



Beijer Institute of Ecological Economics

Annual report 2020/2021

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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. 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.

This is the decisive decade for the future of humanity and the planet.

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Director's column

There is hope. In the midst of the pandemic, we are witnessing actions among businesses, governments and civil society for real change towards sustainable futures. There are commitments to net-zero emissions, biodiversity, natural capital, nature-based solutions and planetary boundaries. There are also efforts to achieve a circular economy, inclusiveness and collaboration, while resilience strategies for 'building back better' are on the table.

“Humanity is waking up late to the challenges and opportunities of active planetary stewardship. But we *are* waking up.”

The whole narrative of globalisation is apparently under reconsideration and in transition, from placing humans as the centre of the universe to viewing humans as part of, embedded within, intertwined with and ultimately dependent upon the living biosphere and the broader Earth system for prosperity and progress. I dare to suggest that the Beijer Institute has played an important role in such change. Many concepts, findings and insights

generated through the Beijer Institute, our Beijer Fellows and our collaborators are now common language and are being applied in policy and practice.

Perhaps the recent most striking evidence is the consensus reached during the first Nobel Prize Summit on the critical issues of global sustainability and the strong emphasis on action. To quote the Summit's call for urgent action, signed by 126 Nobel Laureates, “Humanity is waking up late to the challenges and opportunities of active planetary stewardship. But we *are* waking up.” I invite you to explore in greater depth this very special virtual event – involving Nobel Prize laureates, leading scientists, political leaders and youth leaders – in which the Beijer Institute played a significant collaborative role, particularly in producing the scientific content and sessions (pages 34–35).

Scientific findings provide a solid foundation for our actions and engagements with practice, business and policy. It is truly satisfying, and amazing during times like these, to see the continuous delivery of top-quality scientific information by our researchers and research programmes. This year, we have had publications in *Nature*, *Proceedings of the National Academy of Sciences USA (PNAS)*, *Nature Food*, *Nature Communications*, *Nature Sustainability*, *Environmental Research Letters*, *Ecology & Society*, *One Earth* and many more. It is exciting that, in the year of its golden jubilee, the Academy's journal *Ambio* is highlighting key publications produced over the history of the journal, including influential papers by the Beijer Institute. I highly recommend reading the introductory essay on *Ambio's* journey, reflecting on the emergence of environmental and sustainability challenges since the UN

Stockholm conference on the environment in 1972. A whole set of new publications are in progress as part of the Blue Food Assessment, focusing on the role of seafood in the shift towards a sustainable and healthy food system, a collaboration with our sister organisations GEDB and Stockholm Resilience Centre, and with Stanford University.

Scientific evidence serves as the foundation for our engagement within SeaBOS. After only a few years of collaboration with the world's largest seafood companies, time-bound goals and commitments have already been set, as a way to transform the industry towards ocean stewardship. Our science of the Anthropocene is also at the core of the Executive Programme in resilience thinking at Stockholm Resilience Centre, to which the Beijer Institute contributes. The CEOs of more than thirty Swedish companies have participated to date, including those of Atlas Copco, Axel Johnson, Electrolux, H&M, Investor, Kinnevik, Scania, SEB, Stora Enso, Swedbank and Volvo. Our exciting collaboration with design firm Svenskt Tenn continues, with students in visual communication from the Beckman College of Design showing work inspired by our research in two exhibitions, one on food systems and the other on tipping points. Moreover, our work on tipping points and planetary boundaries has now reached new heights through the recent Netflix film *Breaking Boundaries*!

I am very happy and proud to announce that we have two new full professors, Johan Colding and Beatrice Crona – fantastic and extremely well deserved appointments! Several new major grants have been obtained, thanks to hard work by Beijer colleagues. It is also inspirational to follow the progressive collaboration of the Beijer Young Scholars.

All this has been achieved in the midst of the pandemic! We are now crossing our fingers for a vaccinated collaborative future. The Academy staff have been working from home, which has been a strain for many. We are eagerly looking forward to returning to the Beijer Institute's premises and, when conditions permit, getting going with activities and workshops in the beautifully and functionally renovated Academy, with the renovation of the Academy's Beijer Hall generously supported by the Beijer Foundation.

For thirty years, the Beijer Foundation and its director Anders Wall have provided core support for our research on the interplay between ecological systems and social and economic development. This fundamental commitment is unique and deeply appreciated. During these three decades of progress, Christina Leijonhufvud has been our backbone, often referred to as the ‘real boss’ of the Beijer Institute. Her professionalism and contributions have been simply outstanding, in so many and diverse ways. Personally, I have been extremely lucky to have had Christina working side-by-side with me. Christina has now decided to retire but, as a core member of the Beijer family, “she can check out but she may never leave” (to quote the *Eagles*’ ‘Hotel California’).

As always, the collaboration with the Academy is one of pleasure. My colleagues and fellows of the Beijer Institute, and our close collaborators, are performing impressive and important work, providing insights and guidance for sustainable futures. It is indeed a privilege and rewarding to be the Director of the Beijer Institute!



A handwritten signature in dark ink, appearing to read 'Carl Folke'.

Carl Folke
Director of the Beijer Institute
Stockholm, July 2021



Research programmes × 4

Work at the Beijer Institute strives to create research frontiers 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.

Our research framework recognises that economies and societies are components embedded within the Earth's biosphere, the thin layer around our blue planet where life exists, resulting in biosphere dependence. The situation is different from just a few decades ago. Now, the globalised human world is shaping the operation of the biosphere at planetary level in truly intertwined systems of people and nature. In dialogue with the Institute's scientific advisory board, we discuss, assess and modify our research programmes to better capture and understand the intertwined world. There are currently four research programmes of the Beijer Institute, all combining important theoretical insights with novel and grounded empirical research. The focus and progress of each are presented under this section.

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[1]
Blasiak, R., A. Dauriach, J.-B. Jouffray, C. Folke, H. Österblom, J. Bebbington, F. Bengtsson et al. 2021. Evolving Perspectives of Stewardship in the Seafood Industry. *Frontiers in Marine Science* 09 June 2021.

[2]
Wernli, D. et al. 2020. Evidence for action: A One Health learning platform on interventions to tackle antimicrobial resistance. *The Lancet Infectious Diseases* 20(12):e307–e311

[2]
Léger, A., I. Lambraki, T. Graells, M. Cousins, P.J.G. Henriksson, S. Harbarth, C. Carson, S. Majowicz, M. Troell, E.J. Parmley, P.S. Jørgensen and D. Wernli. 2021. AMR-Intervene: a social-ecological framework to capture the diversity of actions to tackle antimicrobial resistance from a One Health perspective. *Journal of Antimicrobial Chemotherapy* 76(1):1–21.

[3]
Farmery, A. K. et al. 2021. Blind spots in visions of a “blue economy” could undermine the ocean’s contribution to eliminating hunger and malnutrition. *One Earth* 4(1):28–38.

[4]
Brugere, C., M. Troell and H. Eriksson. 2021. More than fish: Policy coherence and benefit sharing as necessary conditions for equitable aquaculture development. *Marine Policy* 123:104271.

[5]
Love, D. C. et al. 2021. Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system. *Global Food Security* 100494

Aquaculture and sustainable seafood

Aquatic foods have the potential to contribute to global food security and to healthy, more nature-positive and resilient food systems. Research within the *Aquaculture and sustainable seafood* programme increases understanding about aquatic food’s links to land- and sea-based resource systems and the environmental performance of a diverse seafood portfolio. Recent insights from the programme show a need for transformation towards more just and equitable growth.

Supporting international policy forums

The Blue Food Assessment is a coalition of international researchers working to put “blue food” (food from marine and freshwater systems) at the top of the global food policy agenda. Activities within the Blue Food Assessment (www.bluefood.earth) have now entered an exciting final phase, with many scientific findings in review at high-profile journals. These publications will feed into the upcoming UN Food Summit (September 2021) and enable a stronger focus on aquatic foods. Participation within the Food Summit’s Action Tracks has emphasised the role of blue foods. In addition, preparations for the FAO decadal Aquaculture and Sustainability symposium in 2021 are ongoing. Our role involves leading the work on a background report on aquaculture’s relationship with the Agenda 2030 Sustainability Goals. A series of policy briefs have been released, aimed at guiding a broad set of stakeholders, including the Swedish government and the seafood industry at large (www.seawin.earth).

Stewardship and antibiotics

Work on antibiotics use in aquaculture within the SeaBOS (www.seabos.earth) initiative, in which ten of the world’s largest seafood companies have committed to a set of time-bound and measurable science-based goals to make the industry more sustainable, has resulted in detailed mapping of company structures and their direct and indirect use of antibiotics. This has enabled identification of risks, necessary actions and development of a common code of conduct. A recent paper examines the extent to which actions by the seafood industry, i.e. globally active multinational corporations like the SeaBOS members, have aligned with theoretical concepts of stewardship¹. The ongoing AM-Resilience project (amr-resilience.gtglab.net) continues to look at the antibiotic challenge from a “One Health” perspective and the researchers involved have published papers on interventions for tackling the spread of antibiotic resistance².

Widening the scope of sustainability

The potential for ocean-based foods to enable more sustainable and healthy human diets is threatened by competing uses of ocean resources in an accelerating “blue economy” and by too narrow a focus on production growth. A perspective paper in the journal *One Earth* argues that policy and research must apply a broader food systems approach and take into account food access, affordability and consumption if “blue foods” are to make significant contributions to reducing hunger and malnutrition, as well as meeting other Sustainable Development Goals³.

A study analysing existing policies for ocean aquaculture (mariculture) development in East Africa showed that important building blocks for equitable mariculture development exist at regional level, but that there is a lack of understanding of the mechanisms through which the benefits from this development can reach stakeholders at national level⁴. Thus policy coherence and benefit sharing should be key considerations in planning and future development of sustainable and equitable aquaculture. These two publications show that much work still remains to be done in shaping the aquaculture sector towards increased equity.

Covid-19 and resilience of the seafood system

Two studies investigated the impact of Covid-19 on the seafood industry. The first mapped impacts and responses to the pandemic at global scale and outlined lessons learnt from a resilience perspective⁵. The second conducted a global web survey in 47 countries in the midst of the COvid-19 pandemic, to assess how aquaculture activities had been affected by the pandemic and to explore how these impacts compare with those from climate change⁶. Although the effects of these two categories of drivers appeared to be largely similar, further analysis suggested that they affected different parts of the supply chain. This indicates that holistic policies simultaneously addressing other ongoing anthropogenic stressors, rather than focusing solely

on the acute impacts of Covid-19, are needed to maximise the long-term resilience of the aquaculture sector.

Improving farming methods

A 20-year retrospective review of global aquaculture in *Nature* revealed that the diverse aquaculture industry has made significant strides toward sustainability, not least on the feed side, where the ratio of wild fish input per fed fish output has dropped almost seven-fold since 1997⁷. However, it also highlighted necessary measures for improvement, for instance on use of antibiotics (read more on page 20).

Several studies during the year scrutinised specific aquaculture production systems and, using various methods, assessed their environmental performance and how it can be improved. One such system is land-based closed Recirculating Aquaculture Systems, a growing sector due to its environmental advantages over traditional open-net-systems, for instance when it comes to eutrophication. Using Life Cycle Analysis (LCA), researchers found that feed production contributed most to all environmental impacts and showed that the main potential for improvement lies in better utilisation of by-products and use of a larger proportion of plant-based feed ingredients⁸.

Farmed seafood generally contains less valuable micronutrients than wild-caught fish. People in many low-income countries are particularly dependent on seafood for their nutrition, so when overfishing decreases fish landings, these people are the worst affected. Another study, also using LCA, investigated how aquaculture systems in Bangladesh can improve the nutritional content of products and the environmental impact of production⁹. The team found that, of the twelve fish types farmed in these aquaculture systems, only a group of small indigenous fish species had better nutritional values than wild-caught fish. By increasing proportion of this fatty fish group to 30–50% of total production, the nutritional density of production could equal that of wild-caught fish. The team also

found that aquaculture systems involving integration of aquaculture and rice farming performed best from an environmental perspective.

Analysis of the environmental performance of specific aquaculture production systems is important for improving sustainability, as shown in another paper pointing out that aquaculture policies based on wild trophic position or historical resource use can be misleading, particularly for fed aquaculture, where the composition of feed differs markedly from that consumed by wild relatives¹⁰. Effective aquaculture policy needs to avoid overly simplistic sustainability indicators, such as trophic level, and instead employ empirically derived metrics based on the specific farmed properties of species groups, management techniques and advances in feed formulation. This will be crucial for identifying and supporting sustainable options for farmed seafood.

“Farmed seafood generally contains less valuable micronutrients than wild-caught fish.”

Learning about sustainable seafood consumption in Japan

A new project funded by the Swedish research council Formas will focus on the role played by certification for sustainable seafood consumption in Japan. Comparison will be made to Sweden and differences in seafood markets, especially mid-supply chain actors, will be investigated. The object of this work, which brings a novel perspective to a research area usually dominated by consumer studies, is to find new leverage for sustainable seafood consumption.

Tilapia farming in Bangladesh, supported by programme partner Worldfish. Photo: Habibul Haque.

[6]
Sarà, G., M. C. Mangano, et al. 2021. The synergistic impacts of anthropogenic stressors and COVID-19 on aquaculture: A current global perspective. *Reviews in Fisheries Science & Aquaculture* 1–13.

[7]
Naylor R.L. et al. 2021. A 20-year retrospective review of global aquaculture. *Nature* 591:551–563.

[8]
Bergman, K., et al. 2020. Recirculating aquaculture is possible without major energy tradeoff: Life Cycle Assessment of warmwater fish farming in Sweden. *Environmental Science & Technology* 54(24):16062–16070.

[9]
Shepon A., et al. 2020. Reorientation of aquaculture production systems can reduce environmental impacts and improve nutrition security in Bangladesh. *Nature Food* (1):640–647.

[10]
Shepon, A. et al. 2021. Exploring sustainable aquaculture development using a nutrition-sensitive approach. *Global Environmental Change* 69:102285



Behaviour, economics and nature

Given the profound significance of human behaviour in shaping future pathways towards sustainability, the mission of the *Behavior, economics and nature (BEN)* programme is to develop an understanding of human behaviour that can assist in the design of robust institutions for environmental stewardship and sustainable development. As researchers at BEN, we study behaviour and behavioural motivators at different levels, as reflected in our varied research topics, our multi-method approach and the interdisciplinary expertise on which we rely.

[1]
Rocha, J.C., C. Schill, L.M. Saavedra-Díaz, R.D.P. Moreno and J.H. Maldonado. 2020. Cooperation in the face of thresholds, risk, and uncertainty: Experimental evidence in fisher communities from Colombia. *PLoS ONE* 15(12):e0242363.

[2]
Lindahl, T., C. Schill, and R. Jarungrattanapong 2021. *Beijer Discussion Paper* 276: The role of resource dependency for sharing increasingly scarce resources: Evidence from behavioural experiments with small-scale fishers. *Beijer Discussion Paper Series*.

The BEN network – looking back and moving forward

BEN started as a network and meeting place for discussing different aspects of human behaviour related to the biosphere and sustainable development. Over the past decade, we have hosted several meetings and workshops with invited scholars from many different disciplines. Some have been close colleagues, but we have also made many new friends. This arrangement has made it possible for us to explore a diverse set of ideas and entry points, while keeping some of the main emerging insights at the core.

Most environmental challenges we face link to our capacity, or rather lack of capacity, to govern shared resources. Successful cooperation in turn requires either voluntary behavioural change that is upheld through social norms, or some type of external intervention that can prevent or promote certain behaviour. One main insight is that we need a better understanding of how social interactions and dynamics at the individual level affect, and are affected by, economic, social and institutional structures at larger scales. For example, we need to know how social expectations and behaviour are affected by policy interventions aimed at changing social norms. We also need to identify other durable influences on human behaviour and acknowledge that human behaviour is almost always embedded in a cultural and ecological context, and that it continuously co-evolves with these changing contexts.

Given these guiding insights, where do we go next? To get new inspiration and ideas for what we see as the next chapter of BEN, we hosted an online workshop in December 2020 where exactly these questions were at the centre of discussion. The workshop was extremely productive, with several interesting ideas emerging. In essence, the group agreed that it is time to move from insights to action. Given our insights, what does it mean to intervene in a system in which individuals are interacting with each other and with the larger economic, social and institutional structures that condition their lives? What role do traditional policies, novel policies, social movements and various actors play in

changing behaviour in a profound way at larger scales? We are excited to develop these ideas and to plan for the next step, where we take these discussions forward with the group.

Developing experimental methods further

BEN is not only a network, it is also an arena for research projects. Several of the ongoing BEN projects focus on resource users and their capacity to manage resources sustainably, which often requires cooperation. To study these issues, BEN researchers have developed an experimental paradigm that allows us to explore individual and collective natural resource use decisions in different contexts, such as during ecosystem regime shifts, increasing resource scarcities and uncertainties, and changing market conditions. Two articles presenting novel results were published during the past year¹⁻².

“Most environmental challenges we face link to our capacity, or rather lack of capacity, to govern shared resources.”

Several BEN projects are also exploring ways in which this experimental paradigm (and others) can be combined with other methods and approaches (e.g. interpretative approaches, agent-based modelling and tools from neuroscience). Having been forced to postpone a large amount of planned data collection in the past year, we found it a particularly good time for being more reflective about combining methods, the pros and cons, potential new knowledge that might be generated and potential pitfalls. Together with colleagues at



Stockholm Resilience Centre, BEN researchers Caroline Schill and Therese Lindahl decided to describe their ‘behind the scenes’ experiences and observations of combining controlled behaviour experiments and agent-based modelling. An article has now been submitted.

Research for positive changes in people’s behaviour

How contact with nature affects human health and human behaviour is a theme BEN has explored within the Beijer Institute’s research collaboration with Stanford University and Stockholm Resilience Centre. New research from this collaboration, published in *Proceedings of the National Academy of Sciences*, demonstrates how access to nature increases physical activity—and therefore overall health—in people living in cities³. This may seem like an intuitive connection, but the new research closes an important evidence gap in understanding how building nature into cities can support overall human wellbeing.

Last year, we received funding for two projects that will allow us to pursue our work in exploring barriers and entry points for changing citizen behaviour (see last year’s annual report). We have been busy launching these new projects, initiating new collaborations and making plans for upcoming data collection that will take place over the next year(s). When the data are successfully collected, we will investigate the potential acceptability of various forms of interventions aimed at reducing greenhouse gas emissions from transportation and food consumption by individuals. We will

evaluate how acceptability is influenced by a range of different factors, both individual and contextual, using a choice experimental design and making an inter-country comparison. These projects will build on ongoing and published work⁴⁻⁵.

Reducing inequality

This year, BEN researchers received funding for a large project investigating synergies and trade-offs between reducing inequalities in society and safeguarding the biosphere (see page 24 in this report). One objective of the project, which has a very strong behavioural component, is to investigate how inequalities influence the interactions between actors (from individuals to corporations) and the biosphere. To inform the experimental design that will be developed, the team is currently working on a major literature review to identify what types of inequalities have been seen or assumed to shape environmental behaviours.

A post-pandemic BEN next year?

When writing last year’s annual report, we believed that we would be able to resume our field work and host face-to-face meetings quite soon. A year has passed in which we repeatedly had to change plans and adapt. We have learnt that nothing is certain and suspect that we may not be past this pandemic just yet. However, whatever the adaptations needed to make progress on our research and collaborations, we know that we are looking forward to the next year.

[3]
Remme, R.P. et al. 2021. An ecosystem service perspective on urban nature, physical activity, and health. *Proceedings of the National Academy of Sciences* 118 (22) e2018472118.

[4]
Engström, G., J. Gars, N. Jaakkola, T. Lindahl, D. Spiro, and A.A. van Benthem 2020. What policies address both the coronavirus crisis and the climate crisis? *Environmental and Resource Economics* 76(4): 789-810.

[5]
Hassler J., B. Carlén, J. Eliasson, F. Johnsson, P. Krusell, T. Lindahl, J. Nylander, Å. Romson and T. Sterner 2020. *Economic Council Report 2020: Swedish Policy for Global Climate*. SNS publisher, Stockholm, Sweden (ISBN: 978-91-88637-59-8).

Governance, technology and complexity

The Covid-19 pandemic has in many ways been an illustration of the urgency and importance of grappling with the impacts of global change, including surprise, complexity and technological innovation. As countries and communities have struggled to protect their populations, economies and health systems, the underlying circumstances to the evolving pandemic should not be forgotten. They include: rapid globalisation and increased connectivity, changes in land use and other environmental changes that increase zoonotic disease risks, and governance failures to prepare for complex risks. Governing such complexity is one of the most difficult challenges facing decision-makers around the world today. The *Governance, technology and complexity* research programme strives to combine important theoretical insights with novel and grounded empirical research. The emphasis is on how societal complexity interacts with complex systems of the biosphere, and on governance issues associated with these interactions.

Digitalisation, automation and data-driven analysis have proven critical during the pandemic. Digital platforms like Zoom have enabled digital meetings and social media platforms have allowed people to stay in touch and share vital information, despite physical distancing and strict “lock-down” in many countries. The trend towards automation and digitalisation seem to have accelerated all over the world, making the programme’s focus on the challenges posed by new technologies even more important.

Combatting disinformation

One area of investigation that will be picking up pace thanks to a new grant from the Swedish research council for sustainable development Formas, is the programme’s growing work on misinformation and disinformation in social and digital media. As the pandemic has shown, the impacts of rapid diffusion of incorrect information, “fake news” and unfounded conspiracy theories (sometimes referred to as an “infodemic”) can have devastating impacts on the collective ability of nations to respond to crises. However, few have explored the dynamics of digital misinformation as regards issues related to climate and ecologically induced crises. In some instances, the diffusion of such problematic information is augmented by technologies that allow malevolent users to automate and mimic human behaviour, also known as ‘social bots’. Fortunately, techniques such as machine learning can be used to analyse and counter such behaviours. We are delighted to be able to advance this work in a project called ‘ClimateBots’ led by Stefan Daume (now both at

the Beijer Institute and Stockholm Resilience Centre) and Victor Galaz, in collaboration with Professor David Garcia at TU Graz (Austria).

The project will focus specifically on the diffusion dynamics of global misinformation and disinformation concerning recent major forest fires, such as those in Australia, the Western U.S. and the Amazon region. Forest fires are environmental emergencies where misinformation can have both short-term and long-term effects, hindering immediate emergency responses and also public understanding of climate change in general. The ClimateBots project will employ a broad range of data science tools to identify generic patterns of bot-driven environmental misinformation on Twitter and assess the impact on users exposed to this information. Ultimately, we hope that the project’s results can help combat misinformation campaigns and support public organisations, journalists and other stakeholders communicating or working with environmental and sustainability topics.

