing food sector worldwide. The intensification of fish and shrimp farming systems has been accompanied by increased use of antimicrobials (AMs), which are hazardous to both human health and the industry itself. In an attempt to reverse this trend, a study by Beijer Institute scientists and colleagues, *Sustainability Science*, identifies some key drivers behind the overuse in different sectors and regions, and suggests ways to reduce it. The good news is there is much room for improvement.

"One of the findings, which was most surprising, is that much of the overuse is due to pure lack of knowledge", says lead author Patrik Henriksson. "This means there are multiple measures for reducing AM use that can be applied at different levels of the value chain."

The dangers of overuse

Successful treatment with AMs constitutes the foundation of modern medicine and the spread of AMR bacteria has been classified by the World Health Organization (WHO) as one of the major threats to the human population in the twenty-first century. Today, the amount of AMs used for animals is much higher compared than that used to treat humans and even involves some AMs that are deemed critically important in human medicine.

While AM use in aquaculture is lower than that in meat production on land, in light of the expected rapid future growth in aquaculture (doubling by 2030), it is critical to come to terms with overuse.

Underlying factors and regional measures

The study provides a systematic overview of reasons behind usage. In particular, six drivers are identified as key: vulnerability to bacterial disease (which varies between species and regions), easy access to AMs, poor disease diagnostic capacity, AMR (caused by overuse, triggering even more use), poor food safety regulations in target markets, and lack of certification.

Building knowledge around these can enable local governments to reduce AM use through farmer training, spatial planning, assistance with disease identification and stricter regulations, the study concludes.

"There is a lot to be gained from training farmers in correct diagnosis of disease, how to use AMs and the consequences of overuse", Patrik Henriksson explains, "not to mention training in better hygiene and other measures to prevent pathogens entering farms or hatcheries in the first place, thereby reducing the risk of disease outbreak". He points out that the aquaculture industry largely consists of small-scale, sometimes uneducated, farmers.

National and international action also needed

Moreover, national governments and international organisations could assist by producing disease-free fish seed and vaccines and enforcing rigid monitoring of the quantity and quality of antimicrobials used by farmers.

"Lack of regulations in many low- and middle-income countries, or inadequate enforcement of existing regulations, has incentivised restrictions on AM residues in seafood imported to high income countries", says study co-author Max Troell. "While this is an important mechanism to limit AM use, it only applies to internationally traded products and leaves production aimed for domestic consumption largely unregulated."

The authors conclude that a better solution would be to limit access to AMs nationally, for example by banning specifically harmful types of AMs or requiring veterinary certificates for every purchase, measures that have proved successful in higher-income countries.

Reference:

Henriksson, P.J.G., A. Rico, M. Troell, D.H. Klinger, A.H. Buschmann, S. Saksida, M.V. Chadag, W. Zhang. 2018. Unpacking factors influencing antimicrobial use in global aquaculture and their implication for management: a review from a systems perspective. *Sustainability Science* 13(4):1105–1120.



Farmers feeding pangasius catfish raised in ponds in the Mekong delta, Vietnam. Antibiotics are commonly used for pangasius production, as for many other aquaculture species, increasing the risk of development of antibiotic resistance. Photo: Alamy

Scenarios for a warmer Arctic

The impacts of climate change are exceptionally dramatic in the Arctic region, with greater temperature increases compared with the Earth as a whole. Climate change is expected to transform the Arctic Ocean from a year-round frozen sea with multi-year ice into a sea with open waters in summer and annual ice in the winter, i.e. similar to the Antarctic Ocean. Such dramatic change will have sizeable impacts on marine ecosystems and economic activities and will alter living conditions for indigenous and local peoples in the region.

The Arctic Ocean also provides essential global climate regulation and substantial ecosystem services and benefits to humanity outside the region and all of these aspects may be affected. Furthermore, Arctic resources such as stocks of marine seafood, oil, gas and minerals are already attracting global interest, especially when resource stocks in the rest of the world are deteriorating, while the population is growing.

A special issue in the journal *Ambio*, co-edited by Beijer deputy director Anne-Sophie Crépin and with contributions by several other Beijer researchers, addresses major key challenges and issues related to Arctic climate change and development of human activities in the Arctic. It focuses specifically on the Arctic Ocean, with the aim of providing some solutions and options. The special issue was based on the transdisciplinary EU project Arctic Climate Change Economy and Society (ACCESS). In an introductory paper led by Anne-Sophie Crépin, the results are synthesised as answers to eight questions:

- » How is sea ice expected to change in the Arctic over the next three decades?
- » What are the expected impacts of climate change on live marine Arctic resources?
- » How does climate change influence the provision of ecosystem services supporting fisheries and aquaculture?
- » What economic activities are likely to expand in the Arctic due to climate change?
- » What environmental impacts are Arctic economic activities likely to generate?
- » What are the expected impacts of climate change on indigenous peoples?
- » What constraints does a changing climate impose on Arctic governance and infrastructure?
- » What kind of management support would help understand and address the complex dynamics triggered by climate change?

Seafood from a changing Arctic

One of the articles, led by Beijer Institute researchers, reviews current knowledge about climate change impacts for capture fisheries and aquaculture, primarily within the Barents Sea, one of the most productive oceans in the world. The authors

conclude that Arctic fisheries are already experiencing high variability and that climate change will further amplify this. Species targeted in capture fisheries are expected to move into new waters and change existing species dynamics. This is bad news for many species, but the Barents sea cod, which is better equipped to deal with the temperature change, could benefit.

“It is likely that moderate warming will improve the conditions for the most important fish stocks in the Arctic, like cod and herring”, says lead author Max Troell.

However, he warns that warming will also contribute to a very different species composition in some ecosystems, including changes at all trophic levels, which will have implications for the governance of Arctic fisheries.

This means that today’s relatively robust governance of commercial fisheries, building on quotas and historical rights, must be adjusted accordingly, which might call for renewed fisheries negotiations among states involved in Arctic fisheries today.

Adaptation necessary, but challenging

For aquaculture, there are challenges ahead too. Changes in water temperature, sea level, water current and salinity are some of the drivers most likely to alter today’s aquaculture, forcing the industry to adapt to the new reality. Some of these effects are already being felt by the salmon industry along the Norwegian coast, with higher temperatures influencing growth and probably the incidence of diseases and parasites. However, diseases such as winter ulcers and cold-water vibriosis may become less frequent, as they are associated with lower temperatures and as some parts of the salmon’s immune system may actually function more effectively at higher temperatures.

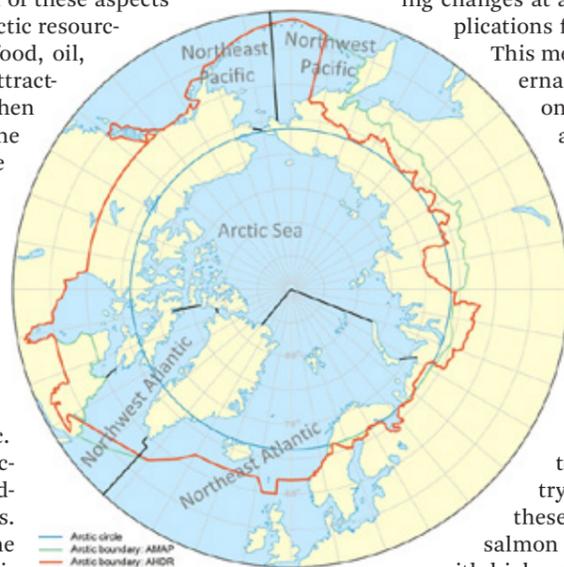
Changing environmental conditions require the aquaculture industry to adapt, but moving north may prove difficult, as there are limitations due to licences currently being geographically restricted and due to a scarcity of available sites with current legislation. Technology and challenges created by the harsher environmental conditions are other possible hurdles.

The authors suggest that a step towards adaptation could be multi-stakeholder dialogue: “It could help identify where and

Image: Compiled by W.K.Dallmann, Norwegian Polar Institute.

About ACCESS:

The ACCESS project convened around 100 researchers from 27 different partner institutions in ten different European countries. The disciplinary background of these researchers covered a wide range of natural and social sciences, including economics, social anthropology, systems ecology, marine biology, climatology and law, and they came from universities, national research centres and small and medium enterprises. Stakeholders from local and indigenous populations, industry and non-government organisations were also involved.



how aquaculture operations can move or change their operations to better adapt.”

A holistic approach to management

In another article, Beijer Institute researchers propose a framework to support management in the Arctic region. This framework accounts for complex interactions between society and nature, possible abrupt change and substantial uncertainties. Application of the framework to two policy-relevant climate change scenarios, a shift in zooplankton composition and a crab invasion, is illustrated in the article.

“Any attempt to manage such a complex system must simultaneously account for the global context and multiple local to global interactions between humans and nature. Not to mention possible unexpected abrupt changes, which can and have occurred as ecosystems in the Arctic lose resilience,” says lead author Anne-Sophie Crépin. “Our holistic approach can help managers identify looming problems arising from complex system interactions and prioritise among problems and solutions, even when available data are limited”.

The framework, called Integrated Ecosystem-Based Management (IEBM), merges insights from Ecosystem-Based Management (EBM) with a Social-Ecological System (SES) approach to support management during uncertainties about future development. EBM focuses on the nature part of a social-ecological system, while IEBM focuses on sustainably managing both nature and humans together as an integrated whole, operationalising the SES approach. It takes into account the crucial role of ecosystems in providing goods, services and other relevant activities that contribute directly or indirectly to human well-being and sustainable development of the Arctic region.

Linking scenarios reveals more

The authors identify six future scenarios and focus in detail on two of these. The first shows how a warmer climate will likely favour the less fatty zooplankton species *Calanus finmarchicus* at the expense of the now dominant *Calanus glacialis*. Such a shift could have negative impacts on the species, such as capelin, that feed on zooplankton, not to mention the potential spin-off effects on herring and Atlantic cod, which in turn prey on capelin.

The second scenario describes a potential future where the introduced invasive species red king crab has grown to be of

great economic importance in parts of the Arctic. Today, red king crab already supports a 26 million USD fishery in the Barents Sea. However, this crab species has been reported to impact bottom-dwelling plants and animals in places like northern Norway and the Kola Peninsula in Russia, including predation on capelin eggs.

“Examining jointly both scenarios with the IEBM framework reveals that they interact, since competition from red king crabs, with associated increased predation pressure on capelin larvae, could further reinforce a decreasing trend in fish stocks from a shift in *Calanus* species”, the authors explain.

Highlighting non-obvious links

The authors emphasise that the Arctic Ocean needs to be set in a global economic and governance context. One example they discuss is how climate change impacts in other parts of the world, e.g. decreasing fish stocks combined with crop failures, might lead to incentives to fish more in the Arctic.

A future extension of the suggested IEBM framework could be to progress from qualitative assessments to quantifying the impacts of each scenario on the whole social-ecological system of the Arctic Ocean.

“The information provided in our framework could facilitate such an exercise by highlighting non-obvious dynamic social, economic and ecological links that need to be included,” the authors note.

Another next step could be to develop a user-friendly interface to test different management strategies and their performance against particular objectives.

References:

- Crépin, A.-S., M. Karcher, and J.-C. Gascard. 2017. Arctic Climate Change, Economy and Society (ACCESS): Integrated perspectives. *Ambio* 46(3):341-354
- Crépin, A.-S., Å. Gren, G. Engström, and D. Ospina. 2017. Operationalising a social-ecological system perspective on the Arctic Ocean. *Ambio* 46(3):475-485.
- Gascard, J.-C., A.-S. Crépin, M. Karcher, and O.R. Young. 2017. Facets of Arctic Change. *Ambio* 46(3):339-340.
- Troell, M., A. Eide, J. Isaksen, Ø. Hermansen and A.-S. Crépin 2017. Seafood from a changing Arctic. *Ambio* 46(3): 368-386.

The town of Illulissat, Greenland. Photo: Alamy



How smart are smart cities?

The **Smart City concept** is by far the fastest growing in the current urban sustainability literature and has been embraced by many politicians and city planners as a way forward for creating more sustainable cities. It comprises an urban development approach for integrating information and communication (ICT) technology and the so-called Internet of Things (IoT) technology to digitally connect a city's infrastructure and services, in order to better manage and control them. This can include collecting data from citizens, monitoring and managing traffic and transportation systems, power plants and water supply networks, and using information systems in remotely diagnosing patients for medical treatment. The idea is that by enhancing the quality, performance and interactivity of urban services, resource consumption and costs can be reduced.

Concerns for resilience and security

In two articles published during the year, Beijer Institute researcher and programme director Johan Colding and colleagues assess the Smart City concept from a social-ecological resilience perspective.

In the first article, in *Journal of Cleaner Production*, the authors identify critical gaps in the thriving literature on Smart Cities and point out that these deserve greater attention. They argue that the literature on Smart Cities needs to better address issues of resilience and cyber security, including how Smart City solutions may affect the autonomy of urban governance, personal integrity and infrastructures that provide inhabitants with basic needs, such as food, energy and water.

As Johan Colding explains:

"We are already seeing vast internet- and computer technology problems related to hacking, sabotage and terrorism that could harm large-scale critical infrastructure, such as electricity, hospitals and other basic services. However, the issue of security is largely absent from the literature."

Connecting technologies – disconnecting to nature?

Another issue that deserves greater attention, according to the study, is how Smart City developments may change human-

nature interactions, for instance whether they hinder or support children's learning and psychological connection with nature.

"Smart City policies may unintentionally further disconnect citizens from nature experiences. Hence, we argue that it is critical to move from a solely sociotechnological focus of the Smart City framework to a more biosociotechnical focus, integrating ecology and including the role of ecosystem services as technologies and promoting reconnection to the biosphere", emphasises Johan Colding.

Energy efficiency

In a second article, in *Environment and Planning B*, the authors call for a greater societal debate on smart cities, raising the question of whether, if carried too far, digitalisation could result in diminishing return on energy savings and create unmanageably complex cities. They predict that, as more people and things are connected by IoT, the complexity of urban systems will increase over time and they point out that throughout the history of human civilisation, increasing complexity has led to growth in energy consumption.

Finally, in a forthcoming article Johan Colding and colleagues elaborate on the role different kinds of disturbance play in the context of Smart City development. They indicate some critical features that developers and planners need to consider carefully and propose a set of policy recommendations for ensuring more resilient development of city digitalisation.

References:

- Colding, J. and S. Barthel. 2017. An urban ecology critique on the "Smart City" model. *Journal of Cleaner Production* 164:95-101.
- Colding, J., M. Colding and S. Barthel. 2018. The smart city model: A new panacea for urban sustainability or unmanageable complexity? *Environment and Planning B: Urban Analytics and City Science*. First online. 10.1177/2399808318763164.
- Colding, J., M. Colding, and S. Barthel. In preparation. The Smart City as an ecosystem: applying resilience thinking on the digital city.



Singapore is one of the cities where the Smart City concept has been implemented to a high degree. Photo: Alamy

Scientists as change-makers

Overfishing, emissions and climate change have imposed severe strains on the world's oceans. In order to cope with the global challenges facing marine ecosystems, researchers at the Beijer Institute, Stockholm Resilience Centre (SRC) and Global Economic Dynamics and the Biosphere (GEDB) have initiated a global coalition, named Seafood Business for Ocean Stewardship (SeaBOS), with several of the world's largest seafood companies. In a study in *PNAS*, they describe how they have engaged with the companies and explore the importance of working together with transnational corporations as a means to promote transformative change and support global sustainability.

The SeaBOS initiative

Starting in 2012, the researchers, together with several colleagues, identified the largest corporations in the global seafood industry. Inspired by a classical ecology study on 'keystone species', these companies were dubbed 'keystone actors' in an article in *Plos ONE* 2015. This term reflects the fact that they are vertically integrated (some operating across entire supply chains from production through to retail), dominate all segments of seafood production, are connected globally through an extensive network of subsidiaries and play a disproportionate role in the dynamics of marine food webs around the world.

These 'keystone actors' are also actively involved in fisheries and aquaculture decision-making processes, which led to the hypothesis that these companies have a disproportionate ability to influence change in the global seafood industry.

Based on this work, the researchers engaged with these powerful actors to develop a collaboration to address unsustainable practices, such as overfishing, modern slavery and destructive impacts on habitats and non-target species. The result was that major companies from Asia, Europe and North America came together to form the SeaBOS initiative.

SeaBOS is unique in that no other initiative connects wild capture fisheries and aquaculture, science and business, and companies from three major global markets. It aims to tackle many important hurdles, such as poor transparency, antibiotic use in aquaculture and climate change.

From words to action

The *PNAS* study describes how SeaBOS came to be formed and the implications for global sustainability. It also describes how a science-business partnership might function, in an area where few scientific case studies exist.

"While substantial literature has focused on how science interacts with policy, relatively little is known about interactions between science and business. The strength of our study is to report in detail on such an interaction while putting it into the broader context of sustainability science", says Jean-Baptiste Jouffray, a PhD student connected to all three research institutions behind SeaBOS. In the study, the authors emphasise the importance and challenges of building relationships and trust between all the actors. Being able to respect different norms and knowledge and translating conversations across cultures and languages are cited as fundamental in the collaborative process.

"The most challenging and time-consuming aspects in-



Company CEOs and representatives and researchers who participated in the third Keystone Dialogue in Amersfoort, the Netherlands, May 2018. Photo: Radhika Gupta, SRC.

involved establishing trust with CEOs and convincing them that this could add value not only to their operations, reputation, and brands, but also in terms of clarifying their responsibility as global actors and the significance of ocean stewardship for sustainability and prosperity", said Henrik Österblom, SRC.