Artificial intelligence and the environment

The work to explore the sustainability opportunities and risks created by artificial intelligence (AI) continues and is attracting increasing interest from colleagues and policy-makers. On 27 January, 2021, Victor Galaz was invited to give input to current discussions at the European Union Parliament about the sustainability opportunities and risks created by the EU’s ambition to integrate its climate and digitalisation agenda. The Op-Ed “Will the Fourth Industrial Revolution Serve Sustainability?” published by *Project Syndicate* in



A new project will focus on the diffusion dynamics of global mis- and disinformation concerning recent major forest fires.

conjunction with the Nobel Summit 2021, has been republished in eight different languages by news outlets in Japan, Jordan, Spain, Taiwan and Germany.

Other evidence of the growing interest in insights offered by the programme was the invitation by the Swedish government’s innovation agency, Vinnova, to coordinate an investigation together with AI Sweden and Research Institutes of Sweden (RISE) to map the potential of AI for climate action, and the role Sweden could play. The results of this work were published on February 10th, 2021¹. We expect the report to help shape the agenda of AI for climate action and sustainability in Sweden as the questions gain prominence amongst policy-makers, civil society and science.

In parallel with ongoing work to develop partnerships and projects, we are delighted to expand the partnership “AI, People, Planet” with Timon MacPhearson and his team at the Urban Systems Lab (USL) at the New School in New York. In recent years, USL has considerably expanded its work on urban resilience, climate shocks and adaptation, and the role of data-driven analysis as a tool to help communities, policymakers and the private sector understand complex urban climate risks. Our joint ambition is to explore the extent to which AI methods such as deep learning can help uncover previously ignored climate risks in urban settings that are of critical importance for people and nature.

Human Development Report 2020

Lastly, the programme had the pleasure and honour of supporting work on the Human Development Report 2020, entitled “The Next Frontier: Human Development in the Anthropocene” (HDR 2020), by producing a background report in collaboration with colleagues at the Stockholm Resilience Centre, as well by reviewing key chapters. The report is key in setting the global

agenda and discussions about changes in human development, and the ways that prosperity for all can be realised. It was the first publication to fully integrate the implications of a new Anthropocene reality for human development with the importance of complexity thinking to address social challenges, including a suggestion for new economic metrics that better reflect the importance of the biosphere and climate for human development.

“AI methods such as deep learning can help uncover previously ignored climate risks in urban settings that are of critical importance for people and nature.”

Looking ahead

The remainder of 2021 and early 2022 will be an important and exciting time for the programme. We are hoping that several of our research applications submitted during 2021 will be successful, allowing us to ramp up our work on climate misinformation and disinformation ahead of the international climate negotiations in COP26, as well as exploring AI tools for analysing satellite imagery to assess carbon flows in forestry. We also look forward to finally being able to host a workshop on January 2022 on “Emotion AI”, artificial intelligence technologies that are learning and recognising human emotions, as new technologies allow us to connect closer to each other, perhaps to the benefit of nature.

[1] Galaz, V., E. Wilson, M. Schewenius and S. Jansson. 2021. AI i klimatets tjänst – en kartläggning av svensk kompetens i ett internationellt perspektiv (AI for climate purposes – a review of Swedish competence in an international perspective) Vinnova.

Urban social-ecological systems

The world is urbanising at an unprecedented rate, with cities currently accounting for around 70% of both global energy use and global greenhouse gas emissions. Cities also contribute to environmental degradation on a global scale, with the highest rates of urban growth in regions that are currently relatively undisturbed by urban development. The *Urban social-ecological systems* research programme aims to contribute to planning and design of more resilient cities that can offer social-ecological benefits and contribute to sustaining life on Earth.

Pros and cons of multifunctional land use

The ambition of the programme to closely monitor urban growth has opened up a new research frontier on multifunctional land use, which has long been advocated as a foundation for improving conditions for humans and non-human species in cities. Examples of land uses that researchers in the programme have been exploring over the years include golf courses and allotment areas that display a positive symbiosis between environmental and social aspirations. Another example is the programme's idea of 'ecological land-use complementation', a design strategy that planners now use to shape land use to better support biodiversity and ecosystem services.

In the past year, the programme began exploring the pros and cons of the multifunctionality land use concept in supporting ecosystem services and human wellbeing. This work involves focusing on specific qualities of green space that environmental psychologists have identified as stress relievers. Beijer Institute researchers Åsa Gren and Johan Colding, together with programme partner Lars Marcus at Chalmers University of Technology, are in the process of compiling the results of this highly interesting research. They show that some of the beneficial qualities of green space, when combined, can in fact counteract each other if area size, location and tenure of green spaces are not adequately considered. This result has important implications for densification, which in many cities is the dominant planning strategy.

Linking urban design and urban ecology

Over the course of the year, the programme also deepened its theoretical exploration of a closer partnership between urban design and urban ecology. Achieving such partnership is not always a straight-forward process, due to different epistemological departure points. Fortunately, social-ecological resilience offers a useful framework for collaboration between ecologists and urban designers, with the aim of promoting a more

non-linear understanding of the interconnectedness of social and ecological systems, as described in a book chapter published online in March 2021¹.

In an effort to further develop the Social-Ecological Urbanism (SEU) framework initiated and developed by this programme in collaboration with the University of Gävle, Chalmers University of Technology in Gothenburg and the Royal Institute of Technology in Stockholm, we are coordinating a special issue with the title 'Social-ecological urbanism: Developing discourse, institutions and urban form for the design of resilient social-ecological systems in cities' in the scientific journal *Frontiers in Built Environment*. The special issue aims to highlight the role of institutions, urban form and social discourse when designing the built environment.

New research project for a fossil-free future

Programme director Johan Colding will be part of a new major research project designed to promote transformation to a fair and fossil-free Sweden. This project, called 'Fair Transformations to a Fossil-Free Future' (FAIRTRANS), will develop economic and political frameworks for transformation together with key actors from the business sector, trade unions and other organisations in Sweden, in order to design roadmaps for Sweden to stay within the remaining carbon budget of the Paris Agreement. Expected impacts include reducing societal polarisation and increasing legitimacy for rapid decarbonisation.

The FAIRTRANS project is being led by Stockholm Resilience Centre. Johan Colding will lead one of the five work packages (WP4), affiliated to the University

of Gävle, entitled "Fair Digital Transformation and Co-creation for Socially Accepted Climate Action". Other partners in FAIRTRANS include the think tank Global Utmaning, Uppsala University, and individual researchers from the Royal Swedish Institute of Technology, Swedish Environmental Research Institute and Lund University. FAIRTRANS is funded jointly by the Swedish research councils Formas and Mistra, with 40 million SEK for four years, and won this funding in fierce competition with ten other research proposals.

WP4 will develop science-based and co-produced knowledge to ensure smart digital climate action that is fair and inclusive and that fosters more democratic values. Hence, the programme's work relating to smart city development has borne fruit by helping securing Mistra funding for FAIRTRANS.

Co-working spaces for sustainability

Emanating from the programme's work on urban commons, WP4 will also explore the role of remote working communities in decarbonisation of society. As teleworking has become increasingly common, a growing number of people are choosing to use co-working spaces, as an alternative to working from home. Co-working spaces are markedly different from conventional workplaces as they are shared by several different organisations and thus users work together with people who are not organisational partners. Johan Colding and colleagues at the University of Gävle have

initiated work on the potential environmental benefits that co-working spaces can offer. Among other things, co-working spaces can be seen as part of the sharing economy, where goods and services are shared to decrease usage of resources and daily commuting, which in turn leads to reduced carbon dioxide emissions. From an environmental point of view, conventional offices have been shown to be an ineffective way to use resources, since the premises are not fully utilised. The US-ES programme's specific interest in co-working spaces concerns their ability to merge the benefits of urban commons and digitalisation.

“From an environmental point of view, conventional offices have been shown to be an ineffective way to use resources, since the premises are not fully utilised.”

During the year, programme director Johan Colding was appointed Professor of Sustainability Science at the University of Gävle and Åsa Gren was appointed Associate Professor in 'Sustainable Urban Design and Planning' at Chalmers University of Technology.

[1] Colding, J., L. Marcus and S. Barthel. 2021. Promoting partnership between urban design and urban ecology through social-ecological resilience building. In M. Wallhagen and M. Cehlin (Eds.): *Urban Transition - Perspectives on Urban Systems and Environments*. Intech Open Book Series.

Topics

Some areas of research at the Beijer Institute are conducted outside the research programmes. This may occur for instance when the research is relevant for several research programmes or is in the form of early investigations into a new field that may develop into a research programme in the future. To highlight these and how they fit within our general research agenda, they have been collected under the section Topics.

[1]
Crépin A.-S. and J. C. Rocha. 2021. Beijer Discussion Paper 275: Cascading regime shifts in pollution recipients and resource systems. *Beijer Discussion Paper Series*.

Biosphere economics

Biosphere economics is a recurring topic in the Beijer Institute's research. Grasping how the economy interplays with the complexity of nature is essential for achieving a deeper understanding of the relationship between ecosystems and socio-economic development.

[2]
Engström, G., J. Gars, C. Krishnamurthy, D. Spiro, R. Calel, T. Lindahl and B. Narayanan. 2020. Carbon pricing and planetary boundaries. *Nature Communications* 11:4688.

Economic dimensions of regime shifts

In a recent Beijer Discussion paper, the implications of multiple systems being connected and whether regime shifts can then spread between systems is investigated¹. The analysis focuses on natural recipients for pollution and ecosystems that provide renewable resources. Using a modelling approach, the authors identify mechanisms through which cascading effects can either increase the probability of a shift in a particular location or decrease it.

[3]
Engström, G. J. Gars, N. Jaakkola, T. Lindahl, D. Spiro and A. van Benthem. 2020. What Policies Address Both the Coronavirus Crisis and the Climate Crisis? *Environmental and Resource Economics* volume 76:789–810.

Land and water resources

Deputy director Anne-Sophie Crépin is continuing her participation in the SESYNC project '*Advancing integrated process-based modelling of complex socio-environmental systems*', with the aim of improving decision support for policy makers dealing with land and water resources. The collaboration is now taking place online only, through meetings and work on joint articles.

Anne-Sophie Crépin applied, as principal Investigator, for project funding from a large grant advertised by the Swedish Research Council on transdisciplinary research environments. The application was among the 12% selected for the second round of evaluations, which will take place in August. The purpose of the proposed project is to improve scientific understanding

and modelling capacity of the dynamic interactions between atmospheric water flows, land-use changes and economic activities. The project will also explore conditions that may trigger abrupt changes resulting from these interactions and identify potential advances related to impacts of climate change and policy design. The project has partners at Stockholm Resilience Centre (Stockholm University, Sweden), the Swedish University of Agricultural Sciences (Uppsala, Sweden) and Kansas University (USA).

Integrated assessment models of global environmental problems

An article in *Nature Communications*, led by Beijer Institute researchers, explores the global environmental effects of carbon pricing, beyond its effects on carbon emissions². The authors show that the case for global carbon pricing is even stronger if the aim is to remain within planetary boundaries, because it would also improve the situation with regard to several planetary boundaries, such as biodiversity or land use (read more on page 22).

The same Beijer Institute researchers, with other co-authors, published an article in *Environmental and Resource Economics* in which they investigated appropriate policies to address both the climate and the Covid-19 crises³. They showed that climate policies such as labour-intensive green infrastructure projects and carbon pricing, coupled with lower taxation on labour, could boost the economic recovery after Covid-19. They also showed that policies aimed at supporting economic recovery after Covid-19 should focus on aiding service sectors, education and healthcare, which are low-emissions sectors.

This strand of research was awarded funding by Formas, for a project under the leadership of Therese Lindahl (read more on page 25).

Anthropocene – the age of mankind

In the Anthropocene, the age of humankind, the human population and human activities have accelerated to become the dominant force shaping the dynamics of the biosphere and the Earth system as a whole. The speed, spread and connectivity of the human dimension are unprecedented in history. Humanity and its actions now constitute the major force in the evolution of life on Earth. Social conditions, health, culture, democracy, power, justice, inequity, matters of security and even survival are intertwined with the Earth system and its biosphere, in a complex interplay of local, regional and global interactions and dependencies.

In this new situation, it is important to recall that existing as part of the biosphere means that the environment is not something outside the economy or society, or a driver to be accounted for when preferred, but rather the very foundation that civilizations exist within and rely upon. Therefore, our research at the Beijer Institute is based on the understanding that the economy is embedded in the biosphere, and that the global economy operates within the planetary boundaries of the Earth system and the new realities of the Anthropocene. The Beijer Institute is engaged in work on Earth resilience in the Anthropocene with the Potsdam Institute for Climate Impact Research and Stockholm Resilience Centre, and in a collaboration with Princeton University on the Earth resilience and sustainability initiative. Beijer researchers also contribute to the Earth Commission as part of Future Earth.

Implications of a new reality

This new human and nature reality was the bottom line for the major synthesis serving as the White Paper for the First Nobel Prize Summit, as reported on pages 34–35 in this Annual Report. It was also the foundation for the Dasgupta Review: *The Economics of Biodiversity*, commissioned by HM Treasury in the UK, a review that calls for changes in how we think, act and measure economic success to protect and enhance our prosperity and the natural world.

In the Anthropocene, the human population is predominantly an urban population. Ongoing global urbanisation is clearly a driver and accelerator of shifts in diversity, new cross-scale interactions, decoupling from ecological processes, and increasing risk and exposure to shocks. This makes it even more important to reconnect development to the biosphere foundation and build resilient futures. This challenge was the focus of a workshop organised together with researchers at Stanford University, some findings from which have now been published¹.

The intertwined human-nature dynamics of the Anthropocene were also investigated this year in relation to the rise in antibiotic and pesticide resistance and associated governance challenges. This work led to suggestions for the creation of an international 'One Health' platform for online learning and sharing experiences².

[1]
Elmqvist et al. 2021. Urbanisation in and for the Anthropocene. *npj Urban Sustainability* 1:6.

[2]
Wernli, D., Jørgensen, P.S., Parmley, E.J., Troell, M., et.al. 2020. Evidence for action: a One Health learning platform on interventions to tackle antimicrobial resistance. *Lancet Infectious Diseases*.

[3]
Walker et al. 2020. Navigating the chaos of an unfolding global cycle. *Ecology and Society* 25(4):23.

[4]
Crona, B., C. Folke and V. Galaz. 2021. The Anthropocene reality of financial risk. *One Earth* 4(5):618–628.

Building back better

The rapid global spread in the recent coronavirus pandemic has exposed the fragility of the tightly interconnected globalised world of the Anthropocene. How to build back better following the pandemic was investigated in a study led by Beijer Fellow Brian Walker³. A critical phase in building back is the brief period after crisis when novelty and innovation can change the future trajectory. Without preparing for this window of opportunity, deep, systemic change may be difficult to achieve. The study concluded that deliberate, fundamental cultivation of emergence is needed to enable transformation toward better futures and avoid inevitable reinforcement of a system that is ultimately worse for all.

New financial realities

Financial investment will inevitably play an important role in transforming Anthropocene dynamics towards sustainable futures and will be critical to confront the new risk landscape of the Anthropocene. However, current financial risk frameworks focus primarily on financial materiality and risks to the financial sector, and do not take into account investment externalities that will aggravate climate and other environmental change and deflect current sustainable finance initiatives from their course. A ground-breaking study in this new research space, led by the Beijer Institute's close partner GEDB, illustrates how the cognitive disconnect around risk plays out in practice⁴.

The Askö meetings

– bringing disciplines together for sustainable solutions

[1]
Polasky S., A.-S.
Crépin et al. 2020.
Corridors of Clarity:
Four Principles to
Overcome Uncertain-
ty Paralysis in the
Anthropocene.
BioScience biaa115

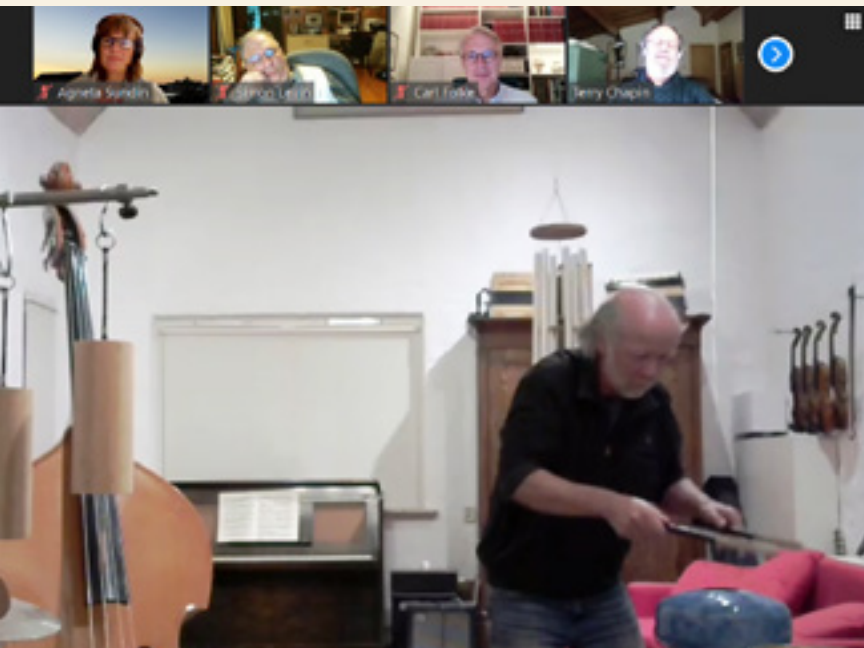
[2]
Adger, W.N., A.-S.
Crépin, C. Folke, D.
Ospina. et al. 2020.
Urbanization, Migra-
tion, and Adaptation
to Climate Change.
One Earth 3(4):
396-399.

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 on Askö, a Swedish island in the Baltic Sea. Over the years, the Askö meetings have generated unique cooperation between these disciplines that has extended to other disciplines. Each year, an exciting frontier issue is discussed and this generally results in a full paper, often published in a leading scientific journal.

The 2020 Askö meeting was held digitally and focused on *Responding to change in diverse ways in social, economic and ecological systems*. It was diligently led by Brian Walker and a core writing group of experts on the topic. The discussions and subsequent draft paper focused on response diversity, which is an important property of ecosystems and social systems that helps maintain their ability to continue to perform essential functions, even in the face of perturbations. In ecosystems, for example, having many different types of species that can perform pollination under a wide range of weather conditions is another way to handle variability. In social systems, migration is a possible response to disruptions like wars or famines.

The Askö meetings provide a forum for interesting and creative discussions, with the goal of learning from each other and combining knowledge in order to devise creative solutions to some of the most pressing problems of our times.

Marten Scheffer entertaining colleagues at the digital Askö meeting in 2020.



An unusual Askö meeting

Because of the Covid-19 pandemic, we decided early on to move the meeting online, a new experiment. How could we possibly achieve the atmosphere of trust and intense discussions through an online meeting?

We decided to hold meetings between 10 pm and 1 am Central European Time (CET) on three consecutive days over a week-end, which meant an early morning for our Australian leader and usual working hours for the American participants.

In an attempt to recreate as much of the usual meeting atmosphere as possible, we organised some short group sessions between plenaries and social sessions during which we could be more informal. The social sessions proved to be very much appreciated. Some sessions were devoted to poetry and musical performances by participants.

Despite the unusual conditions, the 2020 Askö meeting was a success and generated a draft paper that was sufficiently advanced to allow the core writing group to develop a full paper during the year.

Recent Askö publications

Two articles initiated during Askö meetings have been published in the past year.

The first deals with the fact that, despite major consequences for human well-being, both now and in the future, human institutions have largely failed to develop effective responses to global environmental change, not least global warming and loss of biodiversity¹. While acknowledging other factors behind this failure, such as lack of leadership and disagreements over priorities, the study, led by Beijer Fellow Steve Polasky from the University of Minnesota, focused on the role of uncertainty and complexity. The authors claim that too much focus on complex interactions can create a barrier to appropriate policy decisions and cause uncertainty paralysis, signified by failure to act even in the face of looming threats. The authors suggest four principles to overcome this uncertainty.

The second published article, based on the 2017 Askö meeting, argues that migration needs to be part of urban and national planning and international co-operation, because it is a potentially effective adaptation to climate change². (Read more on page 21.)

Selected publications

Fundamentally redefining resilience and development

It is becoming increasingly evident that development challenges such as food and water shortages are inextricably linked to emerging crises like pandemics, rising inequalities and climate change. Despite this, most development interventions still pay too little attention to such interdependencies. Instead, they tend to prioritise short-term goals. Ultimately, this undermines resilience and fails to deliver positive development outcomes, it is argued in a study published in *Ambio*, which takes a new perspective that offers a new alternative.

Redefining development

The team of researchers behind the article, led by Beijer Young Scholar Jamila Haider at Stockholm Resilience Centre (SRC), and including former Beijer Young Scholar Maja Schlüter (SRC) and Beijer Affiliated researcher Belinda Reyers (Stellenbosch University) and director Carl Folke, show what it means to instead adopt a complex social-ecological systems approach to development.

Drawing on the literature on co-evolution, the authors suggest that development can be redefined as a co-evolutionary process of social and ecological interdependence. Co-evolution is a theory that addresses how different entities or relationships mutually influence each other's development.

“Adopting a co-evolutionary perspective encourages a radical rethinking of how resilience and development are conceptualised and practised across global to local scales”, explains Jamila Haider.

The paper proposes three key ingredients of such an approach and explores what these would imply for farmers in the Pamir Mountains, a region of high biocultural diversity in the poorest area of Central Asia that has been the subject of many development interventions.

Proposition 1: “Social-ecological relationships co-evolve”

A co-evolutionary approach enables social and ecological dynamics to be considered in relation to one another and in constant interplay.

For example, over 33 different apple varieties have evolved through social-ecological interactions in the Pamir Mountains. Losing one of these varieties may not appear to be a major issue,

but such loss also influences culture, spirituality and social organisation. Such co-evolved dynamics must also be considered in any development intervention.

Proposition 2: “Resilience is the capacity to filter practices”

Resilience can be conceptualised as the capacity to adapt to change or to transform by filtering social-ecological relationships (i.e. to influence what is selected and retained).