The authors also highlight that former voluntary environmental commitments have produced mixed results, but the fact that SeaBOS is trust-based, and that members are committed to continue meeting face-to-face, could help its chances of success.

In addition, they point out that the network will increase the interactions among keystone actors. Theoretically, a more connected network is more likely to undergo transformative change. Furthermore, SeaBOS is increasing interactions between major companies and sectors, thereby promoting sharing of knowledge and technology, which could benefit their business.

Guarding scientific integrity

By demonstrating how scientists and industry can collaboratively develop solutions to major sustainability issues, this study presents a unique method and case study, which can potentially be replicated in other sectors.

However, Carl Folke stresses that scientific integrity is essential when working so closely with high-level, business-oriented companies: "Sustainability science is a use-inspired approach, where scientists can both be embedded in, and learn from, change processes. Our ambition has been to be impartial knowledge brokers in this process and facilitate a new direction for ocean stewardship."

References:

- Österblom, H., J.-B. Jouffray, C. Folke, J. Rockström. 2017. Emergence of a global science-business initiative for ocean stewardship. *Proceedings of the National Academy of Sciences, USA* 114:9038-9043
- Österblom, H., J.-B. Jouffray, C. Folke, B. Crona, M. Troell, A. Merrie, J. Rockström. 2015. Transnational corporations as 'keystone actors' in marine ecosystems. *PLOS One* 10(5):e0127533.

Conferences



Closing session at the Resilience 2017 conference. Photo: Robert Kautsky/Azote.

Resilience 2017 – Resilience Frontiers for Global Sustainability

The fourth Resilience Conference was hosted in Stockholm on 20-23 August 2017 by Stockholm Resilience Centre (SRC), the Beijer Institute and the Resilience Alliance. This time, almost 1000 researchers, practitioners and policy-makers from more than 70 countries attended, demonstrating how resilience research has established itself among a wider community, and also as a focal point for sustainability science. Just like the first conference in Stockholm 2008 (which was followed by Arizona 2011 and Montpellier 2014), Resilience 2017 blended art, music and culture with the social and natural sciences.

The aim of the conference was to gather resilience scholars from around the world to assess the scientific state-of-the-art regarding the latest advancements in resilience research and to share, clarify and define research frontiers and important next steps. A further aim was to develop joint science positions and syntheses and ideas on key initiatives, with-in science and also bridging science with policy, practice and the arts.

Beijer involvement

Beijer Institute staff members were instrumental in the overall planning process, in planning and leading conference sessions, and in organising the social events and the cultural content. In addition, several Beijer researchers held individual presentations and the Beijer Young Scholars organised their own session entitled *Inequality and the Biosphere: Exploring the interactions between the Bio-*

sphere and human well-being through the lens of inequality. (For more detailed information about sessions and presentations, see Appendix under individual researchers.)

Carl Folke opened the conference together with Katrina Brown of the University of Exeter. They challenged those present to think about the potential for a New Renaissance, in which humans recognise the consequences of their actions. “When you get increased variance, flickering, slowing down, we’re very likely to have tipping points, or new things taking off rapidly. There is a big opportunity space opening up right now and I think the people in this room have a big role to play in that opportunity space to help find pathways into the future”, said Carl Folke.

Positive response

An assessment form was sent out to all participants immediately after the conference and the responses (41% or 376 persons answered) were overwhelmingly

positive, showing for instance that a vast majority found the conference very worthwhile or worthwhile. Moreover, 84% of the respondents said the conference would influence the way they work or act, for instance through getting new perspectives or ideas, gaining a broader network or feeling empowered. Finally, to the great joy of conference manager Louise Hård af Segerstad (SRC and Albaeco) and the planning team, the survey revealed that the conference gave useful networking opportunities and that the atmosphere was warm and created a perfect space to meet and share ideas.

Future Earth conference followed

Back to back with the Resilience 2017 conference, the International Sustainability Science Conference was hosted by Future Earth in partnership with SRC. As a bridge between the two conferences, an Ideas and Innovation Forum on 24 August featured results from a series of “Sustainable Development Goal (SDG) Labs”. These labs brought together participants from a range of research disciplines and sectors of society to develop prototype solutions for complex problems connected to the United Nations’ Sustainable Development Goals.



Allowing time for fun was part of the plan at Resilience 2017. Photo: Robert Kautsky/Azote.

The World Congress of Environmental and Resource Economists

The World Congress of Environmental and Resource Economists (WCERE) takes place every four years and gathers researchers and practitioners from all over the world. This year the 6th World Congress was held in Gothenburg, Sweden, on 25-29 June and attracted more than 1500 participants from throughout the world. Thanks to the proximity of the venue, Beijer had an unusually strong presence at the conference.

Our involvement started even before the conference, with the organisation of a short pre-conference course, Spatial analysis in economics and the environment (see page 31).

Beijer Institute researchers organised a thematic session on the need for, and design of, policies for the Anthropocene. Global environmental problems such as biodiversity loss, overexploitation of renewable natural resources, pollution and climate change are now threatening the current stability domain of the biosphere itself and these developments require policies designed to address these new issues. However, there is a mismatch between the global scale of problems and the mainly national and local scales of policy design. Among others, Anne-Sophie Crépin presented an overview of how resilience thinking and economics could jointly improve management practices in an Anthropocene context.

Two sessions on behavioural research were chaired by Beijer Institute researcher Caroline Schill and Mäler Scholar Herbert Ntuli. Caroline Schill also presented results from field experiments investigating fishermen’s response to potential risk of regime shifts in a collectively managed fishery. Herbert Ntuli presented the results of framed field experiments relating to wildlife management and regime shifts in Zimbabwe. This session also included a presentation by the chair of the Beijer board, Karine Nyborg.

Moreover, the WCERE meeting in Gothenburg offered an opportunity to reconnect with many Mäler Scholars, Beijer Young Scholars and Beijer Fellows.

Read more at www.wcere2018.org



In a poster session, Daniel Ospina, PhD candidate at the Beijer Institute and Stockholm Resilience Centre, presented his work exploring how rural landscapes are affected by migration from the countryside to cities and by the remittances the migrants send home.

Biodiversity and Economics for Conservation

After a long and successful career, Aart de Zeeuw retired in September 2017. Tilburg University organised several events in his honour sponsored and co-organised by the Beijer Institute. In particular, the 19th annual BIOECON (Biodiversity and Economics for Conservation) conference was hosted at Tilburg and its keynote lectures and several plenary panel discussions this year focused on research close to Aart de Zeeuw’s area of expertise.

Beijer researchers Anne-Sophie Crépin and Therese Lindahl, together with Stefan Baumgärtner (Albert-Ludwig-Universität, Germany), held plenary lectures in a panel session dedicated to resource scarcity, resilience and collective action. Former Beijer board director Anastasios Xepapadeas participated in a plenary panel dedicated to the UN’s Sustainable Development Goals (SDGs) and the road to sustainability. The conference ended with Aart de Zeeuw’s valedictorian speech providing a comprehensive overview of the contributions he has made during his career.

Aart de Zeeuw was the Beijer Institute’s co-director 2007-2009 and programme director of the complex system programme (2009-2017), and is still affiliated to the Beijer Institute.



Aart de Zeeuw with his successor Daan van Soest and Beijer Fellow Anastasios Xepapadeas at the BIOECON conference.

The Beijer Young Scholars

The Beijer Young Scholars Programme (BYS) was initially established in 2012 with the aim of creating an international network of young researchers and stimulating the emergence of new research pathways and modes of cooperation across disciplines to address the global challenges facing humanity.

The second generation of Beijer Young Scholars held their third meeting on 21-25 May at the Royal Swedish Academy of Sciences and on the island of Ekskäret in the Stockholm Archipelago. With this final workshop organised by the Institute, Beijer Young Scholars in this group close a cycle of cooperation and look forward to future opportunities to strengthen their network.

Throughout the three years of support from the Beijer Institute, the 18 PhD candidates and early career researchers in the BYS group embarked on an exploration of the potential links between inequality and the biosphere. As a result, they contributed to this body of research with a literature review and a research agenda that outlines mechanisms between different types of inequality, changes in the biosphere and their im-

pact on inequity or the perception of fairness. The paper will appear later this year as part of *Annual Review of Environment and Resources*. Together they also organised a well-attended session on the same theme at the Resilience 2017 conference in Stockholm. Besides an important contribution to the research field, Beijer Young Scholars testify that the experiences with the BYS network have also marked their career paths and inspired them to attempt more interdisciplinary work in the future:

“Having the privilege to be part of the BYS program has been an inspiring and transformative experience, to not only broaden my research horizontally towards becoming an interdisciplinary scientist, but also distil deeper understanding of how different fields such as ecology, economics, geography, and political sciences are inherently connected. It has also reinforced my aspirations for continuing interdisciplinary collaborations that are essential for addressing contemporary wicked social environmental problems”

– Jiangxiao Qiu, University of Florida

“The BYS program is a unique example showcasing a successful process in which a group of scientists from different backgrounds and skills produce quality research, and not least, enjoy it. It also demonstrates how to build successful networks of researchers, that will continue to collaborate into the future.”

– Alon Shepon, Weizmann Institute of Science

“After the BYS I’m also more relentlessly active at the science-policy interface, bringing expert, indigenous, traditional, technical and scientific knowledge into policy and governance discussions through collaboration with NGOs, government, and international organizations such as the United Nations Forum on Indigenous People Issues.”

– Yolanda Lopez-Maldonado, consultant

“The theme of inequality has become like a Greek chorus in all my research thinking - every time I encounter a new project or come up with a new idea, I can’t help but hear the question: “How does this relate to inequality?”

– Tong Wu, Arizona State University



Photo: Andrew Tilman

Conducting collaborative, integrative and interdisciplinary research in the early stages of one’s academic career is challenging. It is a time-consuming endeavour that is not always well recognised in the academic incentives system, but is crucial to advance science into deeper research questions rather than pursuing low-hanging fruits. From the programme evaluations, it is evident that the Beijer Young Scholars recognise the value of such thinking space and acknowledge the support of the Beijer Institute in facilitating the emergence and continuity of that space:

“I have realized that it is very rewarding and intellectually fascinating to engage in interdisciplinary discussions and collective learning. It really encouraged me to broaden my understanding and try hard to understand different disciplinary perspectives and ways of thinking. And it also forced me to confront some of the often unspoken and unquestioned assumptions in my own work and discipline.”

– Maike Hamann, University of Minnesota

“It confirms the strength of interdisciplinary collaboration and learning. And the importance of time for developing good ideas.”

– Jonas Hentati-Sundberg, Swedish University of Agricultural Sciences

“The BYS workshops introduced me to a community of inspiring, brilliant individuals that gave me confidence to pursue questions that I found exciting, rather than questions that I thought would gain accept-

ance among more traditional economists. This experience has been freeing and has led me to begin to tackle questions that are a deeper blend of economics, ecology and geography.”

– Robert Heilmayr, University of California Santa Barbara

“One of the big factors was everyone’s willingness to engage - again, something that is hard to see on paper, but was essential to our group bonding.”

– Amir Jina, University of Chicago

As several of the Beijer Young Scholars affirm, their expectations do not end with the last of these workshops. Their ambition is to pursue the development of their research agenda through at least five research projects for which they are already trying to secure funding. The Beijer Institute is proud to have hosted these extraordinary young scholars and will support their endeavours, with the hope that the seed planted with these workshops grows to produce a successful network of long-lasting collaborations.

We gratefully acknowledge the financial support from the Anna-Greta and Holger Crafoord Foundation.

Reference:

M. Hamann et al. 2018. Inequality and the biosphere. *Annual Review of Environment and Resources*. In press.

Beijer Young Scholars:

- » Kevin Berry, University of Alaska Anchorage
- » Tom Chaigneau, University of Exeter
- » Tracie Curry, University of Alaska Fairbanks
- » Maike Hamann, University of Minnesota
- » Robert Heilmayr, University of California Santa Barbara
- » Patrik Henriksson, the Beijer Institute, SRC and Wiomsa
- » Jonas Hentati Sundberg, Swedish University of Agricultural Sciences
- » Amir Jina, University of Chicago
- » Emilie Lindqvist, SRC
- » Yolanda Lopez, University of Munich
- » Matias Piaggio, CATIE (Centro Agronómico Tropical de Investigación y Enseñanza)
- » Jiangxiao Qiu, University of Florida
- » Juan-Carlos Rocha, SRC
- » Caroline Schill, the Beijer Institute
- » Alon Shepon, Weizmann Institute of Science
- » Andrew Tilman, University of Pennsylvania
- » Inge van den Bijgaart, University of Gothenburg
- » Tong Wu, Arizona State University



Photo: Agneta Sundin



Beijer Young Scholars workshop at the island of Ekskäret. Photo: Andrew Tilman



Photo: Andrew Tilman

Mäler Scholars

The **Mäler Scholarship** is intended for researchers from the Regional Networks in Environmental Economics. Through this scholarship, the Beijer Institute aims to support the networks in creating increased capacity in their respective regions to use ecological economics for analysing environment and development issues. The scholarship allows researchers to spend up to six months at the Beijer Institute preparing manuscripts based on their existing research and developing new projects in collaboration with Beijer Institute researchers.

The Mäler Scholarship is named after Professor Karl-Göran Mäler, Professor of Economics specialising in Environmental and Resource Economics, and Director of the Beijer Institute 1992-2007. During Karl-Göran's leadership, the Beijer Institute worked intensely with capacity building in environmental and resource economics in developing countries, and was instrumental in creating three regional networks in environmental economics in Latin America, Asia and Africa: LACEEP, SANDEE and CEEPA/RANESA.

Herbert Ntuli

Mäler Scholar 2017 was Dr Herbert Ntuli. He visited the Beijer Institute in February-April 2017 and returned for a second visit in September-November 2017. He holds a PhD in Economics from the University of Cape Town and an MSc in Agricultural & Applied Economics from the University of Zimbabwe. He is currently a post-doctoral fellow at the University of Cape Town, South Africa.

Herbert spent his first visit developing an experimental design and research instruments to study the potential impact of management and human behaviour on elephant populations in Zimbabwe. He values the collaboration with Beijer Institute colleagues:

"At the Beijer Institute, I interacted with brilliant researchers such as Anne-Sophie Crépin, Caroline Schill and Therese Lindahl, who helped me to sharpen my ideas and put them into action."

From June to September 2017, Herbert implemented his experimental design in local communities around the Gonarezhou National Park in Zimbabwe, to gather experimental data on behavioural responses to regime shifts using framed field experiments. The field-work was made possible with funding from the Environment for Development (EfD) Initiative. After concluding the data collection exercise, he returned to the Institute for his second visit. During this time, he developed a draft paper entitled "An examination of factors affecting the level of collective action using framed field experiments", together with Anne-Sophie

Crépin and Edwin Muchapondwa, University of Cape Town.

The results show that user groups manage multiple ecosystem resources more efficiently if they have information that the system could undergo a regime shift or if there is a policy in place that punishes overexploitation. Although a punishment policy is often superior in the experiment, the results illustrate that informing about a regime shifts could be a good substitute, especially when punishment provides poor incentives or is expensive as in most developing countries.

Yana Yin

Mäler Scholar 2018 is Dr. Yana Jin, who obtained a PhD in Environmental Economics from Peking University in 2017. Her research focuses on energy and environmental policy, particularly as they pertain to human health and climate impacts. Yana stayed in Stockholm during May and June 2018 and will return for a postponed second visit in spring 2019, due to her taking up a post-doctoral position at the College of William and Mary, Virginia, USA. Yana learned about the Mäler Scholarship already in 2011:

"I met Beijer institute researcher Chuan-Zhong Li and previous Mäler Scholar Dr. Zanxin Wang at a conference in China and from them I learned about the Beijer Institute and the Mäler scholarship as a great training and collaborative opportunity."

After graduating, she did not hesitate to apply for the scholarship, and during her first visit she started a collaboration with Åsa Gren on urban environmental amenities and human health in an integrated, multidisciplinary way. Together they are developing a research design for 1) functional classification of health benefits in urban green areas and 2) examining the current status and future of more efficient provision of such benefits among population groups with different social economic status. The next step is studying these issues in detail using rich geo-spatial datasets.

Besides this project, Yana appreciates other opportunities offered through the scholarship:

"The welcoming and dynamic atmosphere greatly encouraged me to present my previous research and discuss one-on-one with scholars at the Beijer Institute and Stockholm Resilience Centre, which opened up collaborative initiatives for my second visit and in the future."



Herbert Ntuli with Anne-Sophie Crépin and Caroline Schill.

The Gonarezhou National Park in Zimbabwe, where Herbert Ntuli conducted his field experiments related to management of elephant populations. Photo: Alamy



Science in Society

The SeaBOS initiative

The scientific discovery of “keystone actors” in marine ecosystems and the Keystone Dialogues described in last year’s Annual Report have progressed during the year. Today, the initiative has materialised into one of the most important cross-sector collaborations within the global seafood industry, and it has created ripples in the water that have inspired many others. The initiative marks the first time that companies from Asia, Europe and the US have come together in the seafood business with the aim of ending unsustainable practices such as modern slavery, overfishing and other practices that have destructive impacts on habitats and marine species. The SeaBOS initiative uses a transdisciplinary approach of adaptive, learning-based collaboration on responsibility and ethics, aiming to safeguard the resilience and productivity of ocean ecosystems for human well-being.

By connecting the best available scientific knowledge on the ocean with the most powerful industry actors, the SeaBOS initiative offers a potential shortcut wherein leadership by keystone actors could result in cascading effects throughout the entire seafood industry and enable a critical transition towards improved stewardship for healthy oceans. SeaBOS includes the two largest seafood companies by revenue, Maruha

Nichiro and Nippon Suisan Kaisha; two of the largest tuna specialists, Thai Union Group and Dongwon Industries; the two largest companies manufacturing feeds for aquaculture, Nutreco (parent company of Skretting) and Cargill Aqua Nutrition; the two largest farmed salmon companies, Marine Harvest and Cermaq (subsidiary of Mitsubishi); and the Japanese tuna purse seine company Kyokuyo, as well as the agro-industrial conglomerate CP Foods.

SeaBOS is now organised into five task forces: (1) Reducing illegal, unreported and unregulated (IUU) fishing; (2) Improving transparency and traceability in global seafood; (3) Working with governments to improve regulations; (4) Vision, strategy, monitoring and governance of SeaBOS; and (5) Innovation (which is currently focusing on analysing ways to reduce the use of plastics in seafood supply chains). There have been meetings and actions within each task force, requiring substantial collaboration between scientists and SeaBOS members.

Nutreco kindly hosted a major working meeting for SeaBOS members in Amersfoort, the Netherlands, on 14-15 May 2018. The Amersfoort Dialogue represented an important development of substance as representatives from nine of the ten SeaBOS members were present, including three CEOs.

The Keystone Dialogues approach and the SeaBOS initiative have been present

ed at several conferences and meetings during the year, including at AquaVision 2018 in June in Stavanger, Norway, with HRH Crown Princess Victoria of Sweden speaking on the topic “The Ocean Challenge and SeaBOS”. The keystone actors process is initiated and operated by researchers at Stockholm Resilience Centre, the Beijer Institute and the Global Economic Dynamics and the Biosphere (GEDB) programme of the Royal Swedish Academy of Sciences. A scientific article describing the initiative and the processes was published in *Proceedings of the National Academy of Sciences, USA* (PNAS), as mentioned on page 19. The next Keystone Dialogue will be held in Tokyo, Japan, on 3-4 September 2018.

Read more at www.keystonedialogues.earth

The Overview Effect

During The Stockholm Act, a sustainability week at the House of Culture (Kulturhuset) in Stockholm on 21-27 August 2017, a conversation between Carl Folke and journalist and author Johanna Koljonen attracted a large audience. The topic was the Overview Effect, a phenomenon whereby astronauts seeing the Earth from space as a tiny, fragile ball of life, shielded by a paper-thin atmosphere, undergo a cognitive shift and become overwhelmed and awed by the

fragility and unity of life on our blue planet and overcome by a wish to protect it. How can that protectiveness be instilled in humanity as a whole? The conversation was followed by a concert with the Fire! Orchestra, who performed new music to video images of the Earth from space.

The Global Ocean and the Future of Humanity

“We need the oceans more than the oceans need us.” This was a message from Economics Professor Rashid Sumaila, at a half-day symposium at the Academy highlighting threats and opportunities for the future of the global oceans. The symposium was organised together with GEDB, SRC and Volvo Environment Prize in honour of Professor Sumaila, who was the 2017 Volvo Environment Prize Laureate and who has dedicated his career to promoting sustainable use of fisheries and ocean resources. The speakers explored pathways to ensure that the ocean can continue to provide for humanity, while also protecting its intrinsic values and the structure and function of ecosystems. Furthermore, they discussed how improved use of the oceans can provide benefits from these global commons, in a fair way, to citizens of all nations. The seminar was honoured by the presence of HRH Crown Princess Victoria of Sweden and it was well attended by representatives from government, political parties and NGOs, as well as scientists and students.

Speakers:

Rashid Sumaila, University of British Columbia, Maria van Berlekom, Swedish International Development Cooperation Agency, Sida. Beatrice Crona, Global Economic Dynamics and the Biosphere Programme (GEDB), Carl Folke, the Beijer Institute.

Moderator: Henrik Österblom, Stockholm Resilience Centre

Music: Perro del Mar
See video of the seminar at www.beijer.kva.se



The third Keystone Dialogue with SeaBOS members in Amersfoort, the Netherlands, May 2018. Photo: Radhika Gupta/SRC



Top: Carl Folke in a sustainability dialogue at the House of Culture, Stockholm. Bottom: Speakers at the seminar The Global Ocean and the Future of Humanity with HRH Crown Princess Victoria of Sweden (centre). From left: Carl Folke, Rashid Sumaila, Beatrice Crona and Maria van Berlekom.

Art and science collaboration for the oceans

With the **SeaBOS** initiative as a starting point, an exhibition was created by students at Beckmans College of Design to raise awareness about the state of the oceans.

Beijer Institute staff and colleagues from GEDB and SRC gave introductory lectures and provided background readings and tuition to the students throughout a five-week course on different aspects of fishing and aquaculture production and its effects on the global oceans.

The project inspired 16 very diverse works providing visual, emotional and humorous entry points to the subject. These included a kitchen aid that removes plastics from the food we eat, a futuristic news broadcast showing genetically modified fish used to fight eutrophication, carrier bags in a textile made from “ghost nets” (fishing nets left or lost at sea) and a cookery book with information and recipes for sustainable seafood. A digital exhibition was also produced.

These works were shown in the exhibition *Transformation*, created in collaboration with the design company Svenskt Tenn and displayed in its store in central Stockholm on 16-29 January 2018. Through the Kjell and Märta Beijer Foundation, Svenskt Tenn’s profits sup-

port research at the Beijer Institute.

“In recent years, there have been multiple reports of overfishing and dumping of waste in the oceans, so it is important to be able to get involved and contribute to change, not only through providing funding, but also by drawing awareness to the issues through exhibitions such as this”, said Thommy Bindefeld, Marketing Manager at Svenskt Tenn, regarding the collaboration.

Part of the exhibition has since been shown at a gala in Stockholm on 25 April to mark the launch of a campaign to highlight the dire state of the world’s oceans, with a particular focus on plastic pollution, set up by the Keep the Ocean Clean (Håll havet rent) network. Sweden’s Deputy Prime Minister Isabella Lövin was one of the speakers.

This was the second collaboration between the Beijer Institute, Beckmans Design School and Svenskt Tenn, and all three institutions are keen to continue with the courses and exhibitions. Carl Folke comments on why: “The students are able to communicate these important issues in a completely different, innovative and beautiful way to what we as a research institution can do, and, through Svenskt Tenn, they reach a whole new audience. Through such projects and collaborations, I believe the students will become important ambassadors for improved stewardship of the oceans and the biosphere as a whole.”



Top: Emelie Maxdotter made beautiful dinner plates that also serve as a guide to sustainable seafood consumption. Photo: Svenskt Tenn.

Middle: Cookbook with recipes and facts intended to inspire readers to choose sustainable seafood species such as mussels, oysters and algae. By Carl Cavallius. Photo: Svenskt Tenn.

Left: Kitty Schumacher created a futuristic kitchen aid: 'Ready - the Seafood Detoxicator, a machine to remove plastic from your seafood' Photo: Kitty Schumacher.



Part of the exhibition Transformation at Svenskt Tenn.



In May, Carl Folke made a presentation when Svenskt Tenn opened a major event in Helsinki, Finland. From left: Carl Folke; Maria Veerasamy, CEO Svenskt Tenn; Sonja Söderholm, the Swedish-Finnish Cultural Centre; and Anders Wall, Chair of the Beijer Foundation.

Patterns of the Biosphere exhibits

The creative partnership with Svenskt Tenn began in 2015 with the exhibition *Patterns of the Biosphere* (presented in earlier reports), which has since lived on and continues to be shown. During the year, it was part of the Resilience 2017 conference in Stockholm in August 2017. Part of the exhibition was also shown at the House of Culture (Kulturhuset) in Stockholm for a three-day sustainability festival. We are delighted to report that it was also displayed during the whole summer season (9 June-20 August 2018) at the stunning baroque castle Läckö Castle in southern Sweden. Läckö Castle attracts tens of thousands of visitors every year from Sweden and abroad and it is part of the Lake Vänern UNESCO Biosphere Reserve. These reserves are created to be ‘Science for Sustainability support sites’, special places for testing interdisciplinary approaches to understanding and managing changes and interactions between social and ecological systems, including conflict prevention and management of biodiversity. Thus, the exhibition, which interprets research by the Beijer Institute, fits exceptionally well in this context.

At the biosphere reserve centre (Naturum) in the castle grounds, seminars that connect to the agenda of the reserve are organised. On 15 March 2018, Beijer researcher and programme director Therese Lindahl gave a talk to teachers about the importance of children’s connection to nature from a sustainability perspective. Later the same day, she gave an open talk entitled *Nature and its effect on our mental health* to an attentive and interested audience.

Symposium on Arctic climate change

Climate change is having dramatic impacts in the Arctic, with greater temperature increases compared with the Earth as a whole and rapidly melting summer sea ice. These changes are expected to substantially influence the Arctic environment and socio-economic activities.

At a half-day symposium at the Academy on 15 February 2018, co-organised with the Academy's Environmental Committee, new research concerning the direct results of global warming, such as future sea ice conditions and impacts on live marine resources and on the provision of ecosystem services, was presented and discussed. Furthermore, the impacts that these changes have on fishing, oil extraction, aquaculture and other economic activities, and how they in turn affect the environment and the lives of people in local communities, were discussed. A framework to support management in the region that takes into account complex interactions between society and nature, possible abrupt change and considerable uncertainty was also presented.

The presentations were based on results from the transdisciplinary EU-project Arctic Climate Change Economy and Society (ACCESS), published in a special issue of the journal *Ambio* (find out more about the special issue on page 16-17).

We gratefully acknowledge the financial support from the Anna-Greta and Holger Crafoord Foundation for this symposium.

Symposium: Connecting and Protecting our Seas

With the support of the Prince Albert of Monaco Environmental Foundation, the Swedish Foreign Office and the Swedish Embassy in Paris, a symposium entitled 'Connecting and Protecting Our Seas' was held in Monaco on 12-13 October 2017. This symposium was a follow-up to the UN 'Oceans Conference' in June, which was initiated by Sweden and Fiji to support the work on protecting our oceans and achieve the UN's sustainable development goal for the oceans and marine resources (goal 14 in the UN's Agenda 2030).

The aim of the Monaco symposium was to identify common areas for collaboration and to draw lessons from existing solutions to different marine challenges, with particular emphasis on the Baltic Sea and the Mediterranean. The scientific content was provided by re-



Panel discussion on the Symposium Scenarios for a warmer Arctic. Photo: Agneta Sundin

Speakers:

Jean-Claude Gascard, University Pierre and Marie Curie, LOCEAN and CNRS, Michael Karcher, Alfred Wegener Institute, John Isaksen, NOFIMA, Jeremy Wilkinson, British Antarctic Survey, Kathy Law, University Pierre and Marie Curie, LATMOS, Anne-Sophie Crépin, the Beijer Institute.

Panel discussant: Wendy Broadgate, Future Earth

Moderator: Miriam Huitric, Stockholm Resilience Centre

See seminar video at www.beijer.kva.se



Participants at the symposium Connecting and Protecting our Seas. Lisen Shultz, SRC; Carl Folke; Veronika Wand-Danielsson, Sweden's Ambassador to France; HRH Prince Carl Philip of Sweden; Patricia Husson, Sweden's Consul General in Monaco; Marie-Pierre Gramaglia, Environment Minister of Monaco; Mattias Landgren, State Secretary to Sweden's Minister for infrastructure; Barbara Jackson, CEO Race for the Baltic; Max Troell, the Beijer Institute.

searchers from the Beijer Institute and Stockholm Resilience Centre, who also led the panel discussions during the meeting. These discussions were organised within three main themes: *Solutions for the Oceans*, *Future of Seafood* and *The Business Case for the Oceans & Next Steps*. The Beijer Institute's Max Troell led the session on the future of seafood and the director of the Institute, Carl Folke, summed up the various scientific discussions

and strategies for future work.

Prince Albert of Monaco and Prince Carl Philip of Sweden led day two, and Swedish Minister of the Environment Karolina Skog was one of the main speakers. Other participants included researchers, representatives of organisations working on marine sustainability issues and key actors from industry. This broad range of delegates led to very interesting and relevant discussions.

Education

Master's course: Challenges of environmental decision making

During spring 2018, Beijer Institute researchers organised and taught, for the sixth year in a row, a specially designed course in environmental and resource economics for students taking the Master's programme Social-Ecological Resilience for Sustainable Development at Stockholm Resilience Centre. The title of the course is *Challenges of environmental decision making* and it was delivered over a period of three weeks to a class of 16 students.

The objective is to help the students understand the whole range of economic challenges associated with decision making coupled to environmental issues. The course explores alternative approaches for analysing how people make choices individually and collectively to manage social-ecological systems, and the consequences these choices have. The aim is to give the students insights into economic approaches to decision making. In particular, the course focuses on economic approaches for dealing with regime shifts, behavioural biases, climate change and international trade. Together with the students, course leaders explore alternative approaches for analysing how people make choices, individually and collectively, in managing social-ecological systems and the consequences/trade-offs these choices involve.

Course leader and lecturer:

Gustav Engström

Lecturers:

Anne-Sophie Crépin, Therese Lindahl, the Beijer Institute and Johan Gars, GEDB.

Pre-conference course: Spatial analysis in economics and the environment

For the fifth time, the Beijer Institute organised a two-day course just before the World Congress of Environmental and Resource Economists (WCERE) / annual meeting of the European Association of Environmental and Resource Economists (EAERE). It was held in conjunc-



Participants of the course *Spatial analysis in economics and the environment*. Photo: Karin Jonsson

tion with the 6th WCERE in Gothenburg, Sweden, in June 2018.

The course is intended for a selected group of researchers from developing countries and thus contributes to the long legacy of capacity building by the Beijer Institute. Organising it back-to-back with the major conference in the field means that course participants can also participate in the conference and present a paper or a poster, if accepted. This is a good way to connect researchers from low- and middle-income countries to networks of researchers in Europe and North America.

In 2018, the course *Spatial analysis in economics and the environment* provided an overview of the concept of space in economics and ecology. It covered topics such as the design of reserves on land and in the sea, as well as presenting some tools to study spatial issues. For example, in two laboratory sessions the participants were shown how to use the Google Earth Engine to analyse phenomena like night lights and changes in land use activities.

A total of 25 students from 15 different countries participated, and we were pleased to achieve an almost perfect gender balance among students (12 women and 13 men) and in the faculty group (4 men and 4 women).

The course was organised as a joint

collaboration between the Beijer Institute and Gothenburg University, with a grant from Sida and additional funding from EAERE. The generous funding from Sida this year allowed Gothenburg University to provide a similar course, *Application of experimental methods in climate policy*, led by Peter Martinsson, Gothenburg University. Martin Persson, Chalmers University, Sweden, gave an introductory lecture on climate change for both courses.

Course leaders and lecturers:

Anne-Sophie Crépin, the Beijer Institute, and Efthymia Kyriakopoulou, Swedish University of Agricultural Sciences (SLU).

Lecturers:

Elisabeth Robinson, University of Reading, UK, and Beijer Fellows Jim Wilen, University of California Davis, USA, and Anastasios Xepapadeas, Athens University of Economics and Business, Greece, and University of Bologna, Italy.

Laboratory session organiser:

Jeremy Proville, Environmental Defence Fund.

Laboratory session assistant:

Yi Yuanyuan, World Bank.

Collaborations

The Global Economic Dynamics and the Biosphere (GEDB) Academy Programme

The GEDB programme of the Academy focuses on unexplored interfaces and areas of scientific inquiry with the aim of better understanding global economic dynamics in a biosphere context and uncovering the drivers, mechanisms and effects on social-ecological systems and their resilience at multiple scales. The programme combines competencies across unexplored domains to develop sustainability science by:

- » Connecting knowledge and competencies of researchers from disciplines that seldom interact.
- » Combining whole areas of work that have previously not been combined.
- » Enabling new forms of collaboration between science, practice and business for human wellbeing and biosphere stewardship.

The programme is structured around three themes: *(Macro)economy and the biosphere*, *Marine resource trade and its effects on social-ecological systems*, and *Interactions between financial markets and the biosphere*. There are also two cross-cutting themes that have emerged: *Cross-scale dynamics* and *Systems transformation*. The former is a connecting theme running through much of the ongoing work of the GEDB and the latter has emerged through a focus on factors that bolster or impede transformative change, such as the challenge of antimicrobial resistance.

There is continuous collaboration between the GEDB, the Beijer Institute and Stockholm Resilience Centre (SRC). Beatrice Crona is executive director of the programme, which is funded by the Erling-Persson Family Foundation. Joint workshops and seminars were organised during the period. There is an advisory board with several Beijer fellows, while Beijer Fellow James Wilen, Professor of Economics at the University of California Davis, has provided guidance for the work. As we envisioned, GEDB has become a significant channel for research, synthesis and synergies between the Beijer Institute and SRC and there has also been collaboration with Future Earth,

researchers at Princeton University and other networks and organisations, such as the UNEP Finance Initiative.

Funding for a new programme of the GEDB – *New Approaches to the Grand Challenge: Global Finance, Global Health and the Biosphere* – was received in spring 2018 and work will start in 2019. The new programme is funded by the Erling-Persson Family Foundation, in the amount of 32.5 million SEK over five years.