For example, a woman growing her own landrace seeds (locally adapted and domesticated) is constantly selecting successful practices, thereby influencing the variation and retention of both agricultural crops and cultural practices. However, she may not have the same influence that a development organisation has to mould the filter so that her ideas and practices can survive, and thereby the innovative potential for variation also disappears.

Proposition 3: “Development is a co-evolutionary process shaping pathways of persistence, adaptation or transformation”

Development outcomes affect social-ecological relationships, which creates opportunities for future interventions.

For example, an “improved” wheat seed variety was introduced twenty years ago to two communities. The first community abandoned its traditional seed varieties and now relies on food aid imports because the introduced variety failed after two years. The second community kept its traditional varieties and practices and had local wheat seeds to fall back on when the new variety failed.

“Hence, resilience in development is not only about shocks and crisis preparedness, but about understanding the capacities that have evolved to be able to live with changing circumstances and transform to improved and sustainable conditions”, concludes Carl Folke.

Haider, L.J., M. Schlüter, C. Folke and B. Reyers. 2021. Fundamentally redefining resilience and development: A co-evolutionary perspective. *Ambio* 50:1304-1312

A family threshing wheat with oxen in Badakshan province, Northern Afghanistan. Photo: Jamila Haider



Global aquaculture more sustainable in the last 20 years

Twenty years ago, an analysis led by Stanford University sparked controversy by highlighting the damage caused by fish farming to ocean fisheries. A follow-up study takes stock of the industry's progress and points to opportunities for sustainable growth. It shows that over the years, the diverse industry – which ranges from massive open-ocean salmon cages to family farm freshwater tilapia ponds – has made significant strides toward sustainability, but also highlights necessary measures for improvement. The findings can help shape how consumers think about the seafood they buy and inform governance strategies critical to global food and nutrition security.

Measures needed for the environment and the economy

The article, with Beijer programme director Max Troell and Beijer Fellows on the author team, notes that in order for the global aquaculture sector to deliver on its full promise, more effective oversight measures are needed to help ensure that its environmentally sound systems are economically viable.

“If we don't get it right, we risk the same environmental problems we've seen in land-based crop and livestock systems: nutrient pollution, excessive use of antibiotics and habitat change that threatens biodiversity,” says lead author and Beijer Fellow Rosamond Naylor, Stanford's School of Earth, Energy & Environmental Sciences.



From carnivores to more vegetarians

The original study sparked controversy by stating that farmed fish and shellfish in some cases added pressure to ocean fisheries, instead of relieving it, because carnivorous farm-raised species require large amounts of wild fish for feed.

Since then, global aquaculture production has tripled in volume. In the follow-up article in *Nature*, aquaculture specialists and scientists from Asia, Europe, South America and the U.S. assessed the state of the industry by synthesising data from hundreds of studies carried out over the past two decades on issues ranging from value chain developments in freshwater aqua-

culture to the use of wild fish in feeds and market challenges in seaweed and bivalve (oysters and clams) production.

Their analysis considered key challenges and uncertainties, such as the impact of climate change on the industry, adoption of sustainable seafood certification programmes by low-income producers and the ability of shellfish and seaweed farmers to profit from providing ecosystem services, such as carbon capture.

The researchers also found that the ratio of wild fish input per fed fish output has dropped almost seven-fold since 1997.

“We have been successful in converting carnivorous fish, such as salmon and trout, largely into vegetarians,” says study co-author Ronald Hardy of the Aquaculture Research Institute at the University of Idaho.

Concrete measures suggested to limit risks

In the article, the researchers call for better management of antimicrobial use in fish farming to limit the development of drug-resistant microbes that threaten both fish and human health, and regulation of marine farm sites. They also recommend incentives for sustainably designed systems to prevent cross-contamination between fish waste and surrounding waters, and a food systems approach to governance that considers nutrition, equity, justice and environmental outcomes and trade-offs across land and sea.

Text: Sarah Cafasso, Stanford Natural Capital project

Naylor, R.L., R.W. Hardy, A.H. Buschmann, S.R. Bush, L. Cao, D.H. Klinger, D.C. Little, J. Lubchenco, S.E. Shumway, and M. Troell. 2021. A 20-year retrospective review of global aquaculture. *Nature* 591:551–563.

Long legacy of aquaculture research

Beijer Institute director Carl Folke and colleague Nils Kautsky started investigating the rapidly expanding aquaculture industry back in the 1980s, work which resulted in the 1989 *Ambio* paper ‘The role of ecosystems for a sustainable development of aquaculture’.

Contrary to common belief at the time, it showed that the success of the aquaculture industry still rested on the work of marine food webs and ecosystems, and that this should be accounted for in the development of the industry. It also stressed the unsustainability of ‘throughput systems’ of production, i.e. systems that use a lot of inputs and generate a lot of waste and thus put pressure on the environment, which dominated in the early days of salmon farming.

In a ‘Behind the paper’ article in *Ambio* as part of the journal's 50th anniversary, Folke and Kautsky describe the development of this research area, including how a series of workshops organised by the Beijer Institute in the late 1990s, in collaboration with Rosamond Naylor and Rebecca Goldberg (then at the Environmental Defense in New York), led to the *Nature* article in 2000 described above.

Easing the burden of climate migration

The number of people leaving their homes to flee climate-related catastrophes such as storms, wildfires or drought will rise as the effects of global warming become more apparent. Such climate migration comes with great personal costs for those forced to move, but there is also a societal cost for the origin and destination locations. However, according to a commentary published in *One Earth*, migration is a potentially effective adaptation to climate change and thus needs to be part of city and national planning and international cooperation.

Much can be done at country level

The majority of migrants around the world move within their own country. The interdisciplinary team of authors behind the commentary point out that within countries, governments can help to reduce the costs of dislocation, promote safe and orderly resettlement, and provide infrastructure and services in safe locations.

The authors, led by Neil Adger, chair of the Beijer Institute board, gathered at one of the annual Askö meetings arranged by the Institute and attended by a number of Beijer Institute researchers and Fellows.

“More than 140 million people could potentially be directly displaced within their own countries by climate change impacts by 2030”, they write.

Planned relocation can become more effective through accountable governance and participation by all those affected. For example, long-standing consultation processes with coastal communities in Alaska have minimised the trauma of relocation and loss of place and identity, through sensitive deliberation with communities. In another example, investment in systems

to evacuate whole communities in Bangladesh and help them return after damaging cyclones has significantly reduced the costs of displacement and has facilitated planned adaptation over recent decades.

Regional agreements can go far

Cross-border migration between countries currently represents only a fraction of global migration flows, but is likely to become more important given international migration trends and the amplifying effects of climate change. Up to one-third of the global population lives in places that, by 2070, will be warmer than the present-day Sahara Desert.

The authors of the commentary claim that cooperation across borders will make such moves more sustainable and reduce the humanitarian costs in the long run. Since most cross-border migration is to neighbouring countries, regional partnerships are often sufficient for effective cross-border migration agreements.

“For vulnerable populations, the lack of options and capacity to move is a major constraint. Grasping the opportunity to make migration an effective element of adaptation needs to become central to national adaptation strategies and a stronger focus in international agreements between already connected countries,” the authors conclude.

Adger, W.N., A.-S. Crépin, C. Folke, D. Ospina, F.S. Chapin III, K. Segerson, K.C. Seto, J.M. Anderies, S. Barrett, E.M. Bennett, G. Daily, T. Elmqvist, J. Fischer, N. Kautsky, S. A. Levin, J.F. Shogren, J. van den Bergh, B. Walker, and J. Wilen. 2020. Urbanization, migration, and adaptation to climate change. *One Earth* 3(4): 396–399.



Policies to keep us within planetary boundaries

The ‘planetary boundaries’ concept was first developed by a group of scientists, led by Beijer Fellow Johan Rockström, who proposed quantitative planetary boundaries within which humanity can continue to develop and thrive. Building on this concept, a publication in the journal *Nature Communications* looks at how policies to stay within one boundary can affect other boundaries. The research team found that a carbon tax policy, in combination with cuts in biofuel subsidies, could alleviate pressures on all planetary boundaries.

The planetary boundaries

The Earth has been in a remarkably steady state over the past 10,000 years, but human activities since the Industrial Revolution are now starting to threaten its balance. Rockström and colleagues developed a list of nine Earth system processes (ESPs) that are critical to maintaining a stable global environment. These are: stratospheric ozone depletion; loss of biosphere integrity (biodiversity loss and extinctions); chemical pollution and the release of novel entities; climate change; ocean acidification; freshwater consumption and the global hydrological cycle; land system change; nitrogen and phosphorus flows to the biosphere and oceans; atmospheric aerosol loading. There are also nine corresponding planetary boundaries beyond which mankind may not proceed without risking potentially catastrophic consequences.

“In this project, we wanted to investigate the economic activities that put pressure on these boundaries and how they are connected by economic linkages,” says Beijer Institute economist Johan Gars.

A new model reveals the linkages between boundaries

Since the ESPs are interlinked, the research team, led by Beijer Institute researchers in collaboration with colleagues from Uppsala University, and Georgetown University, developed a stylised but empirically grounded framework for analysing these interlocking processes. With the help of this integrative assessment model, they assessed how the main drivers of the planetary boundaries would be affected by stricter climate policies, exemplified by a global carbon pricing policy.

They found that such a policy would have a positive effect not only on carbon emissions, but also on most other planetary boundaries. However, it would also increase the pressures on land use and water, largely as a consequence of a resulting

increase in the incentive to produce biofuel. On extending the model with a biofuel policy, the team found that the combination of carbon pricing and a reduction in biofuel subsidies would be able to ease all of the planetary pressures.

Taking account of human welfare

A new major grant from the Swedish research council sustainable development Formas will enable the team to further investigate policy effects on the planetary boundaries and on other important aspects using this multiboundary perspective. This is important before translating the results into actual policy advice, according to Johan Gars:

“What we haven’t considered is how it would affect human welfare. For instance what we can see is that it would increase food prices and reduce food and energy supply. We would also need to know the broader consequences in other dimensions than reducing the planetary pressures.”



Engström G., J. Gars, C.K. Krishnamurthy, D. Spiro, R. Calel, T. Lindahl, and B. Narayanan. 2020. Carbon pricing and planetary boundaries. *Nature Communications* 11:4688.

The Beijer Institute recognised in *Ambio* jubilee collection

Ambio – a journal of the environment and society – was founded in 1972 in connection with the legendary first United Nations conference on the environment, which was held in Stockholm, Sweden, in June 1972. *Ambio* is an interdisciplinary journal of the Royal Swedish Academy of Sciences with a focus on environmental and sustainability challenges. As such, it offered a natural choice for the Beijer Institute to interact and collaborate with. This collaboration became instrumental already in the early days of the Beijer Institute in the 1990s. Two special issues of *Ambio*, edited by Carl Folke, Charles Perrings, Karl-Göran Mäler and colleagues (1992, 1993), strongly contributed to the institute’s influential research programme *The Ecology and Economics of Biodiversity Loss*. Nearly thirty years later, the Beijer Institute was proud to be given the opportunity to publish the White Paper on the first Nobel Prize Summit ‘Our Planet, Our Future’ in *Ambio*. Since 1991, the institute has published around 50 papers in the journal, which together have been cited some 5800 times (according to Web of Science).

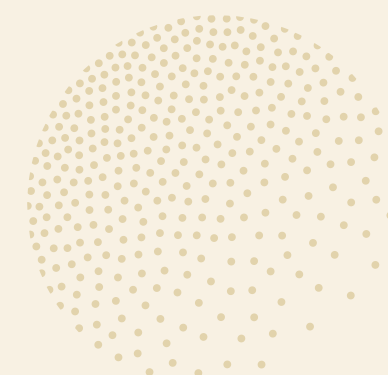
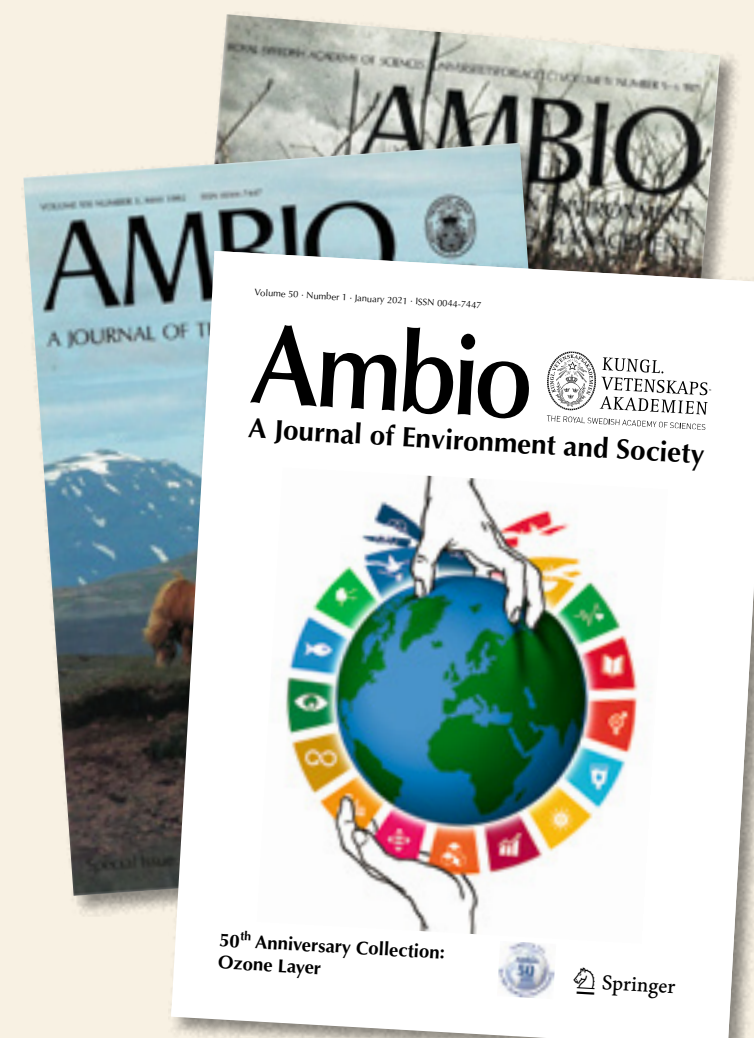
In 2021, *Ambio* celebrates fifty years of great work with an *Ambio* golden jubilee collection and a conference in September 2021. Editor Bo Söderström describes in his editorial “*Ambio* – the first 50 years” how the themes for the celebration were decided and the papers selected. For each selected paper, an *Ambio* editor provides background and historical context for the original articles in an “Editorial”; one (or more) of the authors behind the selected articles provides a personal reflection on the impact of the article from a professional and/or scientific viewpoint in a “Behind the paper”; and, finally, one or more peers reflects in a “Perspective” on the impact, how each article helped reframe policy targets or new standards, the current status of the research field and future challenges.

The *Ambio*-Beijer Institute collaboration has been recognised in a highly recommended historical overview by Sverker Sörlin entitled “The environment as seen through the life of a journal: *Ambio* 1972–2022”, and also in a collection of thematic articles celebrating the 50th anniversary throughout the year, with eight publications focusing on Beijer Institute research. Three of these papers are among the top ten cited of the more than 4000 papers published in *Ambio*, namely:

- Folke, C. et al. 2002. Resilience and sustainable development: Building adaptive capacity in a world of transformations.
- Steffen W. et al. 2011. The Anthropocene: From global change to planetary stewardship.
- Gadgil, M., Berkes, F. and Folke, C. 1993. Indigenous knowledge for biodiversity conservation.

The paper by Folke et al. is a synthesis of a major report from the Swedish Government and the International Council for Science written for the *Rio+ 20 meeting* in Johannesburg in 2002. That by Steffen et al. is one of the three background papers for the *3rd Nobel Laureate Symposium on Global Sustainability: Transforming the World in an Era of Global Change*, held at the Royal Swedish Academy of Sciences in 2011. The paper by Gadgil et al. was part of the Beijer Institute’s biodiversity programme and a forerunner in linking traditional societies and indigenous knowledge to stewardship of the biosphere and biological diversity.

The fruitful and rewarding collaboration with *Ambio* will no doubt continue!



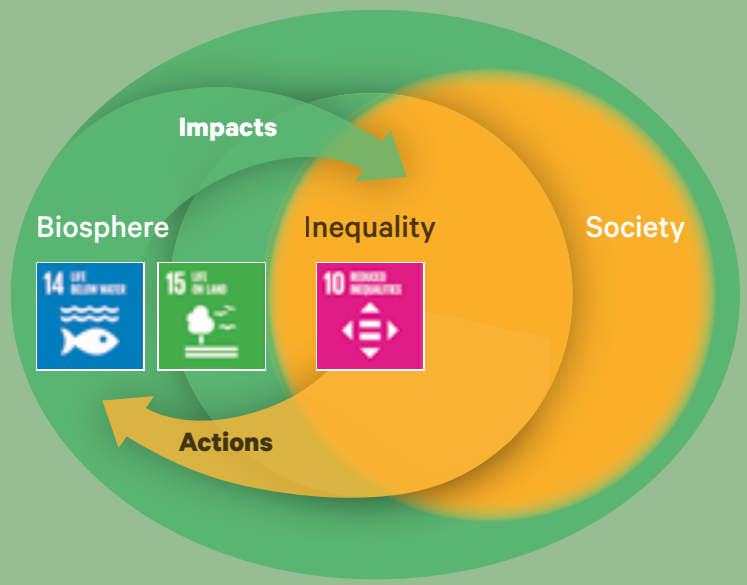
Inequality and the biosphere: Achieving the Sustainable Development Goals in an unequal world

Reducing inequalities and safeguarding the biosphere are essential to achieving sustainable development, yet the interactions between these goals have been largely under-explored. An improvement in one goal can enhance, but can also undermine, progress towards another goal, thereby hindering their collective achievement. The second cohort of the Beijer Young Scholars (BYS2) has received major funding from the Swedish research council for sustainable development, Formas, for a four-year project to identify synergies and trade-offs between reducing inequalities and safeguarding the biosphere. The project was one of only 11 applications (out of 174) to obtain a grant in that Formas funding round.

Project objectives are 1) to identify *patterns* between different types of inequality and environmental indicators; 2) to investigate *processes* hindering achievement of the United Nations Sustainable Development Goals (SDGs), exemplified using the case of the seafood and palm oil industries in Indonesia; and 3) to identify *practices* that can harness win/win interactions between SDGs while minimising negative trade-offs. This project will provide new data and scientific knowledge regarding the interactions between SDGs 10 (Reduced inequalities), 14 (Life below water) and 15 (Life on land). It will also enable application of this knowledge for transformative action at local, regional and global scale.

Due to the Covid-19 pandemic, the focus in work to date has been on project components that do not rely on in-person field-work. For instance, project members have sought to identify patterns in national-scale inequality and environmental indicators by making use of publicly accessible online databases. A large literature review has been initiated, with the aim of uncovering how inequalities in society can shape and influence the biosphere.

Concrete plans for the coming year include laying the foundations for local stakeholder engagement and participation in Indonesia, in close cooperation with the Indonesian Institute of Sciences (LIPI).



Amount received (all to Beijer): 20 000 000 SEK (of which 11 000 000 to Beijer)

Funder: Swedish research council for sustainable development, Formas

Duration: 4 years, January 2021-December 2024

Project team:
Principal investigator: Carl Folke (Beijer Institute). Junior principal investigators: Patrik Henriksson (Beijer Institute and Stockholm Resilience Centre), Caroline Schill (Beijer Institute), Emilie Lindkvist and Juan Rocha (Stockholm Resilience Centre). Research assistant: Emmy Iwarsson (Beijer Institute). Core team members: Tomas Chaigneau (University of Exeter, UK), Maike Hamann (Stellenbosch University, ZA), Robert Heilmayr (University of California Santa Barbara, US), Alon Shepon (Tel Aviv University, IL), Andrew Tilman (University of Pennsylvania, US), Tong Wu (Chinese Academy of Sciences, CN), Tracie Curry, Yolanda Lopez-Maldonado, and Anne-Sophie Crépin (Beijer Institute, senior advisor)

Extended team:
Kevin Berry (University of Alaska Anchorage, US), Jonas Hentati-Sundberg (Swedish University of Agricultural Sciences), Amir Jina (University of Chicago, US), Matias Piaggio (International Union for the Conservation of Nature (IUCN), US), Jiangxiao Qiu (University of Florida, US), Inge van den Bijgaart (Gothenburg University)

Advisory board: Belinda Reyers (Centre for Sustainability Transitions, Stellenbosch University), Shakuntala Thilsted (Worldfish), Henrik Österblom (Stockholm Resilience Centre)

Local project partner: Indonesian Institute of Sciences (LIPI)

Other partners: Seafood Business for Ocean Stewardship (SeaBOS) and Round-table on Sustainable Palm Oil (RSPO)

The Economics of Planetary Boundaries

Human activities are pushing the Earth system beyond its ‘planetary boundaries’, risking catastrophic environmental change. Action is urgently needed, but well-intentioned policies designed to reduce pressure on a single boundary can, through economic feedbacks, lead to aggravation of other pressures. Which policies would keep humanity within the Earth’s safe operating space while meeting other sustainable development goals? This question, of monumental importance for the future of humanity, is what the project *The Economics of Planetary Boundaries* aims to answer.

The project is also funded by Formas with SEK 20 000 000 for four years also as part of the call “Realising the global sustainable development goals 2019”. The interdisciplinary research team, consisting of economists and environmental scientists, will develop and validate an economic-environmental integrated assessment model (IAM) that captures the most important aspects of the two-way interaction between the global economy and the Earth system within which the economy is embedded.

The planetary pressures are related physically and through their drivers in terms of human activities, and reducing a planetary pressure can make it more difficult to fulfil the United Nations Sustainable Development Goals (SDGs). For instance, not converting natural forest cover to agricultural land could potentially conflict with SDG 2, ‘Zero hunger’. Furthermore, the reaction of economic agents to attempts at alleviating one planetary pressure can have negative side-effects on other pressures or make it more difficult to fulfil other SDGs.

A starting point for the project is a previous study, involving several project participants, which highlighted the centrality of the food and energy sectors for planetary pressures¹. This pointed to clear relationships between the planetary boundaries and

other sustainable goals, such as ending hunger. It also showed that policies enacted to address one environmental issue, such as a tax on fossil fuel to combat climate change, can have unintended effects on other planetary boundaries, such as increased land use in agriculture to grow biofuels.

Practically, project activities will consist of a combination of theoretical modelling and empirical work to make the model quantitatively relevant. The model will then be used to analyse various policies that could be enacted to address planetary pressures. The policies considered will be determined based on surveys and other forms of interactions with relevant stakeholders.