[Read more about GEDB at www.gedb.se](http://www.gedb.se)

Stockholm Resilience Centre (and Stanford University)

The interaction with Stockholm Resilience Centre (SRC) continues in a very productive fashion with many synergies and benefits and close collaborations through joint projects, grants, workshops and publications. Beijer researchers are engaged with the themes and streams of the SRC and collaborate and participate in seminars, teaching, supervision etc. The communication, outreach and policy engagements of the Beijer Institute are substantially magnified through SRC. The work with two significant grants is progressing and strengthens and extends 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 provides 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. The programme draws on the legacy of science developed jointly by Stanford University and the Beijer Institute, and more recently, SRC.

The programme's overall focus is to advance fundamental research in four key areas:

- » Characterising, managing and governing natural capital and ecosystem services.
- » Linking social and economic development to biosphere stewardship from local to global level.
- » Sustainable and healthy food and water for a rapidly urbanising world.
- » Human behaviour, cognition and

mental wellbeing in an urbanised, highly dynamic world.

The ongoing research is structured into four themes that address one or cut across several of the research areas. The four themes connect people and nature using the lenses of food systems, urbanisation and the challenges of biosphere stewardship. They cover: nature experiences and mental health, reconnecting urban development to natural capital and ecosystem services, the role of the food system in human affairs and scenarios for transforming development into sustainability pathways. Each theme is co-led by a minimum of two senior researchers from both the SRC/Beijer and Stanford University and a postdoc or early career scientist is assigned to each of the themes.

During the year, a new Stanford-Stockholm programme – *Fundamental Research in Biosphere-based Sustainability Science* – was granted funding. The Marianne and Marcus Wallenberg Foundation will provide 19 million SEK for the five-year programme and the work will start in the second half of 2018, with Carl Folke and Gretchen Daily as project leaders.

Guidance for Resilience in the Anthropocene: Investments for Development (GRAID)

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. The GRAID collaboration takes an integrated view of people and nature, aiming at a deeper understanding of human-environment interactions, wellbeing, resilience and stewardship of social-ecologi-

cal 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 contributor of knowledge to the Global Resilience Partnership (GRP) (see science in society).
- » To further develop methods, practices and actionable 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, based on e.g. on-the-ground experiences and insights from GRP and its implementing partners.

GRAID is a major programme of SRC, is funded by the Swedish International Development Agency (Sida) and works in close collaboration with the restarted Global Resilience Partnership (www.globalresiliencepartnership.org) hosted by Stockholm Resilience Centre.

www.stockholmresilience.org

Environment and Development Economics

The journal *Environment and Development Economics* (EDE) 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 both developed and developing countries. The journal is divided into two main sections, *Theory and Applications*, which includes regular academic papers, and *Policy Options*, which includes papers that may be of interest to the wider policy community. The editor is Eswaran

Somanathan. The journal focuses on encouraging and giving maximum support to authors for high-quality theoretical and empirical research in environmental and development economics, paying special attention to papers submitted from developing areas without compromising the quality of papers published, and planning and publishing special issues that focus on specific areas of policy interest.

HiG Urban Studio, University of Gävle

The Urban programme at Beijer collaborates with the HiG Urban Studio at the University of Gävle, which is a newly established research programme on urban sustainability that is funded from core university funding. Johan Colding is currently employed as a part-time research coordinator at HiG Urban Studio, which conducts research that supports urban development confined within the Earth's carrying capacity, while maintaining a focus on human well-being. A key mission of HiG Urban Studio is to promote collaboration with other prominent research settings in Sweden that are working on sustainable urban development. These include the SMOG group at Chalmers Technical University, Sweden, which holds an internationally leading position in research related to architecture and urban morphology, and environmental psychology groups at Aalto University, Finland and Uppsala University, Sweden.

PECS – Programme on Ecosystem Change and Society

The Beijer Institute and GEDB are central to the Academy's profile on issues of global sustainability and collaboration with SRC. The Beijer Institute is active in



Social event at Stockholm Resilience Centre during the Resilience 2017 conference. Photo: Robert Kautsky/Azote



Overlooking glacial landscapes in Iceland. Photo: Alamy

the Future Earth core project *Programme on Ecosystem Change and Society* (PECS), chaired by Beijer Fellow Steve Carpenter, with the International Programme Office hosted by 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 in the new global context (www.pecs-science.org/). Albert Norström, SRC, is executive director of PECS and Carl Folke is programme director. PECS and the Southern African PECS (SAPECS) serve as important links between the GRAID programme and the joint Wallenberg programme with Stanford University.

www.pecs-science.org

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 seeking 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. Researchers in the Resilience Alliance Young Scholars (RAYs) are also engaged in the Beijer Young Scholars (BYS) group. The journal *Ecology and Society* is owned by the Resilience Alliance, with Beijer Director Carl Folke as the editor-in-chief, together with Lance Gunderson.

www.resilience.org

RISE - Research Institutes of Sweden

RISE, the Swedish Research Institute, is an innovation partner in international collaboration with industry, academia and the public sector. RISE ensures the competitiveness of the business community and contributes to a sustainable society. It is an independent, state-owned research institute that advances research in a broad spectrum of areas. The food sustainability group of RISE has undertaken Life Cycle Assessment studies of foods since the early 1990s and was a pioneer in this now rapidly expanding research field. Through a long-term



Workshop at the SARAS institute.

FORMAS project, the Beijer Institute has established formal collaboration with the seafood group at RISE, which is an internationally highly recognised research group in the field. Main collaborators include Max Troell, Therese Lindahl, Patrik Henriksson and Malin Jonell representing the Beijer Institute and SRC. The collective expertise also involves international collaborators adding insights to the role and challenges related to the future of global seafood.

SARAS - The South American Institute for Resilience and Sustainability Studies

The Beijer Institute has been engaged since 2007 in the South American Institute for Resilience and Sustainability Studies (SARAS). SARAS is an interdisciplinary research institute based in Maldonado, Uruguay, and is intended 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. Beijer fellows Marten Scheffer, Steve Carpenter, Frances Westley and Carl Folke have been deeply engaged with SARAS over the years and, more recently, Juan Carlos Rocha and Henrik Österblom from SRC.

www.saras-institute.org

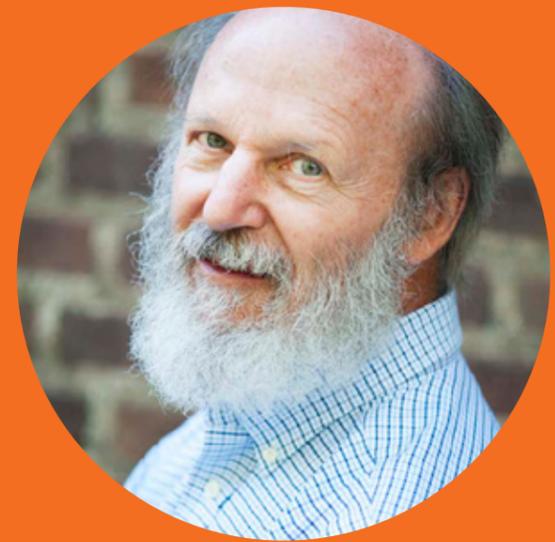


Tilapia fingerling production in Zambia supported by WorldFish. Photo: WorldFish

WorldFish

WorldFish is an integral part of the Consultative Group on International Agricultural Research (CGIAR). It is an international, non-profit, scientific research centre created to conduct, stimulate and accelerate research on fisheries, aquaculture and other living aquatic resources for sustainable benefits of the present and future generations of low-income users in developing countries. WorldFish was early to pick up on the contemporary resilience research and builds its research and actions in poor and vulnerable communities upon it. During the past 10 years, the mode of cooperation between the Beijer Institute and WorldFish has developed from mainly informal partnerships to collaborative research projects. One project investigating equitable development of aquaculture in East Africa is led by Max Troell. Formal support from WorldFish also includes supporting activities within the Beijer Institute programme on sustainable seafood, as well as co-funding a post-doc (Patrik Henriksson) over multiple years.

www.worldfishcenter.org



Reflections of a retiring board member

I have thoroughly enjoyed being a member of the Beijer family during my time on the Board. Through the Institute, I have met some of my closest friends and come to accept as essential features of science some of the Beijer customs and habits that I seldom see in other places. The Beijer Institute takes on some of the toughest problems faced by society and approaches them with the optimism that solutions can be found. Despite the seriousness of the problems addressed, this search for new perspectives is often joyful and humorous because we have to laugh at ourselves as we dive into inevitable blind alleys, and feel exhilarated when a new potential path forward emerges. This helps avoid being overwhelmed by the magnitude of the world's problems.

The Beijer Institute has greatly expanded my horizons of what constitutes legitimate science. From the beginning, it ignored the traditional subdivision of science into disciplines or separation into basic and applied science. Given the Institute's social-ecological emphasis, the role of advocacy, politics, perceptions, power, and persuasion in science are legitimate and fundamental issues of scientific inquiry, rather than

something to shy away from.

Interdisciplinarity as practised by the Beijer Institute is different to that I've found elsewhere. It is not the interdisciplinarity of painful communication contaminated by ornate vocabulary or distrust of other disciplines, but a shared curiosity about how the world works or how it might transform to work differently in the future. This curiosity invites unfettered speculation about things we don't know, but are important. Each person is both a beginner and an expert, so uninformed and unexpected questions are legitimate.

I also admire the classlessness of the Beijer Institute. Ideas offered by graduate students and young scholars have just as much standing as those of senior scientists. In fact, conversations with graduate students are often particularly helpful in getting up to speed on unfamiliar topics.

Highlights of my 2006 sabbatical at the Beijer Institute included Karl-Göran Mäler's patience with me when I first dipped into ecological economics, Carl Folke's exuberance as we tinkered with potential diagrams of social and institutional transformation, and Christina Leijonhufvud's gentle questions about how life was going. Their personal and intellectual generosity is typical of the interactions I've come to appreciate at the Beijer Institute.

Science here is spectacular and spectacularly fun! Not to mention meals together, conversations on the boat, music and art, all mixed together in an unimaginable soufflé.

Stuart "Terry" Chapin



Marten Scheffer and Terry Chapin on the boat to Askö.



The Beijer Institute board: Back-row: Jeroen van den Bergh, Carl Folke, Jason Shogren, Elena Bennett, Jim Wilen, Kathleen Segerson, Anne-Sophie Crépin, Terry Chapin, Marty Anderies. Sitting: Eric Lambin, Karine Nyborg, Neil Adger, Joern Fischer. Photo: Cecilia Nordstrand

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 may 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 current Beijer Institute was elected on 5 June 1991. The 27th annual board meeting was held at the Royal Swedish Academy of Sciences on 15 September 2017.

At this meeting, Professors Karine Nyborg, Stuart "Terry" Chapin and Eric Lambin reached the end of their term. The Beijer Institute wishes to express its warmest gratitude for their great efforts for the Institute over the years.

This meeting was the first for Associate Professor Elena Bennett, McGill University, USA, Professor Joern Fischer, Leuphana University, Germany, and Professor Kathleen Segerson, University of Connecticut, USA, who were welcomed as new members of the board.

STAFF NEWS

Carl Folke

During the past year, Carl Folke received several distinguished awards and recognitions for his work.

First, on 19 October 2017, he was awarded the 2017 Gunnerus Award in Sustainability Science for his outstanding scientific work to promote sustainable development globally. Part of the motivation reads:

"Carl Folke's research quality and quantity is outstanding. He has made substantial contributions to sustainability science and is internationally viewed as one of the most important individuals in forming this new field of research. In particular, he has been extreme-

ly influential in stimulating research into complex social-ecological systems and a pioneer in bringing social sciences, economics and natural science into a fruitful dialogue and interaction addressing the important sustainability challenges facing society."

The Royal Norwegian Society of Sciences and Letters (DKNVS) and Norwegian University of Science and Technology (NTNU) established the international Gunnerus Sustainability Award, which confers a prize of NOK 1 million (approximately USD 190,000), plus a gold medal and diploma. The award honours outstanding scientific work for sustainable development globally and aims to promote research and strengthen the scientific basis of sustainability.

Furthermore, within a few months, Carl Folke was awarded two honorary doctorates from distinguished universities.

In December 2017, he received an honorary doctorate of science from Michigan State University, motivated thus in the words of its President, Lou Anna K. Simon: *"In an extraordinary career dedicated to addressing some of the most challenging problems facing the world today, you have displayed a steadfast commitment to our understanding of the environment and to enhancing our abilities to live in a more sustainable manner. Your effective leadership, which has shaped the field of environmental science, is an excellent example for the MSU community of a career dedicated to advancing the common good in uncommon ways."*

In connection with the doctorate, Carl Folke delivered the 2017 lecture in the Rachel Carson Distinguished Lecture Series, a platform for prominent scientists and scholars to share their ideas about global challenges and opportunities.

To mark its 100-year anniversary in March 2018, Wageningen University awarded honorary doctorates to four leading scientists

Board of Directors

CHAIR

Karine Nyborg
Professor, University of Oslo, Norway

EX-OFFICIO MEMBERS:

Carl Folke*
Director, the Beijer Institute, Sweden

Göran K. Hansson*
Professor, Permanent Secretary of the Royal Swedish Academy of Sciences, Sweden

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

MEMBERS

Neil Adger
Professor, University of Exeter, UK

J. Marty Anderies
Professor, Arizona State University, USA

Elena Bennett
Associate Professor, McGill University, Canada

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

Joern Fischer
Professor, Leuphana University, Germany

Eric Lambin
Professor, University of Louvain, Belgium, and Stanford University, USA

Kathleen Segerson
Professor, University of Connecticut, USA

Jason Shogren*
Professor, University of Wyoming, USA

Jeroen van den Bergh
Professor, Universitat Autònoma de Barcelona, Spain

James Wilen
Professor, University of California, Davis, USA

**Member of the Royal Swedish Academy of Sciences*

from England, Sweden, the USA and China. These honorary doctorates recognise the researchers' contributions to science and society in core sectors for the University: healthy food and a healthy living environment. Apart from Carl Folke, honorary titles were also awarded to Professors Katrina Brown, Eugene Koonin and Fusuo Zhang.



Carl Folke receiving an honorary doctorate from Wageningen University, the Netherlands, from its rector Arthur Mol (left). Beijer Fellow Marten Scheffer (right) was the supervisor of the honorary doctorate.

Beijer Fellow Marten Scheffer, Professor of Aquatic Ecology and Water Quality Management at Wageningen University, was the supervisor of Carl Folke's honorary doctorate, which was awarded *"in recognition of his seminal work on social-ecological systems and resilience."* The motivation continued: *"Prof. Folke has been described as an exceptionally effective and innovative leader. His tireless efforts have helped make 'resilience' and 'ecological footprint' widely renowned themes in both the academic world and wider society. His work bridges the gap between ecology and social sciences."*

Finally, on 12 June Carl Folke was awarded HM The King's Medal 8th size with the ribbon of the Order of the Seraphim *"for outstanding contributions within natural resource management."* He received the medal from the King during a ceremony in the Hall of State at Drottningholm Palace.

HM The King's Medal was instituted around 1814, and is awarded in a number of different sizes. It is awarded to Swedish and foreign citizens for exceptional contributions.

Matteo Giusti

On completing his PhD studies at Stockholm Resilience Centre, co-funded by the Beijer Institute, on 22 March, 2018, Matteo Giusti successfully defended his thesis entitled *Home for Future Earth Lovers: Foundations of Nature-connecting Habitats for Children*. His main supervisor was former Beijer researcher Stephan Barthel, now at Stockholm Resilience Centre and University of Gävle, Sweden. In his thesis, which includes five individual papers, Matteo re-

searches the foundations of habitats that can connect children to nature, which he calls *nature-connecting habitats*. Building on games played with pre-school children, the first paper shows that children who have spent more time in nature are better equipped to feel empathy with living creatures, have a better ability to link ecological resources with products that they use in their daily life and are better at identifying polluted environments as something negative and "clean" nature as a good thing. Based on interviews and observations of schoolchildren while helping rescuing salamanders, the second paper shows that involving young children in authentic nature stewardship actions, as an activity at school, may be a promising way to counteract any weakening connection to nature. The third paper provides a first systematic review of empirical research on human-nature connections, assessing the diversity of subjects, methods and motivations in this research. Building on this review, in the fourth paper Matteo and colleagues developed a framework to help schools, parks and various organisations assess whether an environment connects children to nature or not. The framework, which has implications for the practice of sustainable urban design and environmental education, uses 16 qualities that constitute a "significant nature situation", including "entertainment", "surprise", "creative expression", "intimacy" and "engagement of senses". Finally, the fifth paper investigates how cultural ecosystem services are co-produced by humans and nature.

BEIJER FELLOW PRIZES, HONOURS AND AWARDS

Brian Walker

has been awarded the Blue Planet Prize 2018 (with Malin Falkenmark) which is awarded for "outstanding achievements in scientific research and in so doing help to solve global environmental problems. Brian Walker's *"ideas have exerted a significant influence as resilience has been introduced as a fundamental concept and developed in many fields, including environmental conservation, economics, protection, sustainable development and disaster prevention policy"*, reads part of the motivation which ends: *"He has produced significant achievements as a pioneer of resilience science and has had an enormous impact on society."*

Anastasios Xepapadeas

has been elected foreign member of the US National Academy 2018.

Terry Hughes

has been honoured by the Prince Albert II of Monaco Foundation with the 2018 Climate Change Award, recognizing his contribution to *"advancing understanding of the influence of rapid climate change on the world's coral reefs."*

Aart de Zeeuw

has been given the 2018 EAERE lifetime achievement award. The Award recognizes those who have *"devoted themselves productively and persistently to communicating and enriching our endowment of knowledge in environmental economics."*

Visiting Scientists

Alon Shepon

Weizmann Institute of Science, Israel, 8-27 August, 2017

Stephen Polasky

University of Minnesota, USA, 9 September-19 December, 2017, 4-25 April, 2018

Herbert Ntuli

University of Cape Town, South Africa, 22 September-8 December, 2017

Yana Jin

Peking University, China, 22 May-13 July, 2018

Gretchen Daily

Stanford University, USA, 11-27 June, 2018



Beijer and GEDB staff at Bonnier's Art Museum, Stockholm in March 2018.

Staff Members

Carl Folke

Professor, Director

Anne-Sophie Crépin

PhD, Deputy Director

Johan Colding

Associate professor, Researcher, Programme Director

Gustav Engström

PhD, Researcher

Åsa Gren

PhD, Researcher

Chandra Kiran Krishnamurthy

PhD, Researcher

Sofia-Kristin Kokinelis

MSc, Finance and HR Administrator

Christina Leijonhufvud

BA, Chief Administrator

Therese Lindahl

PhD, Researcher, Programme Director

Daniel Ospina

PhD Candidate

Juan-Carlos Rocha

PhD, Researcher

Caroline Schill

PhD, Researcher

Agneta Sundin

Communications Officer

Max Troell

Associate Professor, Researcher, Programme Director

Affiliated Researchers

J. Marty Anderies

Professor, Programme Director (Arizona State University, USA)

Chuan Zhong Li,

Professor, Programme Director (Uppsala University, Sweden)

Victor Galáz

Associate Professor, Programme Director (Stockholm Resilience Centre, Sweden)

Patrik Henriksson

PhD, Researcher (Stockholm Resilience Centre, Sweden and Wiomsa) >>

Malin Jonell

PhD, Researcher (Stockholm Resilience Centre, Sweden)

Internships

Ola Nilsson

Master's student, Uppsala University

Mimi Diego Nou

Master's student, Stockholm Resilience Centre

Rebecka Johansson

Bachelor's student, Karolinska Institute

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 Royal 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.



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 Sciences. 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 2017 and 30 June 2018 was also provided by:

- » Chalmers University of Technology (Department of Architecture).
- » Stockholm County Council (Stockholms läns landsting).
- » Swedish Research Council (Vetenskapsrådet).
- » The Crafoord Foundation.
- » The Ragnar Söderberg Foundation.
- » The Swedish International Development Cooperation Agency, Sida (Swedbio programme).
- » The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, FORMAS.
- » Western Indian Ocean Marine Science Association, WIOMSA.

TEACHING & TRAINING

In addition to the courses organised by the Beijer Institute listed below, several institute researchers lectures on courses given by other institutions (see under individual researchers) and act as supervisors for graduate and undergraduate students.

Governance and management of social-ecological systems: Challenges of economic decision making – Master's course

Beijer Institute researchers organise and teach the course *Governance and management of social-ecological systems: Challenges of economic 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 in the section 'Education' in this report.

Short courses on economics and the environment

Biannually, the Institute organises a two-day course just before the World Congress of Environmental and Resource Economists (WCERE) or the annual meeting of the European Association of Environmental and Resource Economists (EAERE) intended for researcher from developing countries. Read more in the section 'Education' in this report.

Supervising

- » PhD candidate Elizabeth (Liz) Drury O'Neill, Stockholm Resilience Centre, Stockholm University, Sweden (Therese Lindahl).
- » PhD candidate Lina Isacs (Division of Environmental Strategies Research,

Royal Institute of Technology, Sweden (Therese Lindahl).

- » PhD candidate Noah Linder, Environmental Psychology, Department of Building, Energy and Environmental Engineering, University of Gävle, Sweden (Therese Lindahl).
- » PhD candidate Muhammed A. Oyinlola, University of British Columbia, Canada (Max Troell).
- » Master's student Ola Nilsson, Uppsala University, Sweden. Thesis (2018): Adding Sustainability to Salmon Farming Regulation: A Comparative Case Study of Salmon Farming Regulations and the ASC Salmon Standard. A Summary.
- » Bachelor's student Jeffrey Clark, Stockholm School of Economics, Sweden (Therese Lindahl and Caroline Schill).
- » Bachelor's student Marcus Goni, Stockholm School of Economics, Sweden (Therese Lindahl and Caroline Schill).

SEMINAR & WORKSHOP SERIES

The Stockholm Seminars: Frontiers in Sustainability Science and Policy

The Stockholm Seminars are arranged by Albaeco, the Beijer Institute, Future Earth and Stockholm Resilience Centre. 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 (occasionally at Stockholm Resilience Centre) and are attended by an audience including scientists, students, media and policymakers in the public and private sector.



Askö meeting 2017. Back-row: Gretchen Daily, Scott Barrett, Daniel Ospina, Joern Fischer, Thomas Elmqvist, Jason Shogren, Simon Levin, Paul Ehrlich, Carl Folke, Neil Adger, Nils Kautsky, Lena Kautsky, Agneta Sundin. Front-row: Terry Chapin, Kathleen Segerson, Marty Anderies, Jim Wilen, Karine Nyborg, Brian Walker, Anne-Sophie Crépin, Jeroen van den Bergh, Elena Bennett, Beatrice Crona, Karen Seto. Sitting: Sofia Käll, Christina Leijonhufvud.

Between July 2017 and June 2018, the following seminars were held:

2017

- » 18 September: Prof. Jason Shogren. *Commitment to the public good.*
- » 4 October: Kate Raworth. *Doughnut economics – seven ways to think like a 21st century economist.*
- » 12 October: Dr. Morgan Grove. *The Legacy Effect: How segregation and environmental injustice unfold over time in Baltimore.*
- » 20 October: Prof. John Knox. *Human rights, climate change and biodiversity.*

2018

- » 21 February: Prof. Kristina Gjerde. *Unfinished business of UNCLOS: Marine biodiversity beyond national boundaries.*
- » 16 March: Prof. Karen O'Brien. *Taking climate change seriously: From adaptation to transformation.*
- » 21 March: Prof. Emerita Louise Chawla. *Engaging children and youth as agents for sustainability.*
- » 4 June: Assoc. Prof. Örjan Bodin. *Collaboration in social-ecological systems: Talk or action?*
- » 19 June: Dr. Ross A. Hammond. *Promoting human and environmental health by tailoring evidence-based action to local context.*

Brown Bag Lunch Seminars

The Brown Bag Lunch Seminars are a joint initiative between the Beijer Institute, Stockholm Resilience Centre and Albaeco, and are held at Stockholm Resilience Cen-

tre. The seminars aim to provide a platform for staff, students and visitors at the institutions that together form Stockholm Resilience Centre to share their work in an informal manner with ample time for discussion.

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 2017 was *Migration, Urbanisation and the Anthropocene*.



STAFF MEMBER PUBLICATIONS AND ACTIVITIES

All portraits by Cecilia Nordstrand, except Chandra Kiran Krishnamurthy (by Agneta Sundin).



Johan Colding
Associate Professor,
Programme Director

Research focus

Urban social-ecological systems.

Publications during the period

- » Colding, J. and S. Barthel. 2017. An urban ecology critique on the "Smart City" model. *Journal of Cleaner Production* 164:95-101.
- » Colding, J. and S. Barthel. 2017. The role of university campuses in reconnecting humans to the biosphere. *Sustainability* 9:2349.
- » Colding, J. and S. Barthel. 2017. Resilience and sustainable development. In: Schewenius, M., P. Keränen and R. Rawaf (eds.). *Dreams and Seeds – The Role of Campuses in Sustainable Urban*

Development. TMG, Stockholm, Sweden. pp. 28-29.

- » Colding, J., M. Colding and S. Barthel. 2018. The smart city model: A new panacea for urban sustainability or unmanageable complexity? *Environment and Planning B: Urban Analytics and City Science*. First online. 10.1177/2399808318763164.
- » Schewenius, M., J. Colding and S. Barthel. 2017. Social-ecological, integrated planning and design. In: Schewenius, M., P. Keränen and R. Rawaf (eds.). *Dreams and Seeds – The Role of Campuses in Sustainable Urban Development*. TMG, Stockholm, Sweden. pp. 47-49.

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience Frontiers for Global Sustainability, Stockholm, August 2017. Speaker: *An urban ecology critique on the Smart City model*. Chair of poster tour: *Quantitative data analysis: Approaches and methods for understanding social-ecological system dynamics*. Chair of session: *Ecosystem services mapping, trade-offs and synergies: Approaches and methods for understanding social-ecological system dynamics*.
- » Live Baltic Conference and Partner Meeting, University of Latvia and Riga Technical University, Riga, Latvia, October 2017. Participant.
- » Live Baltic Conference and Partner Meeting, Stockholm Resilience Centre, December 2017. Co-organiser.
- » Conference: Consuming the Environment, Gävle University College, December 2017. Speaker: *Reconnecting to the biosphere through urban green commons*.
- » Workshop: HiG Urban Studio – first research meeting, Gävle University College, April 2018. Co-organiser: *An interdisciplinary research programme on urban sustainability*.
- » SMoG Day – conference on urban planning, Chalmers University of Technology, Gothenburg, Sweden, April 2018. Participant.
- » Seminar for planning students from Gävle University College, Stockholm Resilience Centre, May 2018. Speaker: *The Stockholm Urban Assessment (SUA) 2003-2005*.
- » Cognitive Resilience Building seminar, Gävle University College, May 2018. Co-organiser.
- » Conference: Managing Complexity: Addressing Societal Security Challenges in the Baltic Sea Region, Stockholm International Peace Research Institute

(SIPRI), and the Government Offices of Sweden (Ministry for Foreign Affairs), Fotografiska, Stockholm, June 2018. Invited participant.

Teaching and training

- » Lecturer, undergraduate course *Miljöns påverkan på människan (The human dimension of the environment)*, Gävle University College, autumn 2017.
- » Lecturer, Master's level course *Urban social-ecological systems*, Stockholm Resilience Centre, Stockholm University, spring 2018.

Commissions

- » Member of examination committee for licentiate for PhD student Megan Meachan (Stockholm Resilience Centre, Stockholm University), October 2017.
- » Member of the Campus Albano Reference Group (Akademiska Hus and Svenska Bostäder), as representative for Stockholm Resilience Centre.
- » Member of the Scandinavian Turfgrass Research Foundation (STERF).
- » Member of the research consortium "Social-Ecological Urbanism", Stockholm Resilience Centre, the Beijer Institute, Royal Institute of Technology (Stockholm), Chalmers University of Technology (Gothenburg), Gävle University College (Gävle).
- » Reviewer for *Ecology and Society*.

Other

- » Member of Live Baltic Campus network group.
- » Popular science communications: The smart (Cyborg) city needs smarter ecological resilience thinking. Barthel, S. and J. Colding. *The Nature of Cities* blog, 2 July 2017.



Anne-Sophie Crépin
Associate Professor,
Deputy Director

Research focus:

Modelling social-ecological systems, regime shifts and economics, risk modelling, global dynamics and resilience, complex system approach on the Arctic Ocean, behavioural responses to regime shifts.

Publications during the period

- » Crépin, A.-S., M. Karcher and J.-C. Gascard. 2017. Arctic Climate Change, Economy and Society (ACCESS): Integrated perspectives. *Ambio* 46, Supplement 3:341-354.

- » Crépin, A.-S., Å. Gren, G. Engström and D. Ospina. 2017. Operationalising a social-ecological system perspective on the Arctic Ocean. *Ambio* 46, Supplement 3:475-485.
- » Gascard, J.-C., A.-S. Crépin, M. Karcher and O.R. Young. 2017. Facets of Arctic change. *Ambio* 46, Supplement 3:339-340.
- » Li, C.Z., A.-S. Crépin and C. Folke. 2018. The economics of resilience. *International Review of Environmental and Resource Economics*. In press.
- » Peterson, G.D. Biggs, R., Crépin A.-S. and V. Galaz. 2017. Beijer Discussion Paper 260: Addressing pathological dynamics of global environmental problems. *Beijer Discussion Paper Series*.
- » Turesson A., A.-S. Crépin, G. Finnveden, M. Hennlock, L. Neij, M. Nilsson, G. Engström and L. Berg. 2018. *Möjligheter och begränsningar med samhällsekonomiska analyser* (Opportunities and limitations of cost-benefit analyses). Vetenskapliga Rådet för Hållbar Utveckling (The Swedish Scientific Council for Sustainable Development).
- » Troell, M., A. Eide, J. Isaksen, Ø. Hermansen and A.-S. Crépin. 2017. Seafood from a changing Arctic. *Ambio* 46: Supplement 3: 368-386.

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience Frontiers for Global Sustainability, Stockholm, August 2017. Invited presentation: *Economic principles for building Resilience*.
- » Askö 2017 meeting: Migration, Urbanisation and the Anthropocene, Askö and the Royal Swedish Academy of Sciences, September 2017. Participant.
- » 19th annual BIOECON conference: Evidence-based Environmental Policies and Optimal Management of Natural Resources, Tilburg University, Tilburg, The Netherlands, September 2017. Invited plenary panel presentation: *Regime shifts and common property: the challenges* and presentation: *Remittances can reduce the potential for forest transitions*.
- » Workshop: Marine ecological-economic systems: Shifting the baseline to a regime of sustainability, Tilburg University, Tilburg, The Netherlands, September 2017. Invited plenary workshop presentation: *Operationalising a social-ecological systems perspective on the Arctic Ocean*.

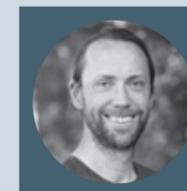
- » Beijer foundation meeting, Uppsala, Sweden, January 2018. Presentation: *Operationalising a social-ecological systems perspective on the Arctic Ocean*.
- » Symposium on scenarios for a warmer Arctic, the Royal Swedish Academy of Sciences, February 2018. Organiser, panel participant and presentation: *A holistic approach to Arctic management*.
- » Seminar, Paris School of Economics, Paris, France, February 2018. Invited presentation: *Inertia risk; improving economic models of catastrophes*.
- » Workshop: Governance and Complexity, the Beijer Institute and the Royal Swedish Academy of Sciences, April 2018. Presentation: *Complexity economics*.
- » Workshop: Political Economics and the Environment, Department of Economics, Oslo University, Oslo, Norway, April 2018. Discussant: *Mirage on the horizon: Geoenvironment and carbon taxation without commitment* by D. Acemoglu and W. Rafey.
- » Beijer Young Scholars workshop: Inequality and the Biosphere, the Royal Swedish Academy of Sciences and Eskäret, May 2018. Resource person.
- » Behaviour, Economics, and Nature Network (BENN) workshop, the Royal Swedish Academy of Sciences, May 2018. Participant.
- » Workshop: Social Tipping Elements Decisive for the Future of the Anthropocene, GESIS Leibniz Institute for the Social Sciences, Cologne, Germany, June 2018. Invited participant.
- » 6th World Congress of Environmental and Resource Economists, Gothenburg, Sweden, June 2018. Presentation: *Economics, resilience and complexity in the thematic session Perspectives on Policies for the Anthropocene*.

Teaching and training

- » Lecturer and examiner, Master's level course *Governance and management of social-ecological systems: Challenges of environmental decision-making*, Stockholm Resilience Centre, Stockholm University, spring 2017.
- » Course organiser and lecturer, summer course *Spatial analysis in economics and the environment*, pre-conference event to 6th World Congress of Environmental and Resource Economists, Gothenburg, Sweden, June 2018.
- » Co-supervisor of PhD candidate Daniel Ospina (Beijer Institute and Stockholm Resilience Centre, Stockholm University).
- » Main supervisor of Mäler scholar (post-doc) Herbert Ntuli.

Commissions

- » Committee member for the PhD thesis defence of L. Jamila Haider with title: *Development and Resilience – Re-thinking Poverty and Intervention in Biocultural Landscapes*, Stockholm Resilience Centre, Stockholm University, Sweden, 29 September 2017.
- » Committee member for the PhD thesis defence of Anne-Sophie Lafuite with title: *Biodiversity Feedbacks and the Sustainability of Social-ecological Systems*, Toulouse University, Toulouse, France, 20 November 2017.
- » Member of the Environmental Research Council of the Swedish Environmental Protection Agency (Miljöforskningsrådet för naturvårdsverket) since 2018.
- » Member of advisory board of the Global Challenges Initiative, Stockholm School of Economics, Stockholm, Sweden, since 2016.
- » Member of the Strategic Advisory Committee at Stockholm Resilience Centre, Stockholm University, Sweden since 2016.
- » Member of the Strategic Advisory Committee for Johan Rockström's European Research Council Advanced Grant Project "Earth Resilience in the Anthropocene", Stockholm Resilience Centre, Stockholm University, since 2017.
- » Reviewer for the 2018 World Congress for Environmental and Resource Economists (WCERE2018), held in June 2018 in Gothenburg, Sweden.
- » Reviewer for *Ambio, Ecology and Society*, and *Nature Human Behaviour*.



Gustav Engström
PhD, Researcher

Research focus

Various economic aspects of global environmental change, in particular the economics of climate change and issues related to energy supply and tipping points in the climate system; urban economic and environment-related issues.