The work within the project aims to integrate social and natural sciences and this is reflected in the cross-disciplinary composition of the team.

Amount received (all to Beijer): 20 000 000 SEK (of which 3 700 000 to Beijer)

Funder: Swedish research council for sustainable development, Formas

Duration: 4 years, January 2021-December 2024

Project team:
Principal Investigators: Johan Gars (Beijer Institute) and Daniel Spiro (Uppsala University). Team members: Lint Barrage (University of California Santa Barbara), Sarah Cornell (Stockholm Resilience Centre, Stockholm University), Gustav Engström (Beijer), Peter Søgaard Jørgensen (Global Economic Dynamics and the Biosphere and Stockholm Resilience Centre), Steven Lade (Stockholm Resilience Centre and The Australian National University), Chuan Zhong Li (Beijer Institute and Uppsala University), Daniel Moran (Norwegian University of Science and Technology) and Arthur van Benthem (The Wharton School, University of Pennsylvania). There will also be four PhD students involved in the project. Fei Ao (Uppsala University) has been involved from the start. Daniel Itzamna Avila-Ortega has just been recruited and will be based at Stockholm Resilience Centre (Stockholm University).

[1]
Engström G., J. Gars, C. K. Krishnamurthy, D. Spiro, R. Calel, T. Lindahl and B. Narayanan. 2020. Carbon pricing and planetary boundaries. *Nature Communications* 11(4688).

A sustainable and resilient food system

Changing the way we produce, process and consume food is one of the world’s most pressing questions. Food and agriculture are at the very heart of global commitments such as the Paris Climate Agreement and the 17 UN Sustainable Development Goals. Therefore, transforming the food system is key to transforming the whole of society for greater alignment with sustainable development and resilience.

Beijer Institute researchers are part of the large research programme Mistra Food Futures (MFF), funded by The Swedish Foundation for Strategic Environmental Research (Mistra). The overarching aim of MFF is to create a science-based platform to enable transformation of the current Swedish food system into a future system that is sustainable (in all three dimensions: environmental, economic and social), resilient and delivers healthy diets.

The work is being carried out by a transdisciplinary consortium where key scientific perspectives are combined and integrated, and where the scientific process of systematic inquiry is pursued in close collaboration with non-academic partners from all parts of the food system, including private companies, non-government organisations and government agencies. MFF will also initiate transformation through activities applied together

with food system actors, through supporting ongoing activities and through dissemination and curation of cutting-edge science to relevant industry and policy actors.

Therese Lindahl is co-leader of Work Package 7 *Developing strategies for food system transformation*, which will investigate behavioural drivers and constraints for a sustainability shift in the production and consumption segments and in various mid-level value chain segments. It will also investigate how policy related to consumption and production can be designed to transform behaviour that supports sustainable development and resilience of the food system.

Programme host:
Swedish Agricultural University (SLU). Other academic partners are Stockholm Resilience Centre (SRC), and Swedish Innovation Institute (Rise).

Total amount to MFF: 64 000 000 SEK

Total amount to WP7: 5 840 000 SEK (of which ~2 920 000 SEK to the Beijer Institute).

Duration: 4 years, January 2021-December 2024

Work package leaders: Therese Lindahl (Beijer Institute) and Helena Hansson (Swedish University of Agricultural Sciences, SLU)

Other members from the Beijer Institute: Malin Jonell

Programme website: mistrafoodfutures.se

What makes effective climate policies politically feasible?

Another aspect of climate and environmental policies is being studied in a major research project led by Therese Lindahl. For climate policies to be effective, they must have the intended effect and different policies must not counteract each other. To function, they also have to be politically and publicly acceptable. In democratic societies, political decisions are the outcome of a process influenced by the opinions of both voters and politicians. The project *What makes effective climate policies politically feasible* aims to study the attitudes of voters and politicians to different climate policies, to tease out the determinants of political feasibility of climate policies focusing on taxes on emissions. Voter attitudes will be studied using surveys and experiments, in order to uncover how various aspects of proposed policies, such as how the tax revenues generated are used, affect voters’ opinions, and to determine how these opinions vary with individual characteristics, such as income, geographical residence and ideological leanings. The attitudes of politicians will be evaluated using transcripts of parliamentary debates. The results from these empirical studies will then be combined with outputs from economic models to identify efficient policies that are also politically feasible.

Amount received (all to Beijer): ~9 600 000 SEK

Funder: Formas

Duration: 4 years, January 2021-December 2024

Principal Investigator: Therese Lindahl (Beijer Institute)

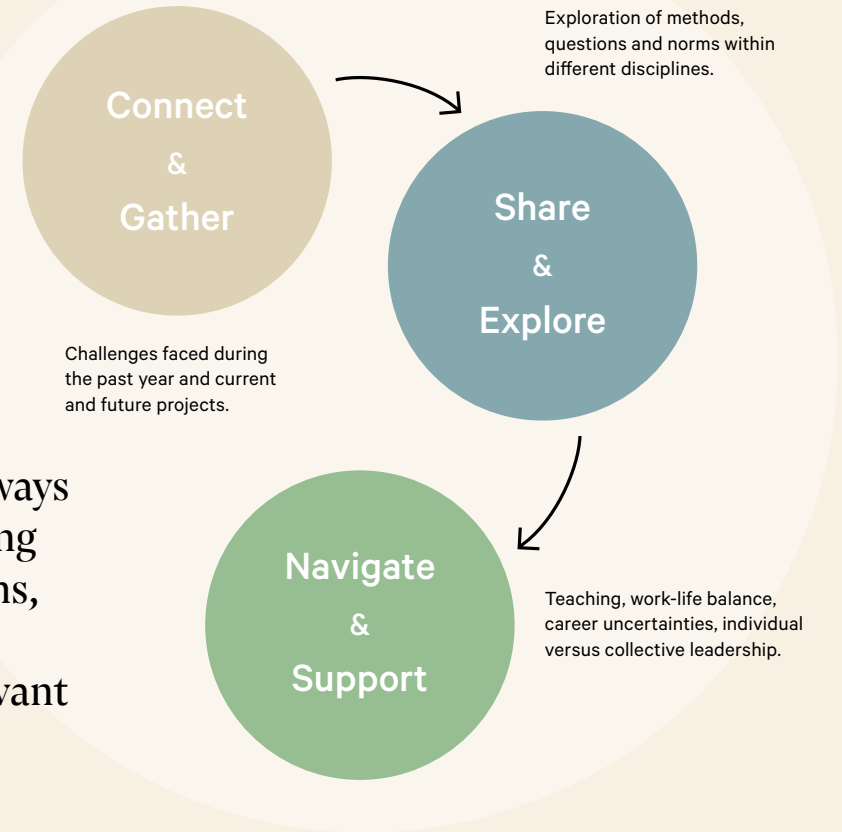
Other project-members from Beijer Institute: Gustav Engström and Johan Gars

The Beijer Young Scholars

For the third cohort of the Beijer Young Scholars Programme (BYS3), 2021 marked the third year of the project and, unfortunately, the second year in a row where Covid-19 made it impossible to gather the whole group in person. Instead, members continued to rely on a series of quarterly online meetings and, ultimately, an enthusiastic three-day online workshop in May 2021, organised by the group members themselves and structured around three sessions.

The first session, “Connect and Gather”, provided time for everyone to update each other on their life and work, with a focus on challenges faced during the past year and current and future projects. The collaborative paper on climate change and Covid-19 (*Reimagining our shared climate future in a post-pandemic world*, in review) was also presented, with a discus-

sion about the process facilitated by lead author Elsa Ordway. The paper, an outcome from last year’s BYS3 annual meeting, uses science-fiction prototyping to describe scenarios of environmental and economic outcomes accruing from decisions made in the wake of the pandemic.



The final session, “Navigate and Support”, centred on the peer support that BYS can provide to each other when it comes to navigating the highs, lows and nitty-gritty of their journeys as early career researchers. Topics included teaching, work-life balance, career uncertainties, individual versus collective leadership and, again, disciplinary expectations. Insights from Beijer directors Anne-Sophie Crépin and Carl Folke emphasised the value of bringing people together and opening new spaces for creative thinking. The group is now exploring ways of capturing insights emerging from these online interactions, with the aim of developing content that

will be also relevant for future BYS cohorts – a “digital space” that becomes the natural home of each BYS cohort and acts as a bridge between cohorts.

“The group is now exploring ways of capturing insights emerging from these online interactions, with the aim of developing content that will be also relevant for future BYS cohorts”

The second session, “Share and Explore”, focused on the challenges of interdisciplinarity, with an exploration of methods, questions and norms within different disciplines. The lively discussion was enriched by contributions from Beijer chair of the board Neil Adger and provided the basis for a model that will be replicated

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Conferences

26th conference of the European Association of Environmental and Resource Economists

The Beijer Institute has been collaborating actively with the European Association of Environmental and Resource Economists (EAERE) for many years. Several former Beijer board members are fellows of the association or recipients of its lifetime achievement award. The Beijer Institute is an institutional member of EAERE and Anne-Sophie Crépin served on its council 2008–2011. The association organises an annual conference, which is one of the main meeting arenas for researchers working at the interface between economics and the environment. It attracts scholars from the whole world and several Beijer Institute researchers attend the conference regularly. Anne-Sophie Crépin reports from behind the scenes as part of the scientific committee:

“This year, the 26th conference of the association was organised by Technische Universität Berlin (TU Berlin) and Humboldt-Universität zu Berlin (HU Berlin) and, for the second time in its history, it was held online. Being in the Scientific committee allowed me to gain a much better understanding of all the thinking and planning required for the organisation of a large and high-quality conference.

More than 2500 papers were submitted and the committee received great support from several hundred reviewers, who read up to 10 full papers each. We also benefited from the invaluable help of the local organising committee and its supporting team of Excel wizards, who helped us sort and analyse the results of the reviews. Thanks to them and my fellow co-chairs, I felt we had in place an efficient and fair process to select almost 900 hundred papers of good quality to be presented at the conference.

Researchers regularly devote a substantial amount of their time to the community to assure the quality of science produced by others. This means reading and evaluating the work of peers as a reviewer or a discussant in a conference and contributing to organise arenas where this work can be assessed and discussed, such as scientific conferences and journals.

The conference included three very interesting plenary sessions: one panel session on sustainable finance and two plenary lectures by Valentina Bosetti (Bocconi University, Italy) and Joseph Stiglitz (Columbia University, US). Stiglitz talked about the social cost of carbon and the multiple difficulties involved in assessing it in a proper way. Bosetti highlighted the complex landscape of integrated assessment modelling and investigated what environmental economics can contribute to the energy transition debate.

There are pros and cons of having a conference fully online. One obvious challenge is that people are participating across multiple time zones. I also desperately missed having a physical meeting space where I could meet colleagues in more informal way and discuss the content of a presentation we had just attended or some potential future collaboration. The local organisers had taken substantial efforts to organise virtual areas

for such discussions and meetings. However, participants were tired after participating in the online scientific sessions and it was difficult to gain the same attendance and social exchange as would have been offered in a physical location.

However, I had the feeling that the online format and, in particular, the Q&A functions available for the plenaries allowed more people to dare to ask questions. This contributed to really interesting discussions in the sessions I attended. The online format also allowed people to join the conference who normally would not have undertaken the long travel – and all this for a tiny fraction of the CO₂ emissions that conference travel usually generates.”

By Anne-Sophie Crépin, Deputy Director

Scientific committee:

Anne-Sophie Crépin (Beijer Institute), Klaus Eisenack (HU Berlin, Germany) and Maria Loureiro (University of Santiago de Compostela, Spain).

NAS Workshop – Progress, Challenges, and Opportunities for Sustainability Science

The Beijer Institute took an active part in the design and content of the public workshop *Progress, Challenges, and Opportunities for Sustainability Science* organised by the US National Academies of Sciences, Engineering, and Medicine, held online 30 November–2 December, 2020. The aim of the workshop was to review the state of cutting edge research that can help societies meet the goals of sustainable development. It also aimed at providing scientific input to the *Grand Challenges in Science* initiative of the National Academy of Sciences (NAS) and to the first Nobel Prize Summit *Our Planet, Our Future* (see page 34–35).

The workshop was designed by a Steering Committee of selected NAS members. It was structured around six themes that research has shown to be important in the pursuit of sustainability: (1) measuring progress toward sustainable development; (2) promoting equity and justice in sustainability efforts; (3) adapting to shocks and surprise; (4) fostering innovation for transformational change; (5) linking knowledge with action; and (6) managing and governing complex nature-society systems. Each theme was addressed in a panel featuring presentations by, and discussions among, a half-dozen or so leading scholars from around the world.

The Beijer Institute was deeply engaged in themes (1), (3) and (4), which featured presentations and discussions by Beijer Institute researchers, Fellows and board members. The full workshop agenda, together with a set of background readings and videos of all the sessions and selected speaker presentations, can also be accessed on the NAS website (nationalacademies.org).

Steering committee:

Pamela Matson (Stanford University), William Clark (Harvard University), Arun Agrawal (University of Michigan), Partha Dasgupta (University of Cambridge), Ruth DeFries (Columbia University), Carl Folke (the Beijer Institute), Robert O. Keohane (Princeton University), Diana Liverman (University of Arizona) and Stephen Polasky (University of Minnesota).

Commoning the Anthropocene

Several Beijer Institute researchers were involved in organising and developing the programme for the conference ‘Commoning the Anthropocene’, hosted by the International Association for the Study of the Commons (IASC), Arizona State University and the University of Arizona. It was part of the 18th global IASC conference (Our Commons Future) 2021 which consists of a series of themed virtual conferences set to take place over the year. Beijer Institute programme director Marty Anderies, professor at the School of Sustainability at Arizona State University, was the conference chair for this particular conference, which aimed to bring together scholars interested in the role that the sharing of common resources (commoning) will play in the Anthropocene.

In many ways in the Anthropocene we are more connected than ever, and increasingly exposed to abrupt changes and deep uncertainties. One example of the issues discussed at the conference was: ‘Are we seeing new types of global commons emerging because of the connectedness?’ Programme director Therese Lindahl found the topic highly stimulating:

“For example, that human societies now affect the moisture cycle presents a very interesting and important challenge for figuring out how to share this resource (often across borders) in regions where rain is scarce.”

“Another topic I found very interesting was related to seed systems, which include plant breeding, genetic material, diversity and much more besides. Several studies presented at the conference gave examples of how new networks and forms of cooperation have developed, a form of commoning that can enhance the sustainability of seed systems.”

The conference, which took place on 21–23 April 2021, brought together participants in various live seminars, method workshops, networking events, pre-recorded talks and channels for sharing ideas.

Steering committee:

Marty Anderies (Arizona State University), Arun Agrawal (University of Michigan), Anne-Sophie Crépin (Beijer Institute), Graham Epstein (University of Central Florida), Therese Lindahl (Beijer Institute), Jean-Denis Mathias (INRAE, France), Beril Ocakli (HU Berlin), Caroline Schill (Beijer Institute), Eduardo Sonnenwend Brondisio (Indiana University Bloomington), Sergio Villamayor-Tómas (Autonomous University of Barcelona), Abigail York (Arizona State University).
2021anthropocene.iasc-commons.org

Tea harvesting in Kenya. The moisture cycle, vital for agriculture around the world, is an example of a common resource increasingly affected by human actions in the Anthropocene.

High-level launch of the landmark review

The Economics of Biodiversity

Beijer Fellow Sir Partha Dasgupta's review, *The Economics of Biodiversity*, commissioned by the UK Treasury, presents the first comprehensive economic framework of its kind for biodiversity. It calls for urgent and transformative change in how we think, act and measure economic success, in order to protect and enhance our prosperity and the natural world. The launch on 2 February, organised by The Royal Society, was introduced by HRH Prince Charles and UK Prime Minister Boris Johnson.

Grounded in a deep understanding of ecosystem processes and how they are affected by economic activity, the new framework presented in the 'Dasgupta Review' sets out the ways in which we should account for nature in economics and decision-making.

Partha Dasgupta was the Beijer Institute's first chair of the Board. In a preface to *The Economics of Biodiversity*, he acknowledges the importance of cooperation with Beijer Institute founder, the late Karl-Göran Mäler, and the broader Beijer network of ecologists and economists that he helped to create.

"The Institute's mandate made it possible, which was unusual at that time, for ecologists and economists to conduct a regular series of workshops in ecological economics."

Those workshops led to international research programmes, several of which led to the body of research on which the review is founded.

Beijer director Carl Folke was one of the reviewers of *The Economics of Diversity*, together with several other Beijer Fellows.

Sir David Attenborough, the broadcaster and naturalist who has spent his life showing audiences around the world the magic of nature's biodiversity, wrote a foreword to the review and attended the launch. In his words, "This comprehensive and immensely important report shows us how by bringing economics and ecology face to face, we can help to save the natural world and in doing so save ourselves."

HRH Prince Charles introducing the report *The Economics of Diversity* at a launch event organised by the Royal Society.



In a new documentary, David Attenborough and Johan Rockström (above) examine biodiversity collapse on Earth and how this crisis can still be averted.

Netflix documentary

— Breaking boundaries: The science of our planet

The Netflix documentary *Breaking boundaries: The science of our planet* follows the scientific journey of Beijer Fellow Johan Rockström and the scientific team which established the nine planetary boundaries that humanity must stay within, not just for the stability of the planet, but also for our own future. The film is narrated by Sir David Attenborough.

The research underpinning the planetary boundaries framework, first published in 2009, was led by Rockström and a group of 28 internationally renowned scientists, among them Beijer Director Carl Folke and several Beijer Fellows.

The framework is based on scientific evidence that human actions since the Industrial Revolution have become the main driver of global environmental change. The researchers wanted to define a "safe operating space for humanity" for the international community. Since then, the planetary boundaries concept has generated enormous interest within science, policy and practice.

The key message in the film is that we still have time. The film also outlines four priorities for action: i) cut greenhouse gases to zero; ii) protect wetlands, soils, forests and oceans that absorb our impacts; iii) change our diets and the way we farm food; and iv) move to a circular economy.

Netflix has 204 million subscribers worldwide. A ten-minute trailer was previewed at the Biden Climate Summit in April 2021 and Christiana Figueres has called it "probably the most important documentary that has ever been filmed".

Student exhibitions on tipping points and food production

The past year featured two exhibitions organised within the Beijer Institute's collaboration with Swedish design firm Svenskt Tenn and Beckman's School of Design. Through the Kjell and Märta Beijer Foundation, Svenskt Tenn's profits support research at the Beijer Institute.

The exhibition *Tipping Points* was shown 8–21 September, 2020, at the Svenskt Tenn store in Stockholm. In this exhibition, students in Visual Communication interpreted Beijer Institute research with humour, imagination and empathy, focusing specifically on the scientific concept of tipping points. Nature is often exposed to gradual environmental impacts, but ecosystems do not always respond gradually. Instead, they can become more sensitive to sudden events, such as storms, floods, and fires, which can cause them to suddenly tip over into a whole new state that is very difficult and expensive, or even impossible, to reverse. With knowledge of what leads to tipping points, the warning signals can be acted upon in time.

At the *Tipping Points* exhibition, visitors could see, among other things, new warning labels for everyday products, drawing customers' attention to the climate impact. They could also visit a museum of materialism and say a collective goodbye to it, and participate in several games, both digital and analogue, reflecting on the consequences of individual actions in a larger perspective.

In the 2021 exhibition *Food for Thought*, shown 14–21 April, students interpreted research on food production, consumption and adaptation, hoping to motivate visitors to make better choices for the climate. The exhibition drew attention to what we will eat in the future, how food will be produced, what behavioural changes are required according to research and how today's attitudes are related to tomorrow's changes.



Detail from the exhibition *Tipping Points*. Photo: Svenskt Tenn.

Food for Thought included diverse works such as an installation that allowed viewers to share dinner with someone from the future and listen to their thoughts on how the food industry has changed over time; a shopping basket divided proportionally in line with the EAT-Lancet Commission's recommendations; and a line of packaging designed to be totally honest and clearly showing the product's content and environmental impact.

When preparing for these two exhibitions, the students attended lectures and tutorials provided by Beijer Institute researchers and colleagues from GEDB and Stockholm Resilience Centre, covering diverse viewpoints of the subjects at hand, as part of their five-week course in Visual Communication.

The exhibitions demonstrated how visual communication can help make complex research findings more accessible to the general public. They were also a valuable experience for students, according to Samira Bouabana, director of the Visual Communication programme at Beckmans.

"For the students, it is both an exercise in research, to absorb complex material, and in design – to find ways to visualise parts of that material. For us, it is a fantastic opportunity to work with such up-to-date and important material, directly from the researchers themselves."

Student exhibition *Food for Thought*. Photo: Svenskt Tenn.



Policy advice for a sustainable seafood industry

Wild caught or farmed seafood can play a major role in the vital transformation to more sustainable and healthy diets worldwide. However, unlike its counterparts on land, the seafood industry encompasses a vast variety of species and production methods. In order to facilitate future transformation, Beijer Institute researchers and colleagues from Stockholm Resilience Centre and RISE Research Institutes of Sweden have produced a series of five policy briefs, providing clear guidance and advice to authorities, companies and consumers on actions that can increase consumption of sustainable and healthy seafood. The briefs are in Swedish and focus largely on Swedish conditions.

The policy briefs were produced within the research project Seawin, funded by the Swedish research council for sustainable development Formas. Seawin is a transdisciplinary project with members from a range of academic institutions, retailers, authorities and NGOs.

Recommendations in the briefs include measures to increase production and intake of less well-known species, not least species that are more nutritious than e.g. prawns and that are indigenous to Sweden, and to develop new products that can tempt consumers to try new species, like mussels, algae or carp. The briefs also cover the reasons for overuse of antibiotics in aquaculture and ways to curb it.

www.seawin.earth

Seafood companies act on science-based goals to save the oceans

For the first time in the history of seafood production, ten of the largest seafood companies in the world have committed to a set of time-bound and measurable goals that will ensure the industry becomes more sustainable. The goals are the result of four years of dialogue through the science-industry initiative Seafood Business for Ocean Stewardship (SeaBOS). SeaBOS is a unique collaboration between scientists and seafood companies operating in the wild capture, aquaculture and feed production sectors.

During a dialogue in October 2020, the companies agreed a number of goals to achieve their original commitments from 2016.

By the end of 2021, SeaBOS members will:

- Eliminate IUU fishing and forced, bonded and child labour in their operations– and implement measures to address those issues in their supply chains – with public reporting on progress in 2022 and 2025.
- Extend the collaboration with the Global Ghost Gear Initiative to solve the problem of lost and abandoned fishing gear; and combine to clean up plastics pollution from global coasts and waterways.
- Agree on a strategy for reducing impacts on endangered species and the use of antibiotics.
- Set CO₂ emissions reduction goals and reporting approaches for each company.

SeaBOS members acknowledge that climate change is having a significant impact on seafood production and that they can all do their share through their own emissions reductions targets and advocacy for implementation of the Paris Agreement.

SeaBOS members highlight the need for government regulations to support sustainable fisheries and aquaculture management, to effectively mitigate climate change risks and impacts, and provide for ‘climate-smart’ seafood production.

In May 2021, a virtual SeaBOS working meeting took place to report on progress towards meeting the set goals and commitments and moving forward with the focus on transformational change, with a strong readiness to push the frontiers of what the seafood industry can do to be better stewards of the ocean.

Unique collaboration guided by science-based solutions

Together, SeaBOS members represent over 10% of global seafood production and over 600 subsidiary companies globally.

SeaBOS is the result of a science-based identification of “key-stone actors” in global seafood carried out by Stockholm Resilience Centre (SRC) in collaboration with the Beijer Institute and the GEDB Program at the Royal Swedish Academy of Sciences, together with Stanford University’s Centre for Ocean Solutions and Lancaster University. This work was led by a strategic team, with Henrik Österblom (SRC) in a central role, which not only established SeaBOS, but also ensured that it is built on best available science. Her Royal Highness Crown Princess Victoria of Sweden has been involved since the start in 2015, providing consistent support and participating in events.

The scientific work is funded by the Walton Family Foundation, the David and Lucile Packard Foundation and the Gordon and Betty Moore Foundation.

www.seabos.org



The Blue Food Assessment

An increase in the consumption of “blue food”, which is a term for all edible aquatic organisms – including fish, shellfish and algae – from marine and freshwater production systems, is a key part of a healthy food future. However, greater clarity is needed to achieve this while staying within the planetary boundaries for food. Sustainably scaling blue food could unlock huge health, environmental and economic opportunities, including job creation and improved livelihoods. It also provides a unique chance to counter some of the most urgent challenges facing our ocean and human health.

The Blue Food Assessment (BFA) initiated in January 2020 is a coalition of international researchers working to put blue food at the heart of the global food policy agenda. The initiative is co-chaired by Beatrice Crona of GEDB and Beijer Fellow Roz Naylor (Stanford University), and involves Beijer Institute researchers Patrik Henriksson, Malin Jonell and Max Troell.



Above: Farming of microalgae, which are widely used for production of Omega 3 for human consumption or as fish feed in salmon farming. Below: Seaweed harvesting in Myanmar lake.



The BFA aims to conduct a robust, high-impact scientific assessment of how the extraordinary diversity of blue foods affects their contributions to nutrition and their environmental impacts and spurs local and national economies. The initiative positions itself as a key scientific assessment that underpins discussions at a number of high-profile global events and food forums, including the UN Food System Summit on 23 September 2021.

The BFA brings together over 100 scientists from more than 25 institutions. Nine peer-reviewed papers will be published across the Springer-Nature journals in the course of 2021, and a Report for Decision-makers will be made available at the official launch on 15 September 2021.

The nine scientific papers cover diverse perspectives. For instance, the paper on blue food and nutrition presents a novel aquatic foods nutrient composition database that highlights aquatic food diversity and its nutritional contributions by nutrient and nation. The paper on environmental performance provides standardised estimates of the environmental pressures stemming from blue food production, while the paper on small-scale producers offers a new framework for understanding the diversity of small-scale actors.

Activities

In 2020, the second UN Ocean Conference would have brought together the global ocean community to assess and catalyse progress towards the implementation of Sustainable Development Goal 14 (“Life Below Water”). Given Covid 19, a series of ‘Virtual Ocean Dialogues’ were held in June 2020 instead. Beatrice Crona and other members of the BFA core team participated at this forum as speakers and panellists.

www.bluefood.earth

In the media

Beijer Institute researchers are sought after as lecturers and experts and are regularly interviewed in the media. Some also contribute actively to the public debate by writing opinion pieces and participating in podcasts. Scientific articles are often gaining much attention in international media. For more detailed information, read under the heading Staff members’ publications and activities in the Appendix.

Nobel Prize Summit

— Our Planet, Our Future

The first Nobel Prize Summit *Our Planet, Our Future*, brought together Nobel Prize laureates, scientists, policy makers, business leaders, and youth leaders to explore the question: What can be achieved in this decade to put the world on a path to a more sustainable, more prosperous future for all of humanity?



The summit took place on 26–28 April, 2021 and was the result of a collaboration between the Nobel Foundation, the US National Academy of Sciences, The Potsdam Institute of Climate Impact Research, the Stockholm Resilience Centre and the Beijer Institute.

Over three days, the virtual event combined keynotes and stimulating discussions with live performance and theatre.

Speakers explored solutions to some of humanity's greatest challenges: climate change and biodiversity loss, increasing inequality, and technological innovation in support of societal goals. The summit asked: What can we learn from our collective response to the global pandemic? And, how can societies distinguish facts from fiction in a new information ecosystem?

By the end of the three days, a scientific statement signed by 126 Nobel Laureates was issued, intended for world leaders and UN meetings, like the UN Food Systems Summit (September 2021, New York, USA), the UN Biodiversity Conference (October 2021, Kunming, China) and the UN Climate Change Conference COP26 (December 2021, Glasgow, Scotland).

White paper – Our Future in the Anthropocene

Beijer Institute director Carl Folke led the work on the scientific “White Paper” for the Nobel Prize Summit, *Our Future in the Anthropocene Biosphere*, which was published in the journal *Ambio*. The team of authors included colleagues from the Beijer Institute and Stockholm Resilience Centre, as well as several Beijer Fellows.

The paper established that humanity is now the dominant force of change on the planet and that human actions are threatening the resilience and stability of Earth's biosphere. It summarised recent research on the scale of human activity showing that 75% of Earth's ice-free land is directly altered as a result of human activity, with nearly 90% of terrestrial net primary production and 80% of global tree cover under direct human influence.

Furthermore, rising greenhouse gas emissions means that within the next 50 years one-to-three billion people are projected to experience living conditions that are outside of the climate conditions that have served civilizations well over the past 6,000 years, depending on how population and climate scenarios play out, according to the report's summary.

“Humanity must become effective stewards of our own future in the biosphere. About 96% of all mammals by weight are us, *H. Sapiens*, and our livestock, cattle, sheep and pigs. Just 4% are wild mammals like elephants, buffalo or dolphins,” said Carl Folke.

Instead of listing well-known solutions such as wind power, solar power or plant-based diets, the researchers pointed to the barriers stopping progress. Two of the greatest barriers are unsustainable levels of inequality and technology that undermines societal goals.

Co-author Victor Galaz, Deputy Director of the Stockholm Resilience Centre and Beijer Institute programme director said: “We have to act forcefully in ways that redirects technological change towards planetary stewardship and responsible innovation.”

According to the authors, this is a time when science is needed more than ever. Science provides



informed consensus on the facts and trade-offs in times of misinformation and polemics. New narratives based on science and with them action for transformation that reconnects development to the biosphere foundation are urgently needed, said the authors, concluding that nurturing resilience is of great significance in transformations towards sustainability. It will require collective action on many fronts and active biosphere stewardship of human actions that lead to prosperous futures within planetary boundaries.

Science as the foundation for action

The Beijer Institute and Stockholm Resilience Centre was heavily involved in organising the two Science sessions. The first focused on the role of science in supporting transformations towards global sustainability and resilient societies. The broadcast commenced in Stockholm University's grand lecture hall Aula Magna with strong opening remarks from Göran K. Hansson, Secretary General of the Royal Swedish Academy of Sciences, and HRH Crown Princess Victoria of Sweden, advocate alumni to the UN Sustainable Development Goals.

The Crown Princess Victoria invoked the image of the giant ship that had recently blocked the Suez Canal, and how after days of tugging and digging with comparatively tiny excavators, it was the tide that finally came to the rescue.

“Despite all our human efforts, in the end we depend on nature to help us”, she said.

Four keynote speakers then set the stage for discussions, Carl Folke, Pamela Matson (Stanford University), Beijer Fellows Sir Partha Dasgupta (University of Cambridge), and Jane Lubchenco, (Deputy Director for Climate and Environment in the White House Office of Science and Technology Policy). Among other things, Partha Dasgupta called for the abolition of misguided subsidies that harm the environment:

“It is an institutional failure”, he said, “Nature is our home, but we pay ourselves to exploit rather than protect our home.”

The keynote speeches were then commented on by the editors-in-chiefs of three of the world's most prestigious science journals Richard Horton of *The Lancet*, Magdalena Skipper of *Nature* and Holden Thorpe of *Science*.

Rosina Bierbaum of the University of Maryland moderated a panel dialogue with its sights set on global science based solutions with Brian Schmidt, Nobel Laureate in physics, Yuan Tseh Lee, Nobel Laureate in chemistry, Marica McNutt, (President NAS) and Hans Joachim Schellnhuber, (Potsdam Institute for Climate Impact Research).

The second day of the science sessions had two exciting panel dialogues. The first, moderated by Lena Srivastava, focused on *Breakthroughs in Technologies and Social Innovations for Resilient Societies and Global Sustainability*, and the second, moderated by Rosina Bierbaum, entitled *Towards Sustainable Futures: Governance, Inclusiveness and Stewardship*. Contributors included the three Nobel Laureates Jennifer Doudna (chemistry), Joe Stiglitz (economics), and Sir Richard Roberts (physiology or medicine), as well as Karen Seto, Frank Geels, Jane Lubchenco, Gretchen Daily, and Eduardo Brondizio.

Nobel Laureates: “Humanity is taking colossal risks.”

Based on the White Paper the Summit discussions generated a scientific statement, now signed by a record 126 Nobel Laureates and many other leading scientists, imploring leaders to act:

“Without transformational action this decade, humanity is taking colossal risks with our common future.” “Time is running out to prevent irreversible changes to the Earth's biosphere. The long-term potential of humanity depends upon our ability today to value our common future. Ultimately, this means valuing the resilience of societies and the resilience of the Earth's biosphere.”

The statement, whose signatories included Nobel laureates such as Brian Schmidt, the Dalai Lama, Steven Chu, Shirin Ebadi, Jennifer Doudna, Alice Munro and Paul Nurse, was submitted to the United Nations Secretary General and also to G7 president

Boris Johnson in advance of the G7 summit in the UK on 11–13 June 2021. It called on leaders to take action to halve greenhouse gas emissions and reverse nature loss by 2030.

By the end of this first Nobel Prize Summit, Carl Folke was optimistic about how different disciplines of science had come together:

“It is fascinating to have such different entry points, but reaching the same conclusion. It's a breakthrough that we're not arguing about the major challenges any more. We agree that a transformation is needed for the benefit of humankind.”

Format:

The Main Stage format was developed to attract a wide audience, with Nobel Laureates, leading politicians, thought leaders, scientists, and youth leaders among the participants. Various formats were used and interactive elements in the forms of questions, a chat room and a video pledge booth, were included in the program. A collaboration with the Theatre of War production concluded the Main Stage program. The Greek play *Oedipus* was performed by actors and Nobel Prize laureates, followed by a discussion with the audience.

The two Academic Science Sessions were open to everyone to watch but participation in the discussions was by invitation only.

There were 12 Solution Sessions on the final day of the summit, arranged in close collaboration with partner organisations, focusing on solutions and disseminating the content more widely.

Facts:

- » 27,838 people from 210 countries registered for the Summit
- » People from 117 countries were active in the chat room during the first session
- » Over the three days there were over 21,500 unique visitors to the platform
- » The Main Stage programme was watched live by between 10,000 and 15,000 people
- » The first Academic Science session was followed by 1200 people live and the second by 625 people
- » The content was published as a video on demand on the Nobel Prize YouTube channel after the Summit. In the first few weeks various sections of it have had almost 35,000 views
- » 38 Nobel Prize laureates were actively involved in the Summit
- » 126 Nobel Prize laureates signed the Call for Action
- » The article in *Ambio* had been downloaded more than 20,000 times by mid-June 2021

Media coverage

- » The Summit attracted significant media attention, with more than 300 registered journalists attending from all over the world
- » Media such as the BBC, the New York Times, the Economist, National Geographic and Science were present
- » The Summit was reported by the media in 42 countries and the top articles had a potential reach of over 71 million people
- » The total number of articles was well over 500 by mid-June

Social media and YouTube

Nobel Prize channels:

- » 3.5 million impressions on Facebook
- » 2.4 million impressions on Twitter
- » 820,000 impressions on Instagram
- » 770,000 impressions on LinkedIn
- » On average every summit-related post reached more than 90,000 people on Facebook alone
- » By mid-June the YouTube playlist of sessions from the event had a total of 34,200 video views. This will only continue to build over time

Collaborations

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

The GEDB Academy Programme – *New Approaches to the Grand Challenge: Global Finance, Global Health and the Biosphere* – focuses on two broad areas of research. The first, *Biosphere Finance*, studies finance and capital markets linked to the latest research on planet Earth as a system. This research area, in largely uncharted terrain, is now rapidly emerging, and GEDB is leading the way.

A recent paper has revealed that current financial risk frameworks primarily focus on financial materiality and risks to the financial sector, but that their failure to account for externalities created by these investments will aggravate climate and other environmental change and push current sustainable finance initiatives off course¹.

Engagement among companies and financial actors is swiftly expanding and throughout the year GEDB researchers have been involved with various actors such as banks and investment companies.

Sustainable Finance Lab

Furthermore, complementary funding has been granted for sustainable finance with a new centre to promote sustainable finance. The Sustainable Finance Lab, which was launched on 11 June 2021, aims to increase the focus on the social and environmental sustainability of Swedish and international financial markets. The five-year centre, funded by Sweden's innovation agency Vinnova, with SEK 47 million, is designed to create an internationally leading competence centre for sustainable financial markets. Among other things, it will focus on new thinking about risk and opportunities, sustainability norms and policies as well as transformation, technology and innovation.

The founding partners of the Sustainable Finance Lab (SFL) are GEDB and the Stockholm Resilience Centre, together with the Royal Swedish Institute of Technology (KTH), Luleå University, Gothenburg University, Stockholm School of Economics Institute for Research, and the Swedish Environmental Research Institute.

GEDB executive director Beatrice Crona will serve as its vice-director, with a particular focus on the science-based assessment of impacts.

www.sustainablefinancelab.se

Global Health and Biosphere Stewardship

The second broad area of research is on *Global Health and Biosphere Stewardship* and there are collaborations with several research groups including medical professionals, psychologists, behavioural economists and food actors, tackling everything

from antibiotic resistance to human health, habitats and food production. This research is linked to the ambition to support innovation and the asset management of landscapes, seas and the biosphere as a whole. Work has focused on the Blue Food Assessment and the risks and resilience of the global food production system. An interesting article was published during the year that provides guidelines on the sustainable and fairer use of the ocean, taking into account increasing interactions between sectors such as fishing, drilling and shipping that risk side-lining efforts for ocean equity and sustainability².

The work on building antimicrobial resilience and health, evolution and biosphere stewardship is progressing nicely, with new analyses underway. For instance, an article on how, where and when it is best to combat anti-microbial resistance has been published, introducing a new online platform that will be an accessible database with searchable evidence about what works, for whom and under what conditions³.

GEDB is a significant channel for research, synthesis and synergies between the Beijer Institute and the Stockholm Resilience Centre and our diverse activities. Last year's achievements are described in the GEDB Annual Report 2020.

GEDB is funded by the Erling-Persson Family Foundation.

www.gedb.se

[1]
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[2]
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[3]
Wernli, D., P.S. Jørgensen, E.J. Parmley, M. Troell et al. 2020. Evidence for action: A One Health learning platform on interventions to tackle antimicrobial resistance. *Lancet Infectious Diseases* 3099(20):1-5.

Stockholm Resilience Centre

The close collaboration with the Stockholm Resilience Centre (SRC) continues to be highly productive, with numerous synergies and benefits through joint projects, grants, workshops and publications. SRC researchers are engaged in the Beijer's research programmes, as well as in major research grants, and Beijer researchers are active as theme leaders at the SRC and collaborate and participate in seminars, teaching, supervision, projects etc. The communication, outreach and policy engagements of the Beijer Institute are substantially enhanced by its collaboration with the SRC.

Stanford collaboration

Work with two significant grants – *Advancing Fundamental Knowledge of Natural Capital, Resilience and Biosphere Stewardship* and *Fundamental Research in Biosphere-based Sustainability Science* – from the Marianne and Marcus Wallenberg Foundation is progressing nicely and strengthening and extending the collaboration between the Beijer Institute, the SRC and Stanford University. The grants provide a research platform for the development of new theory, analysis and synthesis on the stewardship of natural capital and the biosphere for social-ecological resilience, human wellbeing and sustainability. They draw on the long legacy of Beijer collaborations with Stanford researchers and also new collaborations with the Beijer/GEDB/SRC cluster. Carl Folke and Gretchen Daily serve as project leaders.

Executive programme in resilience thinking

Despite the challenges of the pandemic, the SRC's executive programme took place for the third time in autumn 2020 and spring 2021, and will conclude in September 2021. In the programme, carefully selected CEOs and board members of influential companies in diverse business sectors in Sweden meet scientists and opinion leaders to deepen their understanding of the latest research and accelerate the transformation to sustainability. All in all, more than 45 high-level participants have participated in the programme. Corporations represented in the third executive programme are Addtech, Apoteket, Axel Johnson, FAM, H&M, HMS, Investor, Kinnevik, Martin&Servera, Nobia, SEB and Volvo. Conversations revealed how business can indeed play a pivotal role in sustainability transformations, informed by science and driven by purpose. The deeper meaning and challenge of 'corporate biosphere stewardship' is increasingly being appreciated. The Beijer Director is the programme's science director. For more information see www.executive.stockholmresilience.org/ 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 developed and developing countries alike. 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. Its editors are Carlos Chavez, Susana Ferreira, E. Somanathan and the Beijer Fellow Jeff Vincent. 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 on 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 is a collaboration with HiG Urban Studio at the University of Gävle. 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 wellbeing. 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 in Sweden's Chalmers Technical University, which is an international leader in research related to architecture and urban morphology, and environmental psychology groups at Aalto University in Finland and Uppsala University in Sweden.

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. The RA and its 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 of it.

www.resalliance.org

RISE – Research Institutes of Sweden

RISE, the Swedish Research institutes, is an innovation partner in international collaborations 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 range 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 the Seawin project (see page 8) the Beijer Institute has established formal collaboration with the seafood group at RISE, which is an internationally highly recognised research group in the field. The main collaborators are Max Troell, Therese Lindahl, Patrik Henriksson and Malin Jonell representing Beijer and SRC. The collective expertise also involves international collaborators adding insights to the role and challenges related to the future of global seafood.

www.ri.se

SARAS – The South American Institute for Resilience and Sustainability Studies

The Beijer Institute has been involved in the South American Institute for Resilience and Sustainability Studies (SARAS) since 2007. 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 that cooperates 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 closely involved in establishing SARAS over the years. At present Therese Lindahl (Beijer Institute programme director) and Juan Carlos Rocha and Henrik Österblom (both SRC) sit on its advisory board and work as associates.

www.saras-institute.org

WorldFish

WorldFish is an integral part of the Consultative Group on International Agricultural Research (CGIAR). It is an international, non-profit, scientific research centre that was set up to conduct, stimulate and accelerate research on fisheries, aquaculture and other living aquatic resources for sustainable benefits of present and future generations of low-income users in developing countries. WorldFish was early to pick up on contemporary resilience research, providing the basis for its research and activities in poor and vulnerable communities. Over the past 10 years, the mode of cooperation between Beijer and WorldFish has developed from mainly informal partnerships into collaborative research projects. One project investigating the equitable development of aquaculture in East Africa is led by Beijer Institute programme director Max Troell. Formal assistance 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 several years.

www.worldfishcenter.org

Arequita national park,Uruguay. The SARAS institute is involved in several projects concerning governance of water resources in South America.



Reflections from the Chair of the Board

The Beijer Institute was founded on the principle that bringing economics and ecological sciences together is an imperative for a sustainable future. If the consequences of ignoring nature in our economies and societies were once thought to be obscure, hypothetical or minimal, those views have been shown over recent years to be absolute folly. The Covid pandemic in particular has demonstrated the interconnectedness of everything, as have the other great sustainability challenges of climate change, global inequality and even the idea of social progress. The Beijer Institute has in effect sounded a clarion call on these inter-dependencies, and brought evidence to bear through this far-sighted intellectual goal of cross-disciplinary engagement.

The Covid pandemic and the wider failure of global society to come to grips with sustainability provide salutary lessons for interdisciplinary science. There is little use in being right, accurate and clear if the messages are not communicated or are actively ignored because they are heretical to orthodoxies. New alliances and even new ways of doing science are perhaps required. The ongoing research programmes of the Beijer Institute (described elsewhere in this report) are pushing these boundaries every day. They are highlighting connections and issues that may not yet be on the radar of presidents and prime ministers, or may be hidden in the everyday lives of citizens globally. But they are urgent and they touch on the profound relationship of humans to the world around us and our place within it.

I can only say that it has been a privilege and highlight of my career to engage with the Beijer scholars and scientists, not least through the Scientific advisory board,

in this intellectual hothouse. From my experience here and elsewhere, I have observed that the attributes which make for a strong and resilient research centre include a shared ethos and, critically, stability that gives confidence to those involved to be creative and take risks. The Directors and the support of the Royal Swedish Academy of Sciences have been instrumental in making the Beijer Institute a place where cutting edge research is done. In

“In my time on the Board, we have always sought to ask the question ‘how can we help?’ But sometimes it has been enough to sit back, share and admire the work.”



my time on the Board, we have always sought to ask the question ‘how can we help?’ But sometimes it has been enough to sit back, share and admire the work.

My time as Chair has been memorable and stimulating and always convivial through interactions with all Beijer staff and supporters, but of course through the structures built by Carl Folke and Christina Leijonhufvud. Here’s to the next decades of innovation.

Exeter, July 2021

Neil Adger
Professor, University of Exeter, UK

Creating spaces for creativity

Office manager Christina Leijonhufvud, who had been working at the Beijer Institute since the start in 1991, employed by the late Karl-Göran Mäler, retired in December 2020. For 30 years she was the organisational hub of the Beijer Institute and instrumental in creating its success as a world-leading research institute.