Publications during the period

- » Blind, I., M. Dahlberg, G. Engström and J. Östh. 2018. Construction of register-based commuting measures. *CESifo Economic Studies* 64(2):292-326.
- » Crépin, A.-S., Å. Gren, G. Engström and D. Ospina. 2017. Operationalising a so-

cial-ecological system perspective on the Arctic Ocean. *Ambio* 46, Supplement 3:475-485.

- » Engström, G., J. Gars, C. Kiran, R. Calel, T. Lindahl, B.G. Narayanan and D. Spiro. 2017. *Beijer Discussion Paper 261: The unintended consequences of a global carbon tax. Beijer Discussion Paper Series.*
- » Turesson A., A.-S. Crépin, G. Finnveden, M. Hennlock, L. Neij, M. Nilsson, G. Engström and L. Berg. 2018. *Möjligheter och begränsningar med samhällsekonomiska analyser (Opportunities and limitations of cost-benefit analyses).* Vetenskapliga Rådet för Hållbar Utveckling (The Swedish Scientific Council for Sustainable Development).

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience Frontiers for Global Sustainability, Stockholm, August 2017. Presentation: *Valuing ecological resilience in a complex systems context, using response diversity as a proxy.*
- » Workshop: The Economics of the Planetary Boundaries, the Royal Swedish Academy of Sciences, September 2017. Organiser.
- » 6th World Congress of Environmental and Resource Economists, Gothenburg, Sweden, June 2018. Session organiser: *Perspectives on Policies for the Anthropocene.*

Teaching and training

- » Course leader and lecturer, Master's level course *Governance and management of social-ecological systems: Challenges of environmental decision-making*, Stockholm Resilience Centre, Stockholm University, spring 2017.



Carl Folke
Professor, Director

Research focus

Social-ecological systems, resilience thinking, ecological economics, stewardship and transformation reconnecting development to the biosphere.

Publications during the period

- » Folke, C. 2017. The Biosphere Foundation and sustainability: A reflection. In: Kessler, E. and A. Karlqvist. (eds.). *Environmental Reality: Rethinking the Options*, The 12th Royal Colloquium,

Rosersberg's Palace, Sweden, May 23-25, 2016.

- » Gordon, L.J., V. Bignet, B. Crona, P.J. Henriksson, T. Van Holt, M. Jonell, T. Lindahl, M. Troell, S. Barthel, L. Deutsch, C. Folke, L.J. Haider, J. Rockström and C. Queiroz. 2017. Rewiring food systems to enhance human health and biosphere stewardship. *Environmental Research Letters* 12(10):100201.
- » Li, C.Z., A.-S. Crépin and C. Folke. 2018. The economics of resilience. *International Review of Environmental and Resource Economics*. In press.
- » Jørgensen, P.S, D. Wernli, C. Folke and S.C. Carroll. 2017. Changing antibiotic resistance: Sustainability transformation to a pro-microbial planet. *Current Opinion in Environmental Sustainability* 25:66-76.
- » Österblom, H., C. Folke, J.-B. Jouffray and J. Rockström. 2017. Emergence of a global science-business initiative for ocean stewardship. *Proceedings of the National Academy of Sciences, USA* 114:9038-9043.

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience Frontiers for Global Sustainability, Stockholm, August 2017. Opening keynote lecture.
- » Young resilience researcher day, Stockholm Resilience Centre, August 2017. Opening talk.
- » Space talk and concert, Stockholm Act, Kulturhuset, Stockholm, August 2017. Panel participant.
- » Presentations of the exhibition Reflections, Resilience 2017 conference, Stockholm, August 2017.
- » International Advisory Board meeting, Stockholm Resilience Centre, Rosenön, Sweden, August 2017.
- » HM the King's Royal Colloquium Jubilee, Confidencen (Ulriksdal Palace Theatre), Stockholm, September 2017. Participant.
- » Visit by Luxembourg Ministry of the Environment hosted by Anders Wall, Stockholm, September 2017. Presentation.
- » Global Resilience Partnership Council Meeting, Sigtuna, Sweden, September 2017. Participant.
- » Presentation of the Beijer Institute and its research for the Biology Class (VI), the Royal Swedish Academy of Sciences, September 2017.
- » Askö 2017 meeting: Migration, Urbanisation and the Anthropocene, Askö and the Royal Swedish Academy of Sciences, September 2017. Participant.

» Meeting: Connecting and Protecting Our Seas, Monaco, October 2017. Co-organiser and summary presentation.

- » The Gunnerus Sustainability Science Award 2017, Sustainability Science Conference, Norwegian University of Science and Technology (NTNU), Trondheim, Norway, October 2017. Award speeches and plenary award lecture.
- » Scientific advisory committee meeting, SIGHT (Swedish Institute for Global Health Transformation), the Royal Swedish Academy of Sciences, November 2017. Participant.
- » Seminar: The Global Ocean and the Future of Humanity, in honour of Prof. Rashid Sumaila, the Royal Swedish Academy of Sciences, November 2017. Presentation.
- » Rachel Carson Honorary Lecture, Michigan State University, USA, December 2017. Invited honorary lecture.
- » Next Generation Wallenberg meeting, The Wallenberg Foundation, Stockholm, December, 2017. Presentation.
- » Transformation exhibition (a collaboration between Svenskt Tenn, the Beckman College of Design and the Beijer Institute) Svenskt Tenn, Stockholm, January 2018. Opening speech.
- » Copernicus Institute of Sustainable Development, Utrecht University, The Netherlands, January 2018. Invited lecturer.
- » Opening of the Centre for Complex Systems Studies, Utrecht University, The Netherlands, January 2018. Inauguration keynote speaker.
- » Mini-symposium to honour Prof. Gene Likens, Uppsala University, Uppsala, Sweden, January 2018. Invited speaker.
- » Presentation for the Ragnar Söderberg's Foundation, January 2018.
- » The Beijer Foundation's workshop of research groups, Biomedical Centre, Uppsala University, Uppsala, Sweden, January 2018.
- » Workshop: Towards a Mechanism-based Approach in Sustainability Science, Institute for Analytical Sociology and Stockholm Resilience Centre, Stockholm, February 2018. Participant.
- » Half-day seminar: Brunnsviken, the Baltic Sea and the Oceans, with HRH Crown Princess Victoria, SRC, February 2018. Participant.
- » Workshop: Gender and Power, Stockholm Resilience Centre, February 2018. Participant.
- » Master class lecture: 100 years Dies Natalis celebration of Wageningen University, the Netherlands, March 2018. Honorary doctorate lecture.

» Global Resilience Partnership Council meeting, the Hague, the Netherlands, March 2018. Participant.

- » Workshop: Governance and Complexity, the Beijer Institute and the Royal Swedish Academy of Sciences, April 2018. Co-organiser and presentation.
- » Workshop: Anthropocene Ocean, Waxholm, Sweden, April 2018. Participant.
- » Princeton University, Department of Ecology & Evolutionary Biology, April 2018. Invited lecture.
- » Inaugural meeting as Foreign Fellow, National Academy of Sciences, Washington, USA, April 2018. Participant.
- » The Amersfoort dialogue: Advancing the Seafood Business for Ocean Stewardship Initiative, SeaBOS (Seafood Business for Ocean Stewardship), Nutreco, Amersfoort, The Netherlands, May 2018. Presentation.
- » Beijer Young Scholars Workshop on Inequality and the Biosphere, the Royal Swedish Academy of Sciences, May 2018. Welcome presentation and discussion.
- » Svenskt Tenn in Helsinki, presenting the Beijer Institute, May 2018.
- » Behaviour, Economics and Nature Network (BENN) workshop, the Royal Swedish Academy of Sciences, May 2018. Presentation.
- » Aquavision, World Business Conference on Aquaculture, Stavanger, Norway, June 2018. Presentation of SeaBOS (Seafood Business for Ocean Stewardship).
- » Workshop: Ocean Stewardship, the Royal Swedish Academy of Sciences, June 2018. Opening talk.

Teaching and training

- » Lecturer for undergraduate courses at Stockholm University.
- » Lecturer, Massive Open Online Course (MOOC) *Transforming development: The science and practice of resilience thinking*, Stockholm Resilience Centre, Stockholm University, spring 2018.

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*, the Royal Swedish Academy of Sciences since 2012.
- » Co-director (with Beatrice Crona) of the Erling-Persson Family Academy Programme, *New Approaches to the Grand Challenge: Global Finance, Global Health and the Biosphere*, the Royal Swedish Academy of Sciences.

» Principal investigator (with Gretchen Daily, Stanford University) of the research collaboration programme *Fundamental Research in Biosphere-based Sustainability Science*, Stockholm University, funded by the Marianne and Marcus Wallenberg Foundation.

- » Principal investigator (with Gretchen Daily, Stanford University) for *Advancing Fundamental Knowledge of Natural Capital, Resilience and Biosphere Stewardship - a Research Exchange Programme between Stanford University and Stockholm Resilience Centre*, Stockholm University, funded by the Marianne and Marcus Wallenberg Foundation.
- » Member of the Royal Swedish Academy of Sciences, since 2002.
- » Member (Foreign) of the US National Academy of Sciences, since 2017.
- » 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, Global Sustainability, Resilience: International Policies, Practices and Discourses, Reviews in Ecological Economics, Sustainability, 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), South Africa, since 2014.
- » Senior Fellow of IHOPE (Integrated History and future of People on Earth), since 2015.
- » Member of the Academic Advisory Board of STIAS, Stellenbosch Institute for Advanced Study, South Africa, since 2018.
- » Scientific Advisory Committee of SIGHT (The Swedish Institute for Global Health Transformation), the Royal Swedish Academy of Sciences, since 2017.

» Member of International Scientific Advisory Board, Helsinki Institute of Sustainability Science, HELSUS, University of Helsinki, Finland, since 2018.

- » Board member of UNU Institute for the Advanced Study of Sustainability, Tokyo, Japan, since 2014.
- » 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 Yorke Society, since 1997.
- » Elected Member of the Royal Norwegian Society of Sciences and Letters (DKN-VS), Trondheim, Norway, since 2017.
- » Elected Member of the Royal Swedish Academy of Agriculture and Forestry (KSLA), since 2017.
- » Member of the Swedish National Committee for Global Environmental Change, since 2018.
- » Member of the Scientific Committee of the Resilience 2017 conference Resilience Frontiers for Global Sustainability, Stockholm.

Other

- » Gunnerus Award in Sustainability Science, the Royal Norwegian Society of Sciences and Letters and Norwegian University of Science and Technology, Trondheim, Norway, November 2017.
- » HM The King's Medal 8th size with the ribbon of the Order of the Seraphim, June 2018.
- » Lord-in-Waiting (Kabinettskamarherre), Swedish Royal Court, May 2018.
- » Honorary doctorate of science, Michigan State University, East Lansing, USA, December 2017.
- » Honorary doctorate, Wageningen University & Research, The Netherlands, on the occasion of the 100 anniversary celebration, Dies Natalis, March 2018.
- » Honorary Fellow, South American Institute for Resilience and Sustainability Studies (SARAS), Maldonado, Uruguay, March 2018.
- » Recognised as Highly Cited Researcher by Thompson Reuters 2017.



Åsa Gren
PhD, Researcher

Research focus

Creating resilient, sustainable and healthy urban areas by integrating ecosystem services into spatial urban planning and design, and by using the ecosystem service of pollination as an entry point for navigating climate change and urban expansion in cities and to combine urban expansion and sustainable food production in urban agricultural landscapes. Application of an ecosystem service lens for navigating different human health aspects in an urban planning and design context.

Publications during the period

- » Berghäuser-Pont, M., K. Ahrné, Å. Gren, A. Kaczorowska and L. Marcus. 2018. Integrating visibility graph analysis (Vga) with connectivity analysis in landscape ecology. *Proceedings of the 11th Space Syntax Symposium*, Lisbon, Portugal, #157.
- » Crépin A.-S., Å. Gren, G. Engström and D. Ospina. 2017. Operationalising a social-ecological system perspective on the Arctic Ocean. *Ambio* 46(3):475-485.
- » Gren, Å. and E. Andersson. 2018. Being efficient and green by rethinking the urban-rural divide—combining urban expansion and food production by integrating an ecosystem service perspective into urban planning. *Sustainable Cities and Society* 40:75-2.

Conferences, workshops and presentations

- » Urban workshop: Livable, sustainable and resilient cities, Natural Capital Project and Stockholm Resilience Centre, Stockholm Resilience Centre, October 2017. Participant.
- » Baltic Campus Conference, Stockholm Resilience Centre, December 2017. Participant.
- » The Bolin Centre workshop: Sustainable Development Goals and Climate Change, Stockholm University, February 2018. Participant.
- » Workshop: Framtidens Städer – hållbara städer (Future Cities – Sustainable Cities). Stockholm University, March 2018. Participant.
- » Presentation of Urban Resilience research for Stockholm County Council, November 2017.

Teaching and training

- » Lecturer, undergraduate level course *Världens Eko* (Consumption and urban ecosystems), Stockholm Resilience Centre, Stockholm University, autumn 2017.
- » Lecturer, *Sustainable urban planning and design*, School of Architecture, Royal Institute of Technology, Stockholm, April 2018.



Patrik Henriksson
PhD, Researcher

Research focus

Environmental assessments of aquaculture production chains, using life cycle assessments (LCAs) and other environmental proxies; exploring issues related to land-use change and antimicrobials.

Publications during the period

- » Avadí, A., P.J.G. Henriksson, I. Vázquez-Rowe and F. Ziegler. 2018. Towards improved practices in Life Cycle Assessment of seafood and other aquatic products. *The International Journal of Life Cycle Assessment* 23(5):979-981.
- » Gordon, L.J., V. Bignet, B. Crona, P.J. Henriksson, T. Van Holt, M. Jonell, T. Lindahl, M. Troell, S. Barthel, L. Deutsch, C. Folke, L.J. Haider, J. Rockström and C. Queiroz. 2017. Rewiring food systems to enhance human health and biosphere stewardship. *Environmental Research Letters* 12(10):100201.
- » Guinée, J.B., S. Cucurachi, P.J.G. Henriksson and R. Heijungs. 2018. Digesting the alphabet soup of LCA. *International Journal of Life Cycle Assessment* 23(7):1507-1511.
- » Henriksson, P.J.G., B. Belton, K.-M. Jahan and A. Rico. 2018. Measuring the potential for sustainable intensification of aquaculture in Bangladesh using life cycle assessment. *Proceedings of the National Academy of Sciences* 115(12):2958-2963.
- » Henriksson, P.J.G., N. Järviö, M. Jonell, J.B. Guinée and M. Troell. 2018. The devil is in the detail – the carbon footprint of a shrimp. *Frontiers in Ecology and the Environment* 16(1):10-11.
- » Henriksson, P.J.G., A. Rico, M. Troell, D.H. Klinger, A.H. Buschmann, S. Saksida, M.V. Chadag and W. Zhang. 2018. Unpacking factors influencing antimicrobial use in global aquaculture and their implication for management: A review from a

systems perspective. *Sustainability Science* 13(4):1105-1120.

- » Mendoza Beltran, A., V. Prado, D. Font Vivanco, P. J. G. Henriksson, J. B. Guinée and R. Heijungs. 2018. Quantified uncertainties in comparative Life Cycle Assessment: what can be concluded? *Environmental Science & Technology* 52(4):2152-2161.

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience Frontiers for Global Sustainability, Stockholm, August 2017. Co-organiser of session: *Inequality and the Biosphere: Exploring the interactions between the Biosphere and human well-being through the lens of inequality*.
- » Workshop: Doubling aquaculture production within the same environmental boundary, Penang, Malaysia. February 2018. Participant.
- » Beijer Young Scholars Workshop on Inequality and the Biosphere, the Royal Swedish Academy of Sciences and Ek-skäret, May 2018. Participant.

Commissions

- » Reviewer for *Aquaculture, The International Journal of Life Cycle Assessment, Journal of Cleaner Production, Environmental Science and Technology, Ambio and Climate and Development*.
- » Member of the Beijer Young Scholars network 2016-2018.

Other

- » WorldFish visiting scholar, Penang, Malaysia, January-May 2018.



Sofia Kristin Kokinelis
MSc, Finance and HR administrator

Sofia-Kristin has a Master of Science (MSc) degree in Business Administration and Economics from Stockholm University and works as Finance & HR administrator for both the Beijer Institute of Ecological Economics and the Global Economic Dynamics and the Biosphere Programme (GEDB) at the Royal Swedish Academy of Sciences.

More specifically, she works with accounting, financial reporting and budgeting. She also provides support and financial information to researchers about their projects and assists them with budgeting and financial reporting. In her role as HR administra-

tor, she also prepares staff contracts and assists staff members with different issues. Due to the research collaboration between the Beijer Institute and Stockholm Resilience Centre, her work tasks require close cooperation with the administration team at SRC.



Chandra Kiran Krishnamurthy
PhD, Researcher

Research focus

Economics of coupled human-natural systems; economics of electricity markets; urban transportation and pollution.

Publications during the period

- » Engström, G., J. Gars, C. Kiran, R. Calel, T. Lindahl, B.G. Narayanan and D. Spiro. 2017. *Beijer Discussion Paper 261: The unintended consequences of a global carbon tax. Beijer Discussion Paper Series*.