“Christina has been the backbone of the institute”, says Carl Folke. “She always made sure everything worked according to plan, always a step ahead, planning dynamically and with flexibility, ensuring that the Beijer Institute and our activities maintain the highest quality.”

Many Beijer Fellows and collaborators, as well as staff members, have testified to the friendly, relaxed and creative atmosphere at the Beijer Institute, which encourages people to share ideas and ask necessary and sometimes uncomfortable questions, without fear of being judged. Many can also testify to Christina’s role in building this feeling of being with a group of friends or even family, rather than being in a highly competitive research environment. She says that one important focus for her was to see participants as individuals:

“I tried to get to know each person and identify their needs and memorise what they like or dislike, and I often viewed a dinner or a meeting as my personal dinner party, welcoming everyone as their hostess”, she says. “But equally important of course was to make everything

run smoothly and try to anticipate what could go wrong, and follow up on meetings, thanking people for participating and keeping in touch.”

She emphasises, however, that this was a vision shared by the Beijer leadership and that her way of working would have been impossible without the active support and encouragement from both Karl-Göran Mäler and Carl Folke. They included her in all preparations and important decisions, treating her and introducing her to others as an equally important person at the institute.

“Two widely different personalities, but equally great in their way of giving me freedom and responsibility and helping me to grow in my professional role. Neither of them feel the need to assert themselves, but are eager to let other people shine.”

Christina’s main tasks were to organise courses, workshops and travels. In the early days of the Beijer Institute, knowledge and capacity building in developing countries was a significant part of operations, with several courses and workshops every year in places far away from Sweden, both geographically and in an organisational sense. Hard work, but also the subject of some of Christina’s fondest memories from her working years:

“When we started arranging workshops around the world, there was no internet. Karl-Göran brought the largest atlas and looked up, for example, Africa. We had decided on an area

from which the participants would be invited, perhaps South Africa, Botswana, Namibia, Zimbabwe, Zambia and Mozambique. Then we would find a place that was possible to get to fairly easily from these countries, but which was still isolated enough for the participants to concentrate on the workshop. It also had to be in beautiful nature”.

“My task was to find this place, make sure that all the participants got there from their respective countries, that there was a suitable meeting room and that everything would work in practice. It was easier said than done! I travelled with lots of dollars in cash to be distributed to the participants as per diem, a heavy projector and lots of printed material, because it was usually difficult and expensive to copy on-site. I would arrange



Christina in action at the Askö meeting in 2002 (left) and workshop in Malta with Scott Barrett in 1995 (right).



excursions, make sure the meals were ok, take care of emergencies when people got sick or had to go home early, forgot things in taxis etc. I was overwhelmed with questions, sometimes I received some complaints, but mostly lots of praise. It was amazing, the people I got to know and the places I got to see!”

And the social part of the job is clearly what Christina has valued the most, meeting and getting to know people, with many highlights. She describes the first big conferences at the Academy, mixing solemn openings in the Session Hall surrounded by the 18th Century founders of the Academy looking down from their portraits in the wood-panelled hall, with lively mingling in the foyer and the first tentative dinners when people started to get to know each other.

“The Askö meetings, of course have been so important”, she says when trying to choose some special memories. “There you really got to know each other, and shared so much laughter and conversations during walks, salmon dinners and boat trips. The dinners my husband Ivar and I hosted in our home are also special memories, of how important scientific issues could be discussed in the kitchen after a long dinner”.

“Christina creates spaces for creativity, inspiring people to blossom”, says Carl Folke. “She beautifully orchestrated workshops and major meetings, like the Resilience conference in 2008 or the Nobel Laureates symposium on global sustainability in 2011. It is truly amazing how she could combine caring for the details and the people with overall strategic direction and capacity to move things progressively forward”.

But Christina stresses that is not just trips and workshops that have been memorable: “It has been to see the institute grow from just a few people to a large, vibrant, creative and successful place. Lots of fantastic, open-minded people work, and have worked, at the Beijer Institute and have contributed to the positive feeling that is there”.

This focus on the staff and the feeling of belonging and working together as a team grew in later years, as Christina points out: “There has been a move towards letting everyone know what the others are doing, finding out what issues to collaborate on and what our common goal is, as an institute”.

So, what awaits now, when a happy and successful working life has come to its end? Well, in the past year Christina and her husband have spent much time at their farm in the Swedish heartland of Småland, where there is a garden and several old houses to tend to, surrounded by forests full of wild berries and mushrooms to pick. Three small grandchildren and two dogs fill her heart, as well as her time, but still she finds space to plan new adventures:

“We are looking for a house abroad, maybe somewhere in the south of Europe, a new project to fix up and decorate.”

The Beijer Institute certainly wishes her good luck with all she takes on in the future!

And we hope Christina will continue to join friends and colleagues at social gatherings and sharing her experiences when needed.

“Christina is truly professional and a wonderful empathic human being. We, the Beijer family, are deeply impressed and thankful to have had the privilege to work with Christina over the past three decades” says Carl Folke.



Christina with the newest family addition, Welsh springer spaniel Penny and (below) with William “Buz” Brock at a workshop in 2005. Photos: private



“I tried to get to know each person and identify their needs and memorise what they like or dislike, and I often viewed a dinner or a meeting as my personal dinner party, welcoming everyone as their hostess.”

Appendix

Scientific advisory board

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 30th annual board meeting was held digitally due to the prevailing circumstances of the Covid-19 pandemic. This meeting was the first for Professor Karen C. Seto, Yale School of the Environment, USA, and Professor Alessandro Tavoni, University of Bologna, Italy, who were welcomed as new members of the board. Professor Jason Shogren and Professor James Wilen reached the end of their term. The Beijer Institute wishes to express its warmest gratitude for their great efforts on behalf of the Institute as members of the board.

Chair

Neil Adger
Professor, University of Exeter, UK

Ex-officio members

Anne-Sophie Crépin
Associate Professor, Deputy Director of the Beijer Institute

Carl Folke*
Professor, Director of the Beijer Institute

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

Members

Elena Bennet
Professor, McGill University, Canada

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

Reinette (Oonsie) Biggs
Professor, Stellenbosch University, South Africa

Juan Camilo Cárdenas
Professor, Universidad de los Andes, Colombia

Joern Fischer
Professor, Leuphana University, Germany

Kathleen Segerson
Professor, University of Connecticut, USA

Karen C. Seto
Professor, Yale School of the Environment, USA

Jason Shogren*
Professor, University of Wyoming, USA

Alessandro Tavoni
Senior Assistant Professor, University of Bologna, Italy

Elke Weber
Professor, Princeton University, USA

James Wilen
Professor Emeritus, University of California, Davis, USA

*Member of the Royal Swedish Academy of Sciences

Staff members

Carl Folke
Professor, Director

Anne-Sophie Crépin
PhD, Deputy Director

Amar Causevic
MA, Research assistant

Johan Colding
Professor, Programme Director

Gustav Engström
Associate Professor, Researcher

Johan Gars
PhD, Researcher

Åsa Gren
Associate Professor, Researcher

Marie Huss
Operations Manager

Emmy Iwarsson
MSc Research assistant

Malin Jonell
PhD, Researcher

Sofia-Kristin Kokinelis
MSc, Finance and HR Administrator

Christina Leijonhufvud
BA, Office manager

Therese Lindahl
PhD, Programme Director

Caroline Schill
PhD, Researcher

Agneta Sundin
Communications Officer

Max Troell
Associate Professor, Programme Director

Affiliated researchers

J. Marty Anderies
Professor, Programme Director (Arizona State University, USA)

Stefan Daume
PhD, Researcher (Stockholm Resilience Centre, Stockholm University)

Victor Galaz
Associate Professor, Programme Director (Stockholm Resilience Centre, Stockholm University)

Patrik Henriksson
PhD, Researcher (Stockholm Resilience Centre, Stockholm University and WorldFish, Malaysia)

Chuan-Zhong Li
Professor, Researcher (Uppsala University, Sweden)

Daniel Ospina
PhD candidate (Stockholm Resilience Centre, Stockholm University)

Timon McPhearson
Associate Professor, Researcher (The New School, USA)

Belinda Reyers
Professor, Researcher (Centre for Sustainability Transitions, Stellenbosch University, South Africa)

Aart de Zeeuw
Professor Emeritus (Tilburg University, the Netherlands)

Staff news

In addition to the retirement of **Christina Leijonhufvud** reported on page 40, we have seen the departure of two other colleagues. Research assistant **Amar Causevic** has left the Beijer Institute to take up a new position at Stockholm Environment Institute. Amar had been a research assistant within the *Governance, technology and complexity* programme since 2017. PhD candidate **Daniel Ospina**, who joined the Beijer Institute in 2014, has started a new position with Future Earth. We wish all three of them the best of luck in the future.

We welcome two new colleagues, **Marie Huss**, who is succeeding **Christina Leijonhufvud** as operations manager, and **Emmy Iwarsson**, who will work as a research assistant within the new research project *Inequality and the Biosphere*.

Marie has a background in the aviation industry, where she worked as cabin manager and managed the airline's internal travel agency. She

Beijer Fellow Prizes, honours and awards

Eric Lambin

On 16 May 2021, Eric Lambin was appointed member of the European Commission's Group of Chief Scientific Advisors for the next three years. In connection with the appointment, the European Commission stated:

"With their broad, collective expertise, the new configuration of the Group of Chief Scientific Advisors will support EU policy makers by providing independent scientific advice to inform policy-making and improve the interaction between policy-making and scientific advice".

Jane Lubchenco

19 March 2021, the White House Office of Science and Technology Policy (OSTP) announced that Dr. Jane Lubchenco would join the Biden-Harris Administration as Deputy Director for Climate and Environment, stating that:

"In this newly created role, Dr. Lubchenco will lead climate and environment science efforts in the White House, bringing an integrated approach that connects climate and environmental challenges with health, economic recovery, equity and sustainability."

In the same month, Jane Lubchenco also received the Joseph Priestley Award given by Dickinson College, "to a distinguished scientist whose work has contributed to the welfare of humanity."

Thomas Sterner

Thomas Sterner has received the award Knight of the French Legion of Honour in recognition for his work and commitment to the environment. The Legion of Honour is the highest French order of merit, both military and civil. The motivation was:

"By this award, France wants to honour your outstanding work as a researcher, your commitment to the environment, and your indisputably important role in the international debate."

Frances Westley

On 30 December 2020, Frances Westley received the Order of Canada "for her contributions to the study and application of social innovation in Canada and abroad."

The Order of Canada is the cornerstone of the Canadian Honours System, and recognises outstanding achievement, dedication to the community and service to the nation.



Thomas Sterner received the French Legion of Honour from the French ambassador at a ceremony at the French Embassy in Stockholm 4 June 2021. Foto: Pierre Moncorgé

went on to facility management as site manager. Before she joined the Beijer Institute, she ran her own company helping managers and employees to develop personally and professionally.

Emmy holds an MSc in Human Ecology and a BSc in Development Studies specialising in Human Geography, both from Lund University. She has a background within food systems and environmental justice, and has held two research internships at the Institute of Environmental Science and Technology at the Autonomous University of Barcelona.

We congratulate programme director **Johan Colding**, who was appointed Professor of Environmental Sciences at the University of Gävle, Sweden, in March 2021, **Åsa Gren**, who was appointed Associate Professor in Sustainable Urban Design and Planning at Chalmers University of Technology, and **Gustav Engström**, who was appointed Associate Professor at the Department of Economics, Stockholm University. Both Åsa and Gustav took up their appointments during spring 2021.

Congratulations also to **Patrik Henriksson** and **Jean-Baptiste Jouffray**, who both received a scholarship from The King Carl XVI Gustaf's 50th Anniversary Fund for Science, Technology and the Environment (Stiftelsen Konung Carl XVI Gustafs 50-årsfond för vetenskap, teknik och miljö).

Beijer Fellows

J. Marty Anderies
Professor, Arizona State University, USA

Scott Barrett
Professor, Columbia University, USA

Fikret Berkes
Professor, University of Manitoba, Canada

William "Buz" Brock
Professor Emeritus, University of Wisconsin-Madison, USA

Stephen R. Carpenter
Professor Emeritus, University of Wisconsin-Madison, USA

Stuart "Terry" Chapin III
Professor Emeritus, University of Alaska Fairbanks, USA

Kanchan Chopra
Professor Emerita, University of Delhi, India

Gretchen C. Daily
Professor, Stanford University, USA

Partha Dasgupta
Professor Emeritus, University of Cambridge, UK

Paul R. Ehrlich
Professor Emeritus, Stanford University, USA

Lance Gunderson
Professor, Emory University, USA

Michael Hoel
University of Oslo, Norway

Terry Hughes
Professor, ARC Centre of Excellence for Coral Reef Studies, James Cook University, Australia

Eric Lambin
Professor, Stanford University, USA and Université Catholique de Louvain, Belgium

Sander van der Leeuw
Professor, Arizona State University, USA

Simon A. Levin
Professor, Princeton University, USA

Jane Lubchenco
Professor, Oregon State University, USA

Karine Nyborg
Professor, University of Oslo, Norway

Rosamond. L. Naylor
Professor, Stanford University, USA

Stephen Polasky
Professor, University of Minnesota, USA

Johan Rockström
Professor, Potsdam Institute for Climate Impact Research (PIK) and Potsdam University, Germany

Thomas Rosswall
Professor Emeritus, Member of the Royal Swedish Academy of Sciences

Marten Scheffer
Professor, Wageningen University & Research, the Netherlands

Jason Shogren
Professor, University of Wyoming, USA

David A. Starrett
Professor Emeritus, Stanford University, USA

Will Steffen
Professor Emeritus, The Australian National University, Australia

Thomas Sterner
Professor, University of Gothenburg, Sweden

M. Scott Taylor
Professor, University of Calgary, Canada

Jeffrey Vincent
Professor, Duke University, USA

Brian Walker
PhD, Honorary Post-Retirement Fellow, CSIRO, Australia

Frances Westley
Professor Emerita, University of Waterloo, Canada

James Wilen
Professor Emeritus, University of California, Davis, USA

Anastasios Xepapadeas
Professor, Athens University of Economics and Business, Greece

Aart de Zeeuw
Professor Emeritus, Tilburg University, the Netherlands

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 4A, 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, and 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 to 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 2020 and 30 June 2021 was also provided by:

- Futura Foundation
- Mistra
- Swedish Environmental Protection Agency
- Swedish Research Council
- The European Fisheries Inventory in the Central Arctic Ocean (EFICA)
- The Crafoord Foundation
- The Ragnar Söderberg Foundation
- The Swedish International Development Cooperation Agency, Sida
- The Swedish research council for sustainable development Formas
- Western Indian Ocean Marine Science Association, WIOMSA

Teaching and training

In addition to the Master's course organised by the Beijer Institute described below, a number of institute researchers give lectures within courses run by other institutions (see under staff members' individual activities).

Governance and management of social-ecological systems: *Economic perspectives and Theories and methods for governance of the commons*

Beijer Institute researchers organise and teach, together with researchers from Stockholm Resilience Centre, two modules in the course Gov-

ernance and management of social-ecological systems of the Master's programme 'Social-Ecological Resilience for Sustainable Development' at Stockholm Resilience Centre, Stockholm University. The objective of the module *Economic perspectives* is to help students understand a broad spectrum of economic perspectives relevant to the governance and management of social-ecological systems. In the module *Theories and methods for governance of the commons*, students are introduced to different theoretical and applied approaches to understand and study the commons in the context of social-ecological systems, with a particular emphasis on the role of institutions and individual and collective behaviour.

Staff members' publications and activities



Amar Causevic
MA, Research assistant

Research focus

Sustainable finance, human-machine-ecology interactions, climate change and security.

Publications

- » Causevic, A., M. LoCastro, D. David, S. Selvakumaran and Å. Gren. 2021. Financing resilience efforts to confront future urban and sea-level rise flooding: Are coastal megacities in ASEAN doing enough? *Environment and Planning B: Urban Analytics and City Science* 48(5):989-1010.

Reports

- » Galaz, V., S. Daume and A. Causevic. 2020. Dark Machines – a project about the social and environmental costs and malicious use of the dark web and blockchain technology. Online project report for the Futura-funded "Dark Machines" project.



Johan Colding
Professor, Programme Director *Urban social-ecological systems*

Publications

- » Barthel, S., J. Colding, A.S. Hiswåls, P. Thalén and P. Turunen. Urban green commons for socially sustainable cities and communities. *Nordic Social Work Research*. In press.
- » Brandt, S.A., N.J. Lim, J. Colding and S. Barthel. Mapping flood risk uncertainty zones in support of urban resilience planning. *Urban Planning*. In press.
- » Colding, J., S. Barthel and K. Samuelsson. 2020. Supporting bottom-up human agency for adapting to climate change. *One Earth* 3(4):392-395.

- » Colding, J., L. Marcus and S. Barthel. 2021. Promoting partnership between urban design and urban ecology through social-ecological resilience building. In M. Wallhagen and M. Cehlin (Eds.): *Urban Transition - Perspectives on Urban Systems and Environments*. Intech Open Book Series.
- » Elmqvist, T., E. Andersson, T. McPhearson, X. Bai, L. Bettencourt, E. Brondizio, J. Colding, G. Daily, C. Folke, N. Grimm, D. Haase, D. Ospina, S. Parnell, S. Polasky, K.C. Seto and S. van Der Leeuw. 2021. Urbanisation in and for the Anthropocene. *npj Urban Sustainability* 1(6).
- » Sörqvist, P., J. Colding and J.E. Marsh. 2020. Psychological obstacles to the efficacy of environmental footprint tools. *Environmental Research Letters* 15(9).

Conferences, workshops and presentations

- » Seminar: Urban Commons, University of Gävle, October 2020. Speaker: *Urban Commons - A concept and framework for sustainable urban development*.
- » Yearly Academic Research Conference, University of Gävle, Högskola, Sweden, October 2020. Participant.

Teaching and training

- » Lecturer, undergraduate level programme Miljöteknik/Miljöstrateg (Environmental Technology/Environmental Strategy) lecture: Studies of social-ecological systems, Faculty of Engineering and Sustainable Development, University of Gävle, October 2020 and February 2021.

Supervisor and examiner

- » Main supervisor of PhD candidate Caroline Nilsson (Department of Building Engineering, Energy Systems and Sustainability Science, HiG, Gävle).
- » Reserve opponent and member of the examination committee for the PhD thesis *Nature in Urban Regions: Understanding Linkages and Benefits to Human Populations*. Romain Goldenberg (Physical Geography at Stockholm University, Sweden). March 2021.
- » Supervisor of BSc candidate Kerstin Skoglund in Environmental Technology/Environmental Strategy (Faculty of Engineering and Sustainable Development, University of Gävle).

Commissions

- » Member of the Campus Albano Reference Group.
- » Member of the Scandinavian Turfgrass Research Foundation (STERF).
- » Member of the Live Baltic Campus Network Group.
- » Director of HiG Urban Studio, University of Gävle, Sweden.
- » Member of the Steering Board of the Swedish Knowledge Foundation's Research School "Future-Proof Cities".

Other

- » Member of the research consortium "Social-Ecological Urbanism".
- » Member of the working group "Smarta hållbara städer och samhällen" (Smart sustainable cities and societies"), Region Gävleborg.



Anne-Sophie Crépin
Associate Professor, Deputy Director

Research focus

Social-ecological systems, regime shifts and economics, risk, global dynamics and resilience, in particular in relation to global moisture recycling and other spatial dynamics, complex system approach to the Arctic Ocean, behavioural responses to regime shifts, modelling.

Publications during the period

- » Adger, W.N., A.-S. Crépin, C. Folke, D. Ospina, F.S. Chapin III, K. Segerson, K.C. Seto, J.M. Anderies, S. Barrett, E.M. Bennett, G. Daily, T. Elmqvist, J. Fischer, N. Kautsky, S.A. Levin, J.F. Shogren, J. van den Bergh, B. Walker and J. Wilen. 2020. Urbanization, migration, and adaptation to climate change. *One Earth* 3(4):396-399.
- » Crépin, A.S. and S. Polasky. 2021. Decision analysis based on optimization. Chapter 29 in Biggs, R., de Vos, A., Preiser, R., Clements, H., Maciejewski, K. and M. Schlüter (Eds.). *The Routledge Handbook of Research Methods for Social-Ecological Systems*.
- » Elsler, L.G., T.H. Frawley, G.L. Britten, L.B. Crowder, T.C. DuBois, S. Radosavljevic, W.F. Gilly, A.-S. Crépin and M. Schlüter. 2021. Social relationship dynamics mediate climate impacts on income inequality: evidence from the Mexican Humboldt squid fishery. *Regional Environmental Change* 21(2).
- » Folke, C., H. Österblom, J.-B. Jouffray, E.F. Lambin, W.N. Adger, M. Scheffer, B.I. Crona, M. Nyström, S.A. Levin, S.R. Carpenter, J.M. Anderies, S. Chapin, A.-S. Crépin, A. Dauriach, V. Galaz, L.J. Gordon, N. Kautsky, B.H. Walker, J.R. Watson, J. Wilen and A. de Zeeuw. 2020. An invitation for more research on transnational corporations and the biosphere. *Nature Ecology and Evolution* 4:494.
- » Polasky S., A.-S. Crépin, R. Biggs, S.R. Carpenter, C. Folke, G. Peterson, M. Scheffer, S. Barrett, G. Daily, P. Ehrlich, R.B. Howarth, T. Hughes, S.A. Levin, J.F. Shogren, M. Troell, B. Walker and A. Xepapadeas. 2020. Corridors of clarity: Four principles to overcome uncertainty paralysis in the Anthropocene. *BioScience* biae1115.

Media coverage

- » Op-ed: Enander, G., H. Andersson, A.-S. Crépin, K. Hammes, H.V. Haraldsson, Norling, A. Svensson, K. Tumpane, A.-K. Wennberg

and A. Nilsson Vindelfjärd. 2020. Helhetsbilden saknas när vi ska tackla viktiga samhällsutmaningar (A holistic perspective is missing when we deal with important societal challenges). *Alltinget* 27 November, 2020.