Conferences, workshops and presentations

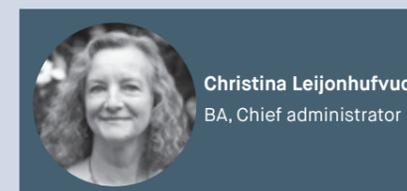
- » Conference: Bergen Economics of Energy and the Environment, The Norwegian School of Economics, 11-12 April, 2018. Presentation: *RTP Revisited: Demand flexibility, micro-generation and integration of renewables*.
- » Workshop: Present Energy Transitions: The multiple dimensions of energy scarcity and current risks. Oslo, Norway, 23-25 April, 2018. Presentation: *RTP Revisited: Demand flexibility, micro-generation and integration of renewables*.
- » 6th World Congress of Environmental and Resource Economists, Gothenburg, Sweden, June 2018. Session organiser: *Perspectives on Policies for the Anthropocene*. June 28, 2018. Session co-organiser and presenter: *The Unintended Consequences of a Global Carbon Tax*.

Teaching and training

- » Lecturer, PhD level course and workshop on *Behavioural Environmental Economics*, Department of Forest Economics, Swedish University of Agricultural Sciences, Umeå, Spring 2018.
- » Lecturer, Module on *Strategic Decision Making* in Master's level course on *Skogsindustriell försörjningsstrategi (Forest Industry Supply Strategy)*, Swedish University of Agricultural Sciences, Umeå, Autumn 2017.

Commissions

- » Reviewer for Resources and Energy Economics, *The Energy Journal, Journal of Forest Economics, and American Journal of Agricultural Economics*.



Christina Leijonhufvud
BA, Chief administrator

Christina was part of the organising team for Resilience 2017 in August 2017. She was responsible for administration of the Board and Askö meetings in September 2017. In April 2018, she organised the Governance and complexity workshop at the Royal Swedish Academy of Sciences, in May the Beijer Young Scholars Workshop at the Academy and on the island of Ekskäret, and in May/June the Behaviour, Economics and Nature Network (BENN) workshop at the Academy. She is responsible for the administration of guest research posts and deals with various office tasks.



Chuan-Zhong Li
Professor, Researcher

Research focus

Resilience research, climate change, energy economics, sustainability and welfare analysis.

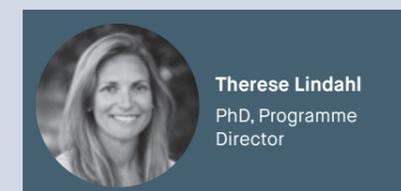
Publications during the period

- » Li, C.Z. 2018. *Beijer Discussion Paper 262: An explicit formula for optimal carbon taxes under general economic settings. Beijer Discussion Paper Series*.
- » Li, C.Z., A.-S. Crépin and C. Folke. 2018. The economics of resilience. *International Review of Environmental and Resource Economics*. In press.
- » Zhang, L., J. Chen, Q. Hao and C.Z. Li. 2017. Measuring the NIMBY effect in urban China: The case of waste transfer stations in the metropolis Shanghai. *Journal of Housing and the Built Environment* 3:1-18.

Conferences, workshops and presentations

- » CES (China Economists Association) Annual Conference, Nanjing, China, July 2017. Session organiser and presentation: *Income threshold, appliance owner-*

ship and household's energy consumption.



Therese Lindahl
PhD, Programme Director

Research focus

Human behaviour in social-ecological systems. In particular how ecosystem dynamics (e.g. threshold effects, uncertainty, variability, spatial dynamics) influence resource users' exploitation and cooperation behaviour and implications for natural resource management. Alternative approaches to environmental policies based on psychological insights.

Publications during the period

- » Engström, G., J. Gars, C. Kiran, R. Calel, T. Lindahl, B.G. Narayanan and D. Spiro. 2018. *Beijer Discussion Paper 261: The Unintended consequences of a global carbon tax. Beijer Discussion Paper Series*.
- » Gordon, L.J., V. Bignet, B. Crona, P.J. Henriksson, T. Van Holt, M. Jonell, T. Lindahl, M. Troell, S. Barthel, L. Deutsch, C. Folke, L.J. Haider, J. Rockström and C. Queiroz. 2017. Rewiring food systems to enhance human health and biosphere stewardship. *Environmental Research Letters* 12(10):100201.
- » Lindahl, T. and R. Jarungrattanapong. 2018. *Beijer Discussion Paper 263: Avoiding catastrophic collapse in small scale fisheries through inefficient cooperation: Evidence from a framed field experiment. Beijer Discussion Paper Series*.
- » Linder, N., T. Lindahl and S. Borgström. 2018. Using behavioural insights to promote food waste recycling in urban households – Evidence from a longitudinal field experiment. *Frontiers in Psychology* 9:352.

Reports

- » Lindahl, T. 2018. *Behavioural Experiments in Social-Ecological Systems with Tipping Points*. Scientific report to Formas, March.

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience Frontiers for Global Sustainability, Stockholm, August 2017. Chair and moderator of session: *Approaches theme plenary II: Novel methods for studying human behaviour and its interrelations with the*

environment. Presentation: *Cooperating efficiently, cautiously or not at all: How a potential resource collapse can influence exploitation behaviour in a Common Pool Resource dilemma*.

- » 19th annual BIOECON conference: Evidence-based Environmental Policies and the Optimal Management of Natural Resources, Tilburg University, Tilburg, The Netherlands, September 2017. Keynote speaker: *Collective action for avoiding tipping points: Insights from behavioural experiments*.
- » Workshop: Marine Ecological-Economic Systems - Shifting the Baseline to a Regime of Sustainability, Kiel University, September 2017. Keynote speaker: *Avoiding catastrophic resource collapse through inefficient cooperation: evidence from a framed field experiment*.
- » Nobel breakfast, seminar organised by Fores, Stockholm, December 2018. Invited speaker: *Thaler's contributions to behavioural economics - implications for environmental policy*.
- » ICA research day, ICA Gruppen, Solna, Stockholm, December 2017. Invited speaker: *Nudging for sustainability and health*.
- » Towards a mechanism-based approach in sustainability science, Institute for Analytical Sociology and Stockholm Resilience Centre workshop, Stockholm, February 2018. Participant.
- » Inspirational day at Lake Vänern Archipelago and Mount Kinnekulle UNESCO Biosphere reserve, Läckö Slott, Sweden, March 2018. Invited speaker: *Children and their contact with nature*.
- » Naturum Lecture Series, Naturum, Läckö Slott, Sweden, March 2018. Invited speaker: *Nature's influence on your mental health*.
- » IASC (International Association for the Study of the Commons) workshop: Working Together on the Commons, Center for Behavior, Institutions and the Environment, Arizona State University, Tempe, Arizona, USA, March 2018. Participant.
- » Workshop: Governance and Complexity, the Beijer Institute and the Royal Swedish Academy of Sciences, April 2018. Participant and moderator of session.
- » Behaviour, Economics and Nature Network (BENN) workshop, the Royal Swedish Academy of Sciences, May 2018. Organiser.
- » 6th World Congress of Environmental and Resource Economists, Gothenburg, Sweden, June 2018. Participant.

Teaching and training

- » Lecturer, undergraduate level course Global challenges: *Water - a common and scarce resource*, Stockholm School of Economics, autumn 2017.
- » Lecturer and examiner, Master's level course *Governance and management of social-ecological systems: Challenges of environmental decision-making*, Stockholm Resilience Centre, Stockholm University, spring 2017.
- » Lecturer, undergraduate course *Ekologisk ekonomi (Ecological economics)*, Department of Physical Geography and Stockholm Resilience Centre, Stockholm University, spring 2018.
- » Co-supervisor of PhD candidate Elizabeth (Liz) Drury O'Neill (Stockholm Resilience Centre, Stockholm University), co-supervisor of PhD candidate Noah Linder (Environmental Psychology, Department of Building, Energy, and Environmental Engineering, Gävle University), co-supervisor of PhD candidate Lina Isacs (Division of Environmental Strategies Research, Royal Institute of Technology, Stockholm), and co-supervisor of Bachelor's students Marcus Goni and Jeffrey Clark (Stockholm School of Economics).

Commissions

- » Scientific council member, Fores, Stockholm, since 2010.
- » Scientific advisor, EAT forum, Stockholm, since 2015.
- » Contributor to EAT-Lancet commission, since 2016.
- » Co-stream leader of Biosphere Stewardship, Stockholm Resilience Centre, Stockholm University, since 2016.
- » SARAS Associate, South American Institute for Resilience and Sustainability Studies (SARAS), since 2018.
- » Internal reviewer for PhD candidates Matteo Giusti and Julie Goodness (Stockholm Resilience Centre, Stockholm University), spring 2018.
- » Reviewer for *Nature Human Behaviour, Environmental and Resource Economics, Journal of Environmental Economics and Management, Scandinavian Journal of Economics, Ecological Economics*, and *Ecology and Society*.

Other

- » Popular science communication: Överskatta inte potentialen med nudging i miljöarbetet (Don't over-estimate the potential of nudging for environmental sustainability). Larsson, M. and T.

Lindahl. *Aktuell Hållbarhet*, 8 December, 2017. Available online (www.aktuellhallbarhet.se/overskatta-inte-potentialen-med-nudging-miljoarbetet/).



Daniel Ospina
PhD Candidate

Research focus

Coupled dynamics of rural livelihoods and landscapes in developing regions, amidst increasing global connectivity and urbanisation. His PhD project is aimed at understanding how rural out-migration and remittances shape land use/management decisions, and particularly the conditions under which these rural-urban teleconnections may contribute to forest regrowth in migrant-origin areas.

Publications during the period

- » Crépin, A.-S., Å. Gren, G. Engström and D. Ospina. 2017. Operationalising a social-ecological system perspective on the Arctic Ocean. *Ambio* 46, Supplement 3:475-485.
- » Haider, L.J., J. Hentati-Sundberg, M. Giusti, J. Goodness, M. Hamann, V.A. Masterson, M. Meacham, A. Merrie, D. Ospina, C. Schill and H. Sinare. 2018. The undisciplined journey: Early-career perspectives in sustainability science. *Sustainability Science* 13(1):191-204.

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience frontiers for global sustainability, Stockholm, August 2017. Presentations: *Rural out-migration and forest regrowth - A minimal model of cross-level feedbacks and Exploring alternative mechanisms underlying the forest transition - An agent-based 'virtual laboratory' approach*.
- » Askö 2017 meeting: Migration, Urbanisation and the Anthropocene, Askö and the Royal Swedish Academy of Sciences, September 2017. Participant.
- » Workshop: Towards a Mechanism-Based Approach in Sustainability Science, Institute for Analytical Sociology and Stockholm Resilience Centre, Stockholm, February 2018. Participant.
- » Focall network meeting. Stockholm Environment Institute (SEI), Stockholm, Sweden, June 2018. Presentation: *Rural-out migration, remittances, and land change - PhD project*.

- » Young Researchers Meeting: Rural Transformation. Challenges and Possibilities for Rural Communities. SLU, Uppsala, Sweden, June 2018. Presentation: *Rural out-migration, remittances, and land change - A systematic review*.
- » 6th World Congress of Environmental and Resource Economists, Gothenburg, Sweden, June 2018. Poster: *Migrant remittances can reduce the potential of local forest transitions - a social-ecological regime shift analysis*.

Teaching and training

- » Lecturer and teaching assistant, Master's level course *Systems theory and resilience thinking - Module 5: Regime shifts*, Stockholm Resilience Centre, Stockholm University, autumn 2017.

Other

- » Vice-chair of the PhD student council at the Stockholm Resilience Centre, Stockholm University, until autumn 2017.



Juan Carlos Rocha
PhD, Postdoctoral researcher

Research focus

Critical transitions and complex adaptive systems.

Publications during the period

- » Biggs, R.O., G.D. Peterson and J.C. Rocha. Accepted. The Regime Shifts Database: A framework for analyzing regime shifts in social-ecological systems. *bioRxiv:018473*. Forthcoming in *Ecology and Society*.
- » Bodin, O., M.L. Barnes, R.R.J. McAllister, J.C. Rocha and A.M. Guerrero. 2017. Social-ecological network approaches in interdisciplinary research: A response to Bohan et al. and Dee et al. *Trends in Ecology & Evolution* (8):547-549.
- » Milkoreit, M., J. Hodbod, J. Baggio, K. Benessaiah, R. Calderon, J. Donges, J.D. Mathias, J. Rocha, M. Schoon and S. Werners. 2018. Defining tipping points for social-ecological systems scholarship - an interdisciplinary literature review. *Environmental Research Letters* 13:033005.
- » Ruiz-Santacruz, J.-S. and J.C. Rocha. 2018. Descripción de campos migratorios internos colombianos usando análisis de redes sociales (Internal migration characterization of Colombia using social network analysis). *Redes. Revista*

hispana para el análisis de redes sociales 29:65-75.

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience Frontiers for Global Sustainability, Stockholm, August 2017. Presentations: *Mapping social-ecological systems archetypes and Cascading effect of regime shifts in social-ecological systems*. Poster: *Sustainability science in Latin America: Who is doing what?*
- » Resilience Alliance meeting, Stockholm, Sweden, August 2017. Participant.
- » Complex Systems Conference, Cancún, Mexico, September 2017. Presentation: *Mapping social-ecological systems archetypes*.
- » SESYNC (Socio-Environment Synthesis Centre) workshop: Causality in Ecology and Economics, Annapolis, USA, September 2017. Presentation: *Time series analysis in Ecology*.
- » The Programme on Ecosystem Change and Society (PECS) conference II, Oaxaca City, Mexico, November 2017. Presentation: *Cascading effects of regime shifts and Uncertainty can protect the commons in the face of climate change*. Session organiser: *Hacking sustainable diets*.
- » Conference: Earth in 2050 - Boundaries, Obstacles and Opportunities, Princeton University, Princeton, USA, November 2017. Participant.
- » Bert Bolin Centre Conference, Stockholm, Sweden, November 2017. Presentation: *Mapping social-ecological systems archetypes*.
- » RStudio conference, San Diego, USA, February 2018. Participant.
- » Environmental Studies Faculty seminar, Javeriana University, Bogotá, Colombia, February 2018. Invited speaker: *Critical transitions in social-ecological systems*.
- » Beijer Young Scholars Workshop on Inequality and the Biosphere, the Royal Swedish Academy of Sciences and Eskäret, Stockholm, Sweden, May 2018. Participant.
- » 6th World Congress of Environmental and Resource Economists, Gothenburg, Sweden, June 2018. Participant.

Commissions

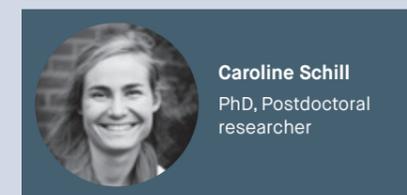
- » Executive board member of SARAS (South American Institute for Resilience and Sustainability Studies), Maldonado, Uruguay, since 2017.
- » Member of the Beijer Young Scholars

network, 2016-2018.

- » Member of the Resilience Alliance Young Scholars, since 2016.
- » Reviewer for *Ecology and Society, Sustainability, Ecosystem Services, The Royal Society Proceedings B* and *Desarrollo y Sociedad*.

Other

- » Member of the Ecological Society of America, since 2015.
- » Member of the Complex Systems Society, since 2015.
- » Popular science communication: Main contributor to the Regime Shifts Database (20 regime shifts, 9 case studies). Each contribution is a literature review intended to the general public, policy making and teaching material.



Caroline Schill
PhD, Postdoctoral researcher

Research Focus

Human behaviour in social-ecological systems. In particular, how individual and collective behaviours respond to, and are shaped by, environmental change and inherent uncertainties, and, in turn, the implications of these responses for collective action towards sustainability.

Publications during the period

- » Haider, L.J., J. Hentati-Sundberg, M. Giusti, J. Goodness, M. Hamann, V.A. Masterson, M. Meacham, A. Merrie, D. Ospina, C. Schill and H. Sinare. 2018. The undisciplined journey: Early-career perspectives in sustainability science. *Sustainability Science* 13(1):191-204.

Conferences, workshops and presentations

- » Resilience 2017 conference: Resilience Frontiers for Global Sustainability, Stockholm, August 2017. Presentation: *Resource use and behavioural responses to uncertainty in social-ecological systems with thresholds: Insights from an experimental study with Colombian small-scale fishers*. Session co-organiser and chair: *Inequality and the Biosphere: Exploring the Interactions between the Biosphere and Human Well-Being through the Lens of Inequality*.
- » Workshop: Untangling social-ecological inter-dependencies in small-scale fisheries, Stockholm Resilience Centre,

the Royal Academy of Sciences, March 2018. Participant.

- » Climate Existence conference, Sigtuna, Sweden, May 2018. Session co-organiser: Workshop: *Unlocking Sustainable Pathways Through Alternative Framings*.
- » Beijer Young Scholars Workshop on Inequality and the Biosphere, the Royal Swedish Academy of Sciences and Ekskäret, Stockholm, Sweden. May 2018. Participant.
- » Behaviour, Economics and Nature Network (BENN) workshop, the Royal Swedish Academy of Sciences, May 2018. Presentation: *A complex adaptive systems perspective on human behaviour*.
- » 6th World Congress of Environmental and Resource Economists, Gothenburg, Sweden, June 2018. Presentation: *Uncertainty can help protect local commons in the face of climate change*.

Teaching and training

- » Lecturer and examiner, Master's level course *Governance and management of social-ecological systems: Drama of the commons*, Stockholm Resilience Centre, Stockholm University, spring 2018.
- » Co-supervisor of Bachelor's students Marcus Goni and Jeffrey Clark (Stockholm School of Economics).