Conferences, workshops and presentations

- » Responding to change in diverse ways, Askö meeting, September 2020. Participant.
- » Annual conference of the Economy and Environment partnership for Southeast Asia (EEPSEA), online, Vietnam and Thailand. 9-11 October 2020. Keynote speaker.
- » Workshop, DominoES Social Tipping Processes, Postdam Institute for Climate Impact research (online). 4 December 2020. Participant.
- » Advancing Integrated Process-Based Modeling of Complex Socio-Environmental Systems, several online SESYNC workshops, during 2020 and 2021. Participant.
- » Commoning the Anthropocene, conference of the International Association for the Study of the Commons online, Tempe, Arizona, USA. 21-23 April 2021. Session chair, plenary opening panel participant and Co-chair of the scientific committee.
- » Beijer Young Scholar III workshop, online, Stockholm, Sweden. 19 May and 1 June 2021. Resource person.
- » Beijer Young Scholar II workshop, online, Stockholm, Sweden. 26-27 May 2021. Participant.
- » Annual conference of the European Association of Environmental and Resource Economists (EAERE) online, Berlin, Germany. 25-28 June 2021. Presenter and co-chair of the scientific committee.

Teaching and training

- » Co-supervisor of PhD students Daniel Ospina and Laura Elsler (Stockholm Resilience Centre, Stockholm University).
- » Main supervisor of Master's student Alicia Björnsdotter (Stockholm Resilience Centre, Stockholm University). Co-supervisor of Master's students Federico Grossi (Economics, University of Bologna, Italy) and Jan Sodoge (Computational Social Sciences, University of Linköping Sweden).
- » Lecturer, Master's level course *Governance and Management of Social-Ecological Systems: Principles of Economic Decision-making*, Stockholm Resilience Centre, Stockholm University, spring 2021.
- » Lecturer and course organiser for a series of lectures for Länsförsäkringar, a major Swedish insurance company.
- » Evaluation committee for the PhD thesis *Valuation of Large Carnivores and Regulated Carnivore Hunting* by Julian Eduardo Lozano Galindez (Department of Economics, Swedish University of Agricultural Sciences, Uppsala, Sweden). 29 January, 2021.

- » Examiner of Master's theses, Stockholm Resilience Centre, Stockholm University, Sweden.

Commissions

- » Ex officio member, Energy and Environmental Committee, Royal Swedish Academy of Sciences, since 2016.
- » Board member, Environmental Research Council, Swedish Environmental Protection Agency (Naturvårdsverkets miljöforskningsråd), since 2018.
- » Committee member, National Committee for Global Environmental Change, Royal Swedish Academy of Sciences, Sweden, since 2018.
- » Committee member, Committee for Applied Systems Analysis, (Kommittén för tillämpad systemanalys), since 2020.
- » Member of the Council for Evidence-based Environmental Analysis (Rådet för evidensbaserad miljöanalys) under FORMAS (Swedish Research Council for Sustainable Development), since 2020.
- » Co-chair of the scientific committee for the Conference of the European Association of Environmental and Resource Economists (EAERE).
- » Associate editor of *Ecological Economics* since 2019.
- » Participant and member of the steering committee (substitute) of the European Fisheries Inventory in the Central Arctic Ocean (EFICA) Consortium, financed by the European Commission, since 2019.
- » Reviewer for *Ecosphere* and the *Commons Journal*.
- » Principal Researcher Stockholm Resilience Centre Stockholm University.



Stefan Daume
PhD, Researcher

Research focus

Connections between digital technologies and sustainability, with particular focus on the promises and risks of AI and social media for public engagement with environmental challenges.

Reports

- » Galaz, V., S. Daume and A. Causevic. 2020. Dark Machines – a project about the social and environmental costs and malicious use of the dark web and blockchain technology. Online project report for the Futura-funded "Dark Machines" project.

Conferences, workshops and presentations

- » Invited talk: Scraping social media for IAS observations, *Twitter Conversations as Embryonic Citizen Science Communities*. COST

Action CA17122 workshop “Increasing understanding of alien species through citizen science”, May/June 2021.

Teaching and training

- » Main supervisor of Bachelor student Emilia Arens for a thesis on automation capabilities of Twitter bots (University of Osnabrück, Cognitive sciences, Germany).

Media coverage

- » Extrakt magazine, joint interview with Victor Galaz for article *Conspiracy theories about wildfires can fuel climate change denial*.



Gustav Engström
Associate Professor,
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 economics and other aspects of the economy and environment interaction.

Publications

- » Engström, G., J. Gars, C. Krishnamurthy, D. Spiro, R. Calel, T. Lindahl and B. Narayanan. 2020. Carbon pricing and planetary boundaries. *Nature Communications* 11:4688.
- » Engström, G., J. Gars, N. Jaakkola, T. Lindahl, D. Spiro and A. van Benthem. 2020. What policies address both the coronavirus crisis and the climate crisis? *Environmental and Resource Economics* 76:4.
- » Engström, G., Å. Gren, C.Z. Li and C. Kiran. 2020. Valuing biodiversity and resilience: An application to pollinator diversity in the Stockholm region. *Spatial Economic Analysis* 15(3):238-261.

Teaching and training

- » Master's level course Governance and management of social-ecological systems: Economic perspectives, Stockholm Resilience Centre, Stockholm University, spring 2021. Lecturer and module leader.

Other

- » Opinion piece: Engström, G., J. Gars, N. Jaakkola, T. Lindahl, D. Spiro and A.A. van Benthem. 2020.
- » Krisåtgårderna som gynnar jobb och klimat *Svenska Dagbladet*. (English version: “How to combat the Corona recession and climate change” re-published by the Kleinman Center for Energy Policy.)



Carl Folke
Professor, Director

Research focus

Social-ecological systems, resilience, ecological economics, transformations, biosphere stewardship.

Publications

- » Adger, W.N., A.-S. Crepín, C. Folke, D. Ospina Medina, F.S. Chapin III, K. Segerson, K. Seto, J.M. Anderies, S. Barrett, E.M. Bennett, G. Daily, T. Elmqvist, J. Fischer, N. Kautsky, S.A. Levin, J.F. Shogren, J. van den Bergh, B. Walker and A. de Zeeuw. 2020. Urbanisation, migration, and adaptation to climate change. *One Earth* 3(4):396-399.
- » Bengtsson, J., M. Nyström, M. Ihse, C. Folke, T. Elmqvist, U. Emanuelsson, F. Moberg and P. Angelstam. 2021. Reserves, resilience and dynamic landscapes 20 years later. *Ambio* 50:962-966.
- » Blasiak, R., A. Dauriach, J.-B. Jouffray, C. Folke, H. Österblom, J. Bebbington, F. Bengtsson, A. Causevic, B. Geerts, W. Grønbrekk, P. Henriksson, S. Käll, D. Leadbitter, D. McBain, G. Ortuno Crespo, H. Packer, I. Sakaguchi, L. Schultz, E. Selig, M. Troell, J. Villalón, C. Wabnitz, E. Wassénius, R. Watson, N. Yagi and B.E. Crona. 2021. Evolving perspectives of stewardship in the seafood industry. *Frontiers in Marine Science* 8:671837.
- » Crona, B.I., C. Folke and V. Galaz. The Anthropocene reality of financial risk. *One Earth* 4(5):619-628.
- » Crona, B.I., E. Wassenius, K. Liljepold, R. Watson, L. Selig, C. Hicks, H. Österblom, C. Folke, J.-B. Jouffray and R. Blasiak. 2021. Sharing the seas: A review and analysis of ocean sector interactions. *Environmental Research Letters* 16:063005.
- » Elmqvist, T., E. Andersson, T. McPhearson, X. Bai, L. Bettencourt, E. Brondizio, J. Colding, G. Daily, C. Folke, N. Grimm, D. Haase, D. Ospina, S. Parnell, S. Polasky, K.C. Seto and S. van Der Leeuw. 2021. Urbanisation in and for the Anthropocene. *npj Urban Sustainability* 1:6.
- » Folke, C., S. Polasky, J. Rockström, V. Galaz, F. Westley, M. Lamont, M. Scheffer, H. Österblom, S.R. Carpenter, F.S. Chapin III, K.C. Seto, E.U. Weber, B.I. Crona, G.C. Daily, P. Dasgupta, O. Gaffney, L.J. Gordon, H. Hoff, S.A. Levin, J. Lubchenco, W. Steffen and B.H. Walker. Our future in the Anthropocene biosphere. *Ambio* 50:834-869.
- » Gadgil, M., F. Berkes and C. Folke. 2021. Indigenous knowledge: From local to global. *Ambio* 50:967-969.
- » Haider, L.J., M. Schlüter, C. Folke and B. Reyers. 2021. Fundamentally redefining resilience and development: A co-evolutionary

perspective. *Ambio* 50:1304-1312.

- » Herrfahrdt-Pähle, E., M. Schlüter, P. Olsson, C. Folke, S. Gelcich and C. Pahl-Wostl. 2020. Sustainability transformations: Socio-political shocks as opportunities for governance transitions. *Global Environmental Change* 63:102097.
- » van der Leeuw, S. and C. Folke. 2021. The social dynamics of basins of attraction. *Ecology and Society* 26(1):33.
- » Nielsen, K.S., J.M. Gilligan, T. Dietz, M.J. Figueroa, C. Folke, W. Gwozdz, D. Ivanova, L. Reisch, D.P. van Vuuren, M.P. Vandenbergh, K.S. Wolske, R. Wood and P.C. Stern. 2020. Improving climate change mitigation analysis: A framework for examining feasibility. *One Earth* 3(3):325-336.
- » Polasky, S., A.-S. Crépin, R. Biggs, G. Peterson, S. Barrett, S.R. Carpenter, G. Daily, P.R. Ehrlich, C. Folke, R. Howarth, T. Hughes, S.A. Levin, M. Scheffer, J. Shogren, M. Troell, B.H. Walker and A. Xepapadeas. 2020. Corridors of clarity: Four principles to overcome uncertainty paralysis in the Anthropocene. *BioScience* 70:1139-1144.
- » Walker, B.H., S.R. Carpenter, C. Folke, L.H. Gunderson, G.D. Peterson, M. Scheffer, M. Schoon and F. Westley. 2020. Navigating the chaos of an unfolding global cycle. *Ecology and Society* 25(4):23.

Conferences, workshops and presentations

- » Workshop, Resilience of Cities and the Global Food System, Stockholm Resilience Centre, Princeton, PIK, August 2020.
- » Askö meeting, Responding to Change in Diverse Ways in Social, Economic, and Ecological Systems, September 2020.
- » International Scientific Advisory Committee, Stockholm Resilience Centre, September 2020.
- » Celebrating Elinor Ostrom's *Governing the Commons*, Keynote speaker, Indiana University, October 2020.
- » The Virtual 2020 Keystone Dialogue, Resilience through Ocean Stewardship – Leadership, Actions, and Opportunities, SeaBOS CEO meeting, presentation, October 2020.
- » Temasek Ecosperity Advisory Group meeting, October 2020.
- » International Advisory Board meeting, Stockholm Resilience Centre, October 2020.
- » Workshop, Behaviour, Economics and Nature (BEN), the Beijer Institute, November 2020.
- » Progress, Challenges, and Opportunities for Sustainability Science, US National Academy of Sciences, steering committee, panel organiser, speaker, November/December 2020.
- » Presentation for the Leadership of Thai Union, December 2020. *Ocean stewardship in the Anthropocene*.
- » Working Party of Innovation and Technolo-

gy Policy, OECD, December 2020. Keynote speaker: *What role for science, technology and innovation in building resilience?*

- » SIGHT advisory board meeting, December 2020.
- » Presentation for the Beijer Foundation Board, February 2021. *The Nobel Prize Summit*.
- » Weatherhead Forum, Harvard University, February 2021. Presentation and panel member: *Progress, Challenges, and Opportunities for Sustainability Research*.
- » Scientific Advisory Board meeting, HELSUS, University of Helsinki, March 2021.
- » Monaco Blue Initiative 12th edition and 3rd meeting of the Monaco Ocean Science Federation, March 2021.
- » Academic Advisory Board meeting, STIAS, Stellenbosch, March 2021.
- » EAT advisory board meeting, April 2021.
- » The first Nobel Prize Summit, US National Academy of Sciences, PIK, SRC/Beijer and the Nobel Foundation, April 2021. Keynote speaker, organiser of the academic science sessions, member of steering group and steering committee.
- » Our Planet – From Human Impact to Climate Action and Sustainable Industry Solutions, the Embassy of Sweden to the U.S, Washington DC, April 2021. Speaker and panel member.
- » The CauSES advisory board meeting, Stockholm Resilience Centre, May 2021.
- » The Family-Erling Persson Foundation, GEDB presentation, May 2021.
- » Co-evolution working group, Konrad Lorenz Institute for Evolution and Cognition Research (KLI), March, May 2021.
- » SeaBOS 4th working meeting, May 2021. Presentation: *Update and opportunities*.
- » Workshop on Governance at Critical Junctions - Timing, Scales and Interdependence in Sustainability Transformations, Princeton, June 2021. Part of advisory group and participant.
- » Transformations Conference 2021, June 2021. Presentation: *Stewardship and Transformation - Strange bedfellows or complementary concepts*.
- » Earth Resilience and the Anthropocene (ERA) workshop, Stockholm Resilience Centre and Potsdam Institute (PIK), June 2021.

Teaching and training

- » Lecture, the CEO Executive Programme in Resilience Thinking: Transformative Business Leadership for a Prosperous Planet, Stockholm Resilience Centre.
- » Lecture, Oscar von Miller Forum, München.
- » Lecture for the leadership of PSA International, Singapore.
- » Lecturing, Master's course Resilience and Sustainable Development, LUMES, Lund University.

- » Lecturing, undergraduate and PhD-courses, Stockholm University.

Commissions

- » Founder, Science Director, Chair of the Board, Stockholm Resilience Centre.
- » Co-director (with Beatrice Crona) of the Erling-Persson Family Academy Programmes, 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) of the research collaboration programme Fundamental Research in Biosphere-based Sustainability Science and Advancing Fundamental Knowledge of Natural Capital, Resilience and Biosphere Stewardship, Stockholm University, funded by the Marianne and Marcus Wallenberg Foundation.
- » Member of the Royal Swedish Academy of Sciences.
- » International Member of the US National Academy of Sciences, Washington.
- » Member of the Royal Norwegian Society of Sciences and Letters (DKNVS), Trondheim.
- » Member of the Royal Swedish Academy of Agriculture and Forestry (KSLA).
- » Advisory and editorial board member of *Ambio*, *the Anthropocene Review*, *Anthropocene Science*, *Ecological Economics*, *Ecology and Society*, *Environmental Conservation*, *Environment and Development Economics*, *Environmental Innovation and Societal Transitions*, *Frontiers in Ecology and the Environment*, *Geography and Sustainability*, *Global Sustainability*, *One Earth*, *PNAS*, *Resilience: International Policies, Practices and Discourses*, *Reviews in Ecological Economics*, and *Sustainability Science*.
- » Fellow of the Resilience Alliance.
- » Honorary Fellow, South American Institute for Resilience and Sustainability Studies (SARAS), Maldonado, Uruguay.
- » Fellow of the Synergy Programme on Resilience and Critical transitionS (SparcS), Wageningen, The Netherlands.
- » Fellow and member of Academic Advisory Board of STIAS - Stellenbosch Institute for Advanced Study, South Africa.
- » Senior Fellow of IHOPE (Integrated History and future of People on Earth).
- » Member of the Ralph Yorque Society.
- » Member of the Monaco Ocean Science Federation.
- » Member of the Earth Resilience and Sustainability Initiative, Princeton, Potsdam Institute for Climate Impact Research, and the Stockholm Resilience Centre.
- » SIGHT Advisory Committee (The Swedish Institute for Global Health Transformation), Royal Swedish Academy of Sciences.
- » International Scientific Advisory Board,

Helsinki Institute of Sustainability Science, HELSUS, University of Helsinki, Finland.

- » International Scientific Advisory Council, The Waterloo Institute for Complexity and Innovation (WICI), University of Waterloo.
- » Advisory board, International Network of Research on Coupled Human and Natural Systems (CHANS-Net).
- » Lead faculty of Earth System Governance Project.
- » Scientific Director for the CEO Executive Programme in Resilience Thinking: Transformative Business Leadership for a Prosperous Planet, Stockholm Resilience Centre.
- » Advisory board of EAT and EAT Forum.
- » Steering Committee, SeaBOS
- » Board member of the SeaBOS Foundation.
- » Senior Advisor of the Ecospherity Advisory Group, Temasek.
- » Chair of the scientific committee of the Volvo Environment Prize.
- » Selection committee of the Kenneth Boulding Award, International Society for Ecological Economics.
- » Lord-in-Waiting (Kabinettskammarherre), Swedish Royal Court.

Other

- » Steering Committee of the US National Academy of Sciences workshop Progress, Challenges, and Opportunities for Sustainability Science, 2020.
- » Steering Committee of the Nobel Prize Summit, Our Planet, Our Future. The US National Academies of Sciences, Engineering, and Medicine, in partnership with the Nobel Foundation, Potsdam Institute for Climate Impact Research, and the Stockholm Resilience Centre/Beijer Institute.
- » Recognised as Highly Cited Researcher by Thompson Reuters 2020.



Victor Galaz
Associate Professor,
Affiliated researcher,
Programme Director
*Governance, technology
and complexity*

Research focus

Governance, institutions, Earth system governance, complex adaptive systems, networked risks, technological change, financial systems.

Publications

- » Crona, B., C. Folke and V. Galaz. 2021. The Anthropocene reality of financial risk. *One Earth* 4(5):618-628
- » Folke, C., S. Polasky, J. Rockström, V. Galaz, F. Westley, M. Lamont, M. Scheffer, H. Österblom, S.R. Carpenter, F.S. Chapin III, K.C. Seto, E.U. Weber, B.I. Crona, G.C. Daily, P. Dasgupta, O. Gaffney, L.J. Gordon, H. Hoff, S.A. Levin, J. Lubchenco, W. Steffen and B.H. Walker. 2021.

Teaching and training

- » Co-supervisor for PhD candidate Oskar Nyberg (Department of Ecology, Environment and Plant Sciences, Stockholm University).
- » Lecturer, graduate level course, *Food for thought*, Beckman's School of Design and the Beijer Institute of Ecological Economics, spring 2021.

Other

- » Paternity leave May 01–June 3



Marie Huss
Operations Manager

Marie will co-ordinate the Beijer Institute's operational activities. This will include planning and organising international research meetings, and structuring the internal and operational work at the institute, administration of travel and meetings, archiving and responsibility for the administration of an international environmental award.



Emmy Iwarsson
MSc, Research Assistant

Research assistant within the Inequality and Biosphere project, assisting in research on inequality-biosphere interactions and in the project co-ordination.



Malin Jonell
PhD, Researcher

Research focus

Food systems, sustainable aquatic production and the role of private regulatory mechanisms in transforming food production and consumption.

Publications

- » Bergman, K., P.J.G. Henriksson, S. Hornborg, M. Troell, L. Borthwick, M. Jonell, G. Philis and F. Ziegler. 2020. Recirculating aquaculture is possible without major energy tradeoff: Life Cycle Assessment of warmwater fish farming in Sweden. *Environmental Science & Technology* 54(24):16062–16070.

Reports

- » Henriksson, P., K. Bergman, S. Hornborg, M. Jonell, T. Lindahl, M. Troell and F. Ziegler. 2021. Hållbar sjömat - vilken sjömat ska man välja? (Sustainable seafood – what seafood should one choose?) Seawin Policy Brief 1, Seawin Earth and Lantbruksnätverket.

- » Hornborg, S., K. Bergman, P. Henriksson, M. Jonell, T. Lindahl, M. Troell and F. Ziegler. 2021. Frisk med fisk utan risk? Att gasa och bromsa svensk sjömatkonsumtion (Healthy with fish without risk? To speed up or slow down the Swedish seafood production). Seawin Policy Brief 2, Seawin earth and Lantbruksnätverket.

- » Jonell, M., T. Lindahl, K. Bergman, P. Henriksson, S. Hornborg, M. Troell and F. Ziegler. 2021. Hållbar konsumtion av sjömat - hur nå dit? (Sustainable seafood consumption – how do we get there?) Seawin Policy Brief 4, Seawin Earth and lantbruksnätverket.

- » Troell, M., K. Bergman, P. Henriksson, S. Hornborg, M. Jonell, T. Lindahl and F. Ziegler. 2021. Antibiotika – en utmaning också för sjömat. (Antibiotics – a challenge also for seafood) Seawin Policy Brief 5, Seawin Earth and Lantbruksnätverket.

- » Ziegler, F., K. Bergman, P. Henriksson, S. Hornborg, M. Jonell, T. Lindahl and M. Troell. 2021. Lokal eller långväga sjömat? Vilken roll spelar transporten för hållbarheten? (Local seafood or seafood from afar? What is the role of transportation for sustainability?) Seawin Policy Brief 3, Seawin Earth and Lantbruksnätverket.

Conferences, workshops and presentations

- » Seminar, Seaweed: Exploring its untapped potential to contribute to healthy and sustainable food systems. Hosted by UN Global Compact, Lloyd's Register Foundation, and EAT, 9 December 2020. Participant.

- » Public talk, Vegoforum DIGITAL – Vego in politics, 5 December 2020. Presentation: *The EAT Lancet commission*.

- » North Atlantic Seafood Forum, DNV Launch of Aquaculture Forecast to 2050, 9 June 2021. Speaker and participant in panel discussion.

- » Baltic Breakfast: Increased consumption of seafood from a sustainability perspective, Public digital talk, Stockholm University Baltic Sea Centre, 18 June 2021. Presentation.

Teaching and training

- » Lecturer, Bachelor's level course, *Sustainability perspectives on contemporary fisheries - Where Have all the Fishes Gone*, Swedish University of Agricultural Sciences, September 2020.
- » Lecturer, graduate level course, *Food for thought*, Beckman's School of Design and the Beijer Institute, spring 2021.

Commissions

- » Part of the Aquaculture Stewardship Council's technical working group on revision of the shrimp aquaculture standard (2019-2020).
- » Journal Reviewer for *Marine Policy*.

Other

- » Part of the Postdoc Academy for Transfor-

mational Leadership (2019-2021), funded by the Robert Bosch Stiftung in collaboration with four leading academic research centres in Europe.

- » Interview with Swedish TV channel Expressen TV, 4 May 2021. On the Swedish critique against the Netflix documentary *Seaspiracy*.



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



Chuan-Zhong Li
Professor, Affiliated researcher

Research focus

Environmental and resource economics, dynamic welfare analysis, sustainability, energy economics, resilience studies.

Publications

- » Engström, G., Å. Gren, C.Z. Li and C.K.B. Krishnamurthy. 2020. Valuing biodiversity and resilience: An application to pollinator diversity in the Stockholm region. *Spatial Economic Analysis* 15(3):238-261.
- » Guo, J., C.Z. Li and C. Wei. 2021. Decoupling economic and energy growth: Aspiration or reality? *Environmental Research Letters* 16(4):1-11.
- » Löfgren, K.G. and C.Z. Li. Envelope theorems in economics: Historical development and modern cost-benefit applications. *Frontiers of Economics in China* (FEC). In press.