Commissions

- » Member of the Beijer Young Scholars network 2016-2018.

Other

- » Shortlisted for the Postdoc Academy for Transformational Leadership of the Robert Bosch Foundation, participation in Assessment Workshop, Berlin, Germany, June 2018.



Agneta Sundin
Communications
officer

Agneta divides her time between the Beijer Institute and its partner, the Global Economic Dynamics and the Biosphere Programme (GEDB) of the Academy. Her responsibilities include developing and editing the website and 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's communications team, Agneta is involved in activities arranged jointly by SRC, Beijer and Albaeco, for example the Stockholm Seminars series. In addition, she was co-organiser of the

Arts section of the Resilience 2017 conference in Stockholm, August 2017, co-organiser of the Beijer Young Scholars workshop in May at the Academy and on the island of Ekskäret, and, on behalf of the Beijer Institute, project leader for the *Transformation* course for students at the Beckman School of Design in December 2017 and the subsequent exhibition at Svenskt Tenn in January 2018 (described in the Science in Society section of this report).



Max Troell
Associate Professor,
Senior Researcher

Research focus

Sustainability of seafood, aquaculture, capture fisheries, governance of coastal and marine ecosystems, mangrove ecosystems, ecosystem services, ecosystem functions, biodiversity, resilience, regime shifts, food systems and food security, integrated aquaculture, sustainability metrics, lifecycle analysis, eco-certification.

Publications during the year

- » Buck B.H., M. Troell, G. Krause, D.L. Angel, B. Grote and T. Chopin. 2018. State of the art and challenges for offshore integrated multi-trophic aquaculture (IMTA). *Frontiers in Marine Science* 5:165.
- » Gordon, L.J., V. Bignet, B. Crona, P.J. Henriksson, T. Van Holt, M. Jonell, T. Lindahl, M. Troell, S. Barthel, L. Deutsch, C. Folke, L.J. Haider, J. Rockström and C. Queiroz. 2017. Rewiring food systems to enhance human health and biosphere stewardship. *Environmental Research Letters* 12(10):100201.
- » Henriksson, P.J.G., N. Järviö, M. Jonell, J.B. Guinée and M. Troell. 2018. The devil is in the detail – the carbon footprint of a shrimp. *Frontiers in Ecology and the Environment* 16(1):10-11.
- » Henriksson, P.J.G., A. Rico, M. Troell, D.H. Klingler, A.H. Buschmann, S. Saksida, M.V. Chadag and W. Zhang. 2018. Unpacking factors influencing antimicrobial use in global aquaculture and their implication for management: a review from a systems perspective. *Sustainability Science* 13(4):1105-1120.
- » Oyinlola, M.A., G. Reygondeau, C.C.C. Wabnitz, M. Troell and W.W.L. Cheung. 2018. Global estimation of areas with suitable environmental conditions for mariculture species. *PLoS ONE* 13 (1): e0191086.
- » Tallis, H.M., P.L. Hawthorne, S. Polasky, J. Reid, M.W. Beck, K. Brauman, J.M.

Bielicki, S. Binder, M.G. Burgess, E. Cassidy, A. Clark, J. Fargione, E.T. Game, J. Gerber, F. Isbell, J. Kiesecker, R. McDonald, M. Metian, J. L. Molnar, N. D. Mueller, C. O'Connell, D. Ovando, M. Troell, T.M. Boucher and B. McPeck. An attainable global vision for conservation and human well-being. *Frontiers in Ecology and the Environment*. In Press.

- » Troell, M., A. Eide, J. Isaksen, Ø. Hermansen and A.-S. Crépin. 2017. Seafood from a changing Arctic. *Ambio* 46 Supplement 3: 368-386.

Other

- » Troell, M., F. Ziegler and M. Jonell. 2018. Sjömat som håller i längden (Seafood that lasts in the long run). SEAWIN Report, 9 p.

Conferences, workshops and presentations

- » Workshop: Features of a Resilient Global Food System, Saltsjöbaden, Sweden, September 2017, Participant.
- » Connecting and Protecting Our Seas meeting, Monaco, October 2017. Presenter and panel discussant.
- » MASMA Interception and grantee evaluation meeting, Dar es Salaam, Tanzania, October 2017. Participant and evaluator.
- » Workshop: An Analytical Approach to Nutrient Sensitive Aquaculture, SES-YN, Maryland, USA, October 2017. Invited expert. WIOJMS 10th Symposium, Dar es Salaam, Tanzania, 30 November-3 December 2017. Participant and session chair.
- » Workshop: China's Role for Future Seafood, Royal Swedish Academy of Sciences, Stockholm, Sweden, December 2017. Co-organiser.
- » Workshop: Doubling aquaculture production within the same environmental boundary, Worldfish, Penang, Malaysia, February 2018. Organiser and presenter: *Doubling aquaculture by 2050*.
- » Stockholm University Sustainability Forum: Framtidens energi och resurser (Future Energy and Resources), Stockholm University, Sweden, March 2018. Co-organiser and seminar leader: *Future foods – getting the fish – challenges and solutions for sustainable food from the ocean*.
- » Swedish National Aquaculture Conference – Challenges and Possibilities, Södra Berget, Sundsvall, Sweden, March 2018. Presentation: *Formas research project Seawin*.
- » The Amersfoort dialogue: Advancing the Seafood Business for Ocean Stewardship Initiative, SeaBOS (Seafood Business for Ocean Stewardship), Nutreco,

Amersfoort, The Netherlands, May 2018. Presentation: *Work towards reducing the use of antibiotics in aquaculture*.

- » EAT Competence Forum, Quality Hotel Globe, Stockholm, June 2018. Invited expert, presentation: *Disruptive Dialogue – The Big Catch: Collaborative Ocean Action Towards Food Security*.
- » Workshop: Sustainable Seafood Consumption Initiative, Stirling University, UK, June 2018. Invited Participant.

Teaching and training

- » Co-supervisor of PhD candidate Muhammed Oyinlola, Nereus PhD Fellowship, University of British Columbia, Vancouver, Canada.
- » Member of supervisor committee of J. Timor, IFREMER, Plouzané, France.
- » Supervisor of postdoc Patrik Henriksson, Stockholm Resilience Centre, Stockholm University.
- » Co-supervisor of Master's student Ola Nilsson, Uppsala University. Thesis (2018): *Adding Sustainability to Salmon Farming Regulation: A Comparative Case Study of Salmon Farming Regulations and the ASC Salmon Standard. A Summary*.
- » Supervision/training: Svenskt Tenn and Beckmans Art/science Project. Spring 2017.
- » Supervision of Rebecka Johansson, student, Department of Biosciences and Nutrition, Karolinska Institutet, Sweden. Dissertation: *Mapping Nutritional Content of Fish and Seafood Products Consumed in Sweden and Improving our Understanding about Variability*.

Commissions

- » Member of ICES Working Group on Social and Economic Dimensions of Aquaculture (WGSEDA), since 2011.
- » Member of the MASMA Programme Committee, Western Indian Ocean Marine Science Association, since 2007.
- » Member and contributor to the EAT-Lancet Commission, since 2016.
- » Review editor for journals: *Journal of Aquaculture Environment Interactions* (AEI), *Frontiers in Marine Science*, *Western Indian Ocean Journal of Marine Science*.
- » Journal reviewer for: *Nature*, *Science*, *PNAS*, *Aquaculture Research*, *Aquaculture*, *WIOJMS* and *Journal of Fisheries and Aquaculture*.
- » Evaluator at SWEDBIO and responsible for their marine portfolio and strategy, since 2017.

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 528, of which 33 were published on our website between July 2016 and June 2017. 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. 263 discussion papers have been produced since 1991.

E-PRINT SERIES

2018

- » **528.** Global estimation of areas with suitable environmental conditions for mariculture species. Oyinlola, M.A., G. Reygondeau, C.C.C. Wabnitz, M. Troell and W.W.L. Cheung. 2018. *PLoS ONE* 13 (1): e0191086.
- » **527.** State of the art and challenges for offshore integrated multi-trophic aquaculture (IMTA). Buck B.H., M. Troell, G. Krause, D.L. Angel, B. Grote and T. Chopin. 2018. *Frontiers in Marine Science* 5:165.
- » **526.** Descripción de campos migratorios internos colombianos usando análisis de redes sociales (Internal migration characterization of Colombia using social network analysis). Ruiz-Santacruz, J.-S. and J.C. Rocha. 2018. *Revista hispana para el análisis de redes sociales* 29:65-75.
- » **525.** Defining tipping points for social-ecological systems scholarship – an interdisciplinary literature review. Milkoreit, M, J. Hodbod, J. Baggio, K. Benessaïah, R. Calderon, J. Donges, J.D. Mathias, J. Rocha, M. Schoon and S. Werners. 2018. *Environmental Research Letters* 13:033005.
- » **524.** The undisciplined journey: Early-career perspectives in sustainability science. Haider, L.J., J. Hentati-Sundberg, M. Giusti, J. Goodness, M. Hamann, V.A. Masterson, M. Meacham, A. Merrie, D. Ospina, C. Schill and H. Sinare. 2018. *Sustainability Science* 13(1):191-204.
- » **523.** Quantified uncertainties in comparative Life Cycle Assessment: what can be concluded? Mendoza Beltran, A., V. Prado, D. Font Vivanco, P. J. G. Henriksson, J. B. Guinée and R. Heijungs. 2018. *Environmental Science & Technology* 52(4):2152-2161.
- » **522.** Unpacking factors influencing antimicrobial use in global aquaculture

and their implication for management: A review from a systems perspective. Henriksson, P.J.G., A. Rico, M. Troell, D.H. Klingler, A.H. Buschmann, S. Saksida, M.V. Chadag and W. Zhang. 2018. *Sustainability Science* 13(4):1105-1120.

- » **521.** The devil is in the details – the carbon footprint of a shrimp. Henriksson, P. J.G., N. Järviö, M. Jonell, J.B. Guinée and M. Troell. 2018. *Frontiers in Ecology and the Environment* 16(1):10-11.
- » **520.** Measuring the potential for sustainable intensification of aquaculture in Bangladesh using life cycle assessment. Henriksson, P.J.G., B. Belton, K.-M. Jahan and A. Rico. 2018. *Proceedings of the National Academy of Sciences* 115(12):2958-2963.
- » **519.** Digesting the alphabet soup of LCA. Guinée, J.B., S. Cucurachi, P.J.G. Henriksson and R. Heijungs. 2018. *International Journal of Life Cycle Assessment* 23(7):1507-1511.
- » **518.** Towards improved practices in Life Cycle Assessment of seafood and other aquatic products. Avadí, A., P.J.G. Henriksson, I. Vázquez-Rowe and F. Ziegler. 2018. *The International Journal of Life Cycle Assessment* 23(5):979-981.
- » **517.** Construction of register-based commuting measures. Blind, I., M. Dahlberg, G. Engström and J. Östh. 2018. *CESifo Economic Studies* 64(2):292-326.
- » **516.** The smart city model: A new panacea for urban sustainability or unmanageable complexity? Colding, J., M. Colding and S. Barthel. 2018. *Environment and Planning B: Urban Analytics and City Science*. First online. 10.1177/2399808318763164.
- » **515.** Social-ecological, integrated planning and design. Schewenius, M., J. Colding and S. Barthel. 2017. In: Schewenius, M., P. Keränen and R. Rawaf (eds.). *Dreams and Seeds – The Role of Campuses in Sustainable Urban Development*. TMG, Stockholm, Sweden. pp. 47-49.
- » **514.** Resilience and sustainable development. Colding, J. and S. Barthel. 2017. In: Schewenius, M., P. Keränen and R. Rawaf (eds.). *Dreams and Seeds – The Role of Campuses in Sustainable Urban Development*. TMG, Stockholm, Sweden. pp. 28-29.
- » **513.** Facets of Arctic change. Gascard, J.-C., A.-S. Crépin, M. Karcher and O.R. Young. 2017. *Ambio* 46, Supplement 3:339-340.
- » **512.** Measuring the NIMBY effect in urban China: The case of waste transfer stations in the metropolis Shanghai. Zhang, L., J. Chen, Q. Hao and C.Z. Li. 2017. *Journal of Housing and the Built*

Environment 3:1-18.

- » **511.** Social-ecological network approaches in interdisciplinary research: A response to Bohan et al. and Dee et al. Bodin, O., M.L. Barnes, R.R.J. McAllister, J.C. Rocha and A.M. Guerrero. 2017. Trends in Ecology & Evolution 8:547-549.
- » **510.** Being efficient and green by re-thinking the urban-rural divide—Combining urban expansion and food production by integrating an ecosystem service perspective into urban planning. Gren, Å. and E. Andersson. 2018. Sustainable Cities and Society 40:75-82.
- » **509.** Using Behavioural Insights to Promote Food Waste Recycling in Urban Households—Evidence From a Longitudinal Field Experiment. Linder, N., Lindahl, T., Borgström, S. 2018. Frontiers in Psychology 9.

2017

- » **508.** The 'seafood gap' in the food-water nexus literature — issues surrounding freshwater use in seafood production chains. Gephart, J. A., M. Troell, P.J.G. Henriksson, M.C.M. Beveridge, M. Verdegem, M. Metian, L.D. Mateos and L. Deutsch. 2017. Advances in Water Resources 110: 505-514.
- » **507.** Unpacking factors influencing antimicrobial use in global aquaculture and their implication for management: a review from a systems perspective. Henriksson, P.G.J., A. Rico, M. Troell, D. H. Klinger, A. H. Buschmann, S. Saksida, M.V. Chadag and W. Zhang. 2017. Sustainability Science 13 (4):1105-1120.
- » **506.** The Role of University Campuses in Reconnecting Humans to the Biosphere. Colding, J. and S. Barthel. 2017. Sustainability 9 (12):2349.
- » **505.** Capturing the value of green space in urban parks in a sustainable urban planning and design context: pros and cons of hedonic pricing. Engstrom, G. and Å. Gren. 2017. Ecology and Society 22(2):21.
- » **504.** Optimal Management of Ecosystem Services with Pollution Traps: The Lake Model Revisited. Grass, D., A. Xepapadeas and A. de Zeeuw. 2017. Journal of the Association of Environmental and Resource Economists 4 (4):1121-1154.
- » **503.** Ocean space for seafood. Troell, M., M. Jonell, P.J.G. Henriksson. 2017. Nature Ecology and Evolution 1:1224-1225.
- » **502.** Operationalising a social-ecological system perspective on the Arctic Ocean. Crépin, A.-C., Å. Gren, G. Engström and D. Ospina. 2017. Ambio 46(3):475-485.
- » **501.** Seafood from a changing

Arc-tic. Troell, M., A. Eide, J. Isaksen, Ø. Hermansen and A.-C. Crépin. 2017. Ambio 46(3):368-386.

- » **500.** Arctic Climate Change, Economy and Society (ACCESS): Integrated perspectives. Crépin A., M. Karcher., J.-C. Gascard. 2017. Ambio 46(3):341-354.
- » **499.** An urban ecology critique on the "Smart City" model. Colding, J. and Barthel, S. 2017. Journal of Cleaner Production. 164: 95-101.
- » **498.** Rewiring Food Systems to Enhance Human Health and Biosphere Stewardship. Gordon, L.J., V. Bignet, B. Crona, P. Henriksson, T. van Holt, M. Jonell, T. Lindahl, M. Troell, S. Barthel, L. Deutsch, C. Folke, J. Haider, J. Rockström, and C. Queiroz. 2017. Environmental Research Letters 12:100201.
- » **497.** Emergence of a Global Science-Business Initiative for Ocean Stewardship. Österblom, H., C. Folke, J.-B. Jouffray, and J. Rockström. 2017. Proceedings of the National Academy of Sciences, USA 114:9038-9043.
- » **496.** Changing antibiotic resistance: sustainability transformation to a pro-microbial planet. Søgaard Jørgensen, P., D. Wernli, C. Folke, and S.C. Carroll. 2017. Current Opinion in Environmental Sustainability 25:66-76.

» Discussion Papers

- » **263.** Avoiding catastrophic collapse in small scale fisheries through inefficient cooperation: evidence from a framed field experiment Therese Lindahl and Rawadee Jarungrattanapong. 2018.
- » **262.** An explicit formula for optimal carbon taxes under general economic settings. Chuan-Zhong Li. 2018.
- » **261.** The Unintended Consequences of a Global Carbon Tax. Gustav Engström, Johan Gars, Chandra Kiran, Raphael Calel, Therese Lindahl, Badri G. Narayanan and Daniel Spiro. 2018.
- » **260.** Addressing Pathological Dynamics of Global Environmental Problems. Garry D. Peterson, Reinet Biggs, Anne-Sophie Crépin, and Victor Galaz. 2017.



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- 1. Askö meeting.
- 2. Beijer Young Scholars.
- 3. Beijer Young Scholars, Jonas Hentati-Sundberg sharing his home made mead at food sharing session.
- 4. BENN workshop. Carl Folke, Marty Anderies, Steve Polasky and Juan Camilo Cardenas.
- 5. Scott Barrett and Karine Nyborg at Askö.
- 6. Therese Lindahl at BENN workshop.
- 7. Askö meeting.
- 8. Beatrice Crona and Nils Kautsky on the boat to Askö.
- 9. Ann-Sophie Crépin at symposium on Arctic climate change.

All photos by Agneta Sundin except 2 (Andrew Tilman) and 7 (Christina Leijonhufvud).

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 2017 – 30 June 2018.

www.beijer.kva.se