Conferences, workshops and presentations

- » The Transnational and Interdisciplinary Studies in Social Innovation (TAISI) Symposium 2020, Waseda University, Tokyo, July

2020. Presentation: *On the Covid-19 pandemic - some Swedish experiences*.



Therese Lindahl
PhD, Programme Director
Behaviour, economics and nature

Research focus

Human behaviour in social-ecological systems. For example how ecosystem dynamics (e.g. threshold effects, uncertainty, variability, spatial dynamics) influence resource users' exploitation and cooperation behaviour and the implications for natural resource management. Understanding how attitudes, perceptions and behaviour towards the environment are formed and can be changed.

Publications

- » Engström, G., J. Gars, C. Krishnamurthy, D. Spiro, R. Calel, T. Lindahl and B. Narayanan. 2020. Carbon pricing and planetary boundaries. *Nature Communications* 11(1):1-11.
- » Engström, G., J. Gars, N. Jaakkola, T. Lindahl, D. Spiro and A.A. van Benthem. 2020. What policies address both the coronavirus crisis and the climate crisis? *Environmental and Resource Economics* 76(4):789-810.
- » Remme, R.P., H. Frumkin, A.D. Guerry, A.C. King, L. Mandle, C. Sarabu, G.N. Bratman, B. Giles-Corti, P. Hamel, H. Baolong, J.L. Hicks, P. James, J.J. Lawler, T. Lindahl, H. Liu, Y. Lu, B. Oosterbroek, B. Paudel, J.F. Sallis, J. Schipperijn, S. De Vries, B.W. Wheeler, S.A. Wood, T. Wu and G.C. Daily. 2021. An ecosystem service perspective on urban nature, physical activity, and health. *Proceedings of the National Academy of Sciences* 118(22):e2018472118.
- » Lindahl, T., C. Schill and R. Jarungrattanapong. 2021. Beijer Discussion Paper 276: The role of resource dependency for sharing increasingly scarce resources: Evidence from behavioural experiments with small-scale fishers. *Beijer Discussion Paper Series*.
- » Lindahl, T., M.A. Janssen and C. Schill. Controlled behavioural experiments. In: Biggs, R., A. de Vos, R. Preiser, H. Clements, K. Maciejewski and M. (eds.) *The Routledge Handbook of Research Methods for Social-Ecological Systems*, Routledge, London, UK. In press.

Reports

- » Henriksson, P., K. Bergman, S. Hornborg, M. Jonell, T. Lindahl, M. Troell and F. Ziegler. 2021. Hållbar sjömat - vilken sjömat ska man välja? (Sustainable seafood – what seafood should one choose?) Seawin Policy Brief 1, Seawin Earth and Lantbruksnätverket.
- » Hornborg, S., K. Bergman, P. Henriksson, M. Jonell, T. Lindahl, M. Troell and F. Ziegler. 2021. Frisk med fisk utan risk? Att gasa och bromsa svensk sjömatkonsumtion (Healthy with fish without risk? To speed

up or slow down the Swedish seafood production). Seawin Policy Brief 2, Seawin earth and Lantbruksnätverket.

- » Jonell, M., T. Lindahl, K. Bergman, P. Henriksson, S. Hornborg, M. Troell and F. Ziegler. 2021. Hållbar konsumtion av sjömat - hur nå dit? (Sustainable seafood consumption – how do we get there?) Seawin Policy Brief 4, Seawin Earth and lantbruksnätverket.
- » Röös, E., J. Larsson, K. Resare Sahlin, M. Jonell, T. Lindahl, E. André, S. Säll, N. Haring and M. Persson 2021. *Policy Options for Sustainable Food Consumption: Review and Recommendations for Sweden*. Mistra Sustainable Consumption Report 1:10, Chalmers university of Technology.
- » Troell, M., K. Bergman, P. Henriksson, S. Hornborg, M. Jonell, T. Lindahl and F. Ziegler. 2021. Antibiotika – en utmaning också för sjömat. (Antibiotics – a challenge also for seafood) Seawin Policy Brief 5, Seawin Earth and Lantbruksnätverket.
- » Ziegler, F., K. Bergman, P. Henriksson, S. Hornborg, M. Jonell, T. Lindahl and M. Troell. 2021. Lokal eller långväga sjömat? Vilken roll spelar transporten för hållbarheten? (Local seafood or seafood from afar? What is the role of transportation for sustainability?) Seawin Policy Brief 3, Seawin Earth and Lantbruksnätverket.

Conferences, workshops and presentations

- » SIGURD kunskapskluster (SIGURD knowledge cluster) on the value of cohesion, trust and safety in urban planning. Online workshop. Mistra Urban Futures, Gothenburg. September 2020. Presentation: *Social capital and social cohesion: a behavioural economist's perspective*.
- » Seminar Series at Department of Psychology, Karolinska University. Online seminar. October 2020. Speaker: *Our biggest sustainability challenges require collective action - but how can this be achieved? Insights from economic lab and field experiments*.
- » SNS early meeting: A talk with environmental economist Therese Lindahl about sustainable food consumption. Online seminar. SNS (Centre for Business and Policy Studies), Stockholm. October 2020. Presenter: *Sustainable food consumption: how do we get there?*
- » KlimATval. Digital workshop. Stockholm Resilience Centre and Sveriges kommuner och Regioner (Swedish Municipalities and Regions), Stockholm. November 2020. Presentation: *To test and evaluate interventions for sustainable food consumption*.
- » CBIE Round Table Discussion: The role of cognitive abilities in the commons and social-ecological systems, Center for Behavior, Institutions and the Environment (CBIE) Seminar Series, Arizona State University, Tempe, Arizona, USA, online, November 2020. Panel member.
- » BEN workshop. Online workshop. Beijer In-

stitute of Ecological Economics, Stockholm, Sweden. December 2020. Organiser.

- » Commoning the Anthropocene. Online conference. International Association for the study of the Commons, Tempe Arizona. April 2021. Plenary panel participant and Co-chair of the scientific committee.

Teaching and training

- » Co-supervisor of PhD candidate Noah Linder, Environmental Psychology, Department of Building, Energy, and Environmental Engineering, University of Gävle.
- » Co-supervisor of PhD candidate Lina Isacs, Division of Environmental Strategies Research, Royal Institute of Technology, Stockholm.
- » Lecturer, undergraduate level course Ekologisk ekonomi (*Ecological Economics*), Department of Physical Geography and Stockholm Resilience Centre, Stockholm University, autumn 2020.
- » Lecturer, undergraduate level course, *Världens eko* (The world's eco), Stockholm Resilience Centre, Stockholm University, autumn 2020.
- » Lecturer, undergraduate level course, *Environmental management in planning*, Department of Physical Geography, Stockholm University, spring 2021.
- » Lecturer, Master's level course, *Governance and management of social-ecological systems: Challenges of environmental decision-making*, Stockholm Resilience Centre, Stockholm University, spring 2021.
- » Lecturer, PhD level course, *Behavioural Environmental Economics*, Department of Economics, Swedish Agricultural University, spring 2021.
- » Lecturer, Lecture series for Länsförsäkringar (a major Swedish insurance company), Beijer Institute, spring 2021.
- » Lecturer, graduate level course, Food for thought, Beckman's School of Design and the Beijer Institute, spring 2021.

Commissions

- » SARAS Associate, South American Institute for Resilience and Sustainability Studies (SARAS), since 2018.
- » Journal reviewer for *Nature Sustainability*, *Proceedings of the National Academy of Sciences*, *Environmental and Resource Economics*, *Economic Policy*, *Sustainability*, *Frontiers in Psychology*, *Resources Conservation and Recycling* and *Global Food Security*.
- » Executive team member, Mistra Food Futures, 2020-2021.

Other

- » Opinion piece: Engström, G., J. Gars, N. Jaakkola, T. Lindahl, D. Spiro and A.A. van Benthem. 2020.
- » Krisåtgärderna som gynnar jobb och klimat *Svenska Dagbladet*. (English version: "How

- to combat the Corona recession and climate change” re-published by the Kleinman Center for Energy Policy.)
- » Podcast guest, *Rethink Talks: a podcast on resilience and global change, Building back better: economic and financial decision-making in a post-corona world*. August 2020.
 - » Podcast guest, In Common, Commoning#5 - Commoning the Anthropocene. April 2021.



Caroline Schill
PhD, Researcher

Research focus

Human behaviour in complex and intertwined social-ecological systems. How human behaviour shapes, and is shaped by, different social-ecological contexts. Particular interest in the commons, collective action and sustainability in contexts of environmental change and uncertainty.

Publications

- » Care, O., M. Bernstein, M. Chapman, I. Diaz Reviriego, G. Dressler, M. Felipe-Lucia, C. Friis, S. Graham, H. Haenke, L. Haider, M. Hernández-Morcillo, H. Hoffmann, M. Kernecker, P. Nicol, C. Piñeiro, H. Pitt, C. Schill, V. Seufert, K. Shu, V. Valencia and J. Zaehring. 2021. Creating leadership collectives for sustainability transformations. *Sustainability Science* 16:703–708.
- » Lindahl, T., M.A. Janssen and C. Schill. Controlled behavioural experiments. In: Biggs, R., A. de Vos, R. Preiser, H. Clements, K. Maciejewski and M. Schlüter (eds.). *The Routledge Handbook of Research Methods for Social-Ecological Systems*. Routledge, London, UK. In press.
- » Lindahl, T., C. Schill and R. Jarungrattanapong. 2021. Beijer Discussion Paper 276: The role of resource dependency for sharing increasingly scarce resources: Evidence from behavioural experiments with small-scale fishers. *Beijer Discussion Paper Series*.
- » Rocha, J.C., C. Schill, L.M. Saavedra-Díaz, R.D.P. Moreno and J.H. Maldonado. 2020. Cooperation in the face of thresholds, risk, and uncertainty: Experimental evidence in fisher communities from Colombia. *PLoS ONE* 15(12):e0242363.

Conferences, workshops and presentations

- » CEREAL (Conversation on the Environment, Responsible Energy, And Life) breakfast talk, High Meadows Environmental Institute, Princeton University, online, October 2020. Invited speaker: *Understanding human behaviour in the Anthropocene – a complex adaptive systems perspective*.
- » Postdoc Academy for Transformational Lead-

ership Seminar III, Bosch Foundation, Social Innovation & Local Experimentation for Transformative Change, Drift, the Dutch Research Institute for Transitions, Rotterdam, The Netherlands, online, November 2020. Participant.

- » CBIE Round Table Discussion: The role of cognitive abilities in the commons and social-ecological systems, Center for Behavior, Institutions and the Environment (CBIE) Seminar Series, Arizona State University, Tempe, Arizona, USA, online, November 2020. Panel member.
 - » Behaviour, Economics and Nature research programme workshop, Beijer Institute, online, November 2020. Presentation: *A more dynamic understanding of human behaviour for the Anthropocene*.
 - » The Scientific and Technical Advisory Panel (STAP) to the Global Environment Facility (GEF), virtual workshop *How behavioral and social sciences can help the GEF deliver its objectives*, March 2021. Participant.
 - » IASC (International Association for the study of the Commons) 2021 Commoning the Anthropocene Virtual Conference, Arizona State University, Tempe, Arizona, USA, online, April 2021. Member of steering committee and moderator of webinar panel discussion on *Conceptualizing global commons and building capacity for multi-level governance*.
- ### Teaching and training
- » Module leader, lecturer and examiner, Master’s level course *Governance and management of social-ecological systems: Theories and methods for governance of the commons*, Stockholm Resilience Centre, Stockholm University, spring 2021.
 - » Supervisor of Master’s student trainees Kinga Psiuk and Hannah Marlen Lübker and co-supervisor of Master’s student trainee Anna Garre (Social-Ecological Resilience for Sustainable Development, Stockholm Resilience Centre, Stockholm University).

Commissions

- » Theme Leader for the Interacting Complexities research theme (together with Emilie Lindqvist and Juan C. Rocha), Stockholm Resilience Centre, Stockholm University, since August 2020.
- » Reviewer of applications for the 4th cohort of the Postdoc Academy for Transformational Leadership, Bosch Foundation.
- » Journal reviewer for *One Earth*.

Other

- » Part of the Postdoc Academy for Transformational Leadership (since 2018), funded by the Robert Bosch Stiftung in collaboration with four leading academic research centres in Europe.
- » Parental leave: July-October 2020 (20%); October 2020-June 2021 (10%)



Agneta Sundin
Communications Officer

Agneta’s 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 (SRC) communications team, Agneta is involved in activities arranged jointly by SRC, Beijer and Albaeco, for example the Stockholm Seminars series. In addition, she was project leader for the course for students at the Beckman School of Design in February-March and the subsequent exhibition *Food for Thought* in April 2021.



Max Troell
Associate Professor,
Programme Director
Aquaculture and sustainable seafood

Research focus

Sustainability of global food and seafood system, aquaculture, capture fisheries, governance of coastal and marine ecosystems, food and seafood policy, ecosystem functions and services, biodiversity, resilience, regime shifts, food systems, nutrition and food security, climate change, integrated aquaculture, food/seafood trade dynamics, sustainability metrics, life-cycle analysis, seafood certification standards.

Publications

- » Blasiak, R., A. Dauriach, J-B. Jouffray, C. Folke, H. Österblom, J. Bebbington, F. Bengtsson et. al. 2021. Evolving perspectives of stewardship in the seafood industry. *Frontiers in Marine Science* 8:671837.
- » Brugere, C., M. Troell and H. Eriksson. 2021. More than fish: Policy coherence and benefit sharing as necessary conditions for equitable aquaculture development. *Marine Policy* 123:104271.
- » Cottrell, R.S., M. Metian, H.E. Froehlich, J.L. Blanchard, N. Sand Jacobsen, P.B. McIntyre, K.L. Nash, D.R. Williams, L. Bouwman, J.A. Gephart, C.D. Kuempel, D.D. Moran, M. Troell and B.S. Halpern. 2021. Time to rethink trophic levels in aquaculture policy. *Reviews in Aquaculture* 13(3):1583-1593
- » Crona, B., E. Wassénius, M. Troell, K. Barclay, T. Mallory, M. Fabinyi, W. Zhang, V.W.Y. Lam, L. Cao, P.J.G. Henriksson and H. Eriksson. 2020. China at a crossroads: An analysis of China’s changing seafood production and consumption. *One Earth* 3(1):32-44.
- » Farmery, A.K., E.H. Allison, N.L. Andrew, M. Troell, M. Voyer, B. Campbell, H. Eriksson, M. Fabinyi, A.M. Song and D. Steenbergen. 2021. Blind spots in visions of a “blue economy”

could undermine the ocean’s contribution to eliminating hunger and malnutrition. *One Earth* 4(1):28-38.

- » Gephart, J., C.D. Golden, F. Asche, B. Belton, C. Brugere, H.E. Froehlich, J.P. Fry, B.S. Halpern, C.C. Hicks, R.C. Jones, D.H. Klinger, D.C. Little, D.J. McCauley, S.H. Thilsted, M. Troell and E.H. Allisom. 2020. Scenarios for global aquaculture and its role in human nutrition. *Reviews in Fisheries Science & Aquaculture* 29(1):122-138.
- » Henriksson, P.J., S. Cucurachi, J.B. Guinée, R. Heijungs, M. Troell and F. Ziegler. 2021. A rapid review of meta-analyses and systematic reviews of environmental footprints of food commodities and diets. *Global Food Security* 28:100508.
- » Lambraki I.A., S.E. Majowicz, E.J. Parmley, D. Wernli, A. Léger, T. Graells, M. Cousins, S. Harbarth, C. Carson, P. Henriksson, M. Troell and P.S. Jørgensen. 2021. Building social-ecological system resilience to tackle antimicrobial resistance across the One Health spectrum: Protocol for a mixed methods study. *JMIR Research Protocol* 10(4):e24378.
- » Léger A, I. Lambraki, T. Graells, M. Cousins, P.J.G. Henriksson, S. Harbarth, C. Carson, S. Majowicz, M. Troell, E.J. Parmley, P.S. Jørgensen and D. Wernli. 2021. AMR-Intervene: a social-ecological framework to capture the diversity of actions to tackle antimicrobial resistance from a One Health perspective. *Journal of Antimicrobic Chemotherapy* 176(1):1-21.
- » Love, D.C., E.H. Allison, F. Asche, B. Belton, R.S. Cottrell, H.E. Froehlich, J.A. Gephart, C.C. Hicks, D. Little, E.M. Nussbaumer, P. Pinto da Silva, F. Poulain, A. Rubio, J.S. Stoll, M.F. Tlusty, A.L. Thorne-Lyman, M. Troell and W. Zhang. 2021. Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system. *Global Food Security* 28:100494.
- » Naylor R.L., R.W. Hardy, A.H. Buschmann, S.R. Bush, L. Cao, D.H. Klinger, D.C. Little, J. Lubchenco, S.E. Shumway and M. Troell. 2021. A 20-year retrospective review of global aquaculture. *Nature* 591:551–563.
- » Wernli, D., P.S. Jørgensen, E.J. Parmley, M. Troell et al. 2020. Evidence for action: a One Health learning platform on interventions to tackle antimicrobial resistance. *The Lancet Infectious Diseases* 20:e307–11.

Reports

- » Henriksson, P., K. Bergman, S. Hornborg, M. Jonell, T. Lindahl, M. Troell and F. Ziegler. 2021. Hållbar sjömat - vilken sjömat ska man välja? (Sustainable seafood – what seafood should one choose?) Seawin Policy Brief 1, Seawin Earth and Lantbruksnätverket.
- » Hornborg, S., K. Bergman, P. Henriksson, M. Jonell, T. Lindahl, M. Troell and F. Ziegler. 2021. Frisk med fisk utan risk? Att gasa och bromsa svensk sjömatkonsumtion (Healthy with fish without risk? To speed up or slow down the Swedish seafood pro-

duction). Seawin Policy Brief 2, Seawin earth and Lantbruksnätverket.

- » Jonell, M., T. Lindahl, K. Bergman, P. Henriksson, S. Hornborg, M. Troell and F. Ziegler. 2021. Hållbar konsumtion av sjömat - hur nå dit? (Sustainable seafood consumption – how do we get there?) Seawin Policy Brief 4, Seawin Earth and lantbruksnätverket.
- » Leape, J., F. Micheli, M. Tigchelaar et al. 2021. *The Vital Roles of Blue Foods in the Global Food System*, A Blue Food Assessment Policy brief to UNFSS Scientific group. The Blue Food Assessment.
- » Troell, M., K. Bergman, P. Henriksson, S. Hornborg, M. Jonell, T. Lindahl and F. Ziegler. 2021. Antibiotika – en utmaning också för sjömat. (Antibiotics – a challenge also for seafood) Seawin Policy Brief 5, Seawin Earth and Lantbruksnätverket.
- » Ziegler, F., K. Bergman, P. Henriksson, S. Hornborg, M. Jonell, T. Lindahl and M. Troell. 2021. Lokal eller långväga sjömat? Vilken roll spelar transporten för hållbarheten? (Local seafood or seafood from afar? What is the role of transportation for sustainability?) Seawin Policy Brief 3, Seawin Earth and Lantbruksnätverket.

Conferences, workshops and presentations

- » Webinar, Antibiotics resistance in the Anthropocene, Axfoundation, Sweden, 24 November 2020. Panellist and Speaker: *Antibiotic resistance in Aquaculture*.
- » Expert Dialogue, Powering the Seaweed Revolution for Transformational Change in our Food System, UN Global Compact, 28 April 2021.
- » Webinar, The Big Fish series, Is Aquaculture Breaking Into the Global Food System? Center on Food Security and the Environment. 29 March 2021. Panellist.
- » The Stockholm dialogue, Seafood Business for Ocean Stewardship, Presentation and lead for Antibiotic groups, Taskforce III: Working with Governments, 17-19 May 2021
- » Alternative Seafood Workshop, Advancing Alternative Seafood Review: Assessing Food, Nutrition and Livelihood Futures of Plant-Based and Cell-Based Seafood, WIOMSA, 5 August 2020. Participant.
- » World One Health Congress 2020 [online] Oct/Nov 2020. Poster (together with Léger A, I. Lambraki, T. Graells, M. Cousins, P.J.G. Henriksson S. Harbarth, C. Carson, S. Majowicz, E.J. Parmley, P.S. Jørgensen and D. Wernli.): *AMR-Intervene, a database at the interface between science and policy to foster learning and improve interventions targeting antimicrobial resistance*.
- » World One Health Congress 2020 [online] Oct/Nov 2020. Poster (together with Lambraki I.A., S.E. Majowicz, E.J. Parmley, D. Wernli, A. Léger, T. Graells, M. Cousins, S. Harbarth, C. Carson, P. Henriksson, and P.S. Jørgensen): *Exploring factors influencing AMR in the European and South East Asian*

food system using a participatory systems modelling approach.

Teaching and training

- » Co-supervisor of PhD student Ola Luthman (Södertörns University, Sweden). 2019.
- » Evaluator of PhD Thesis Stockholm University, half time evaluation, Oskar Nyberg, *Assessing Sustainability and Antimicrobial Resistance Development in Aquaculture*. 29 January 2021.
- » Member of evaluation committee, PhD defence, Deogratias Mulokozi, *Integrated Agriculture and Aquaculture Systems (IAA) for Enhanced Food Production and Income Diversification in Tanzania*, 11 February 2021.

Commissions

- » Member of advisory team UNFSS AT3, Action Area 2
- » Member of Action Areas and Solution Clusters Working Groups – Blue foods, UNFSS
- » MASMA Programme Committee, Research reviews and program support 2020, Western Indian Ocean Marine Science Association, since 2007.
- » Axfoundation. Member expert group – *Responsible antibiotic use in animal production*. Since 2018.
- » Seafood Business for Ocean Stewardship, Scientific lead for *Working with governments to improve regulations; Antibiotics*.
- » Member of steering group Blue food Assessment, Stanford University/Stockholm Resilience centre,
- » Review editor for journals: *Journal of Aquaculture Environment Interactions (AEI)*, *Frontiers in Marine Science* and *Western Indian Ocean Journal of Marine Science*.
- » Journal Reviewer for *Nature Foods*

Other

- » Part of the consultative group for the report: Practical Guidance for the Sustainable Ocean Principles: Aquaculture. *UN Global Compact, Sustainable Ocean Business Action Platform. 2020*.

Outreach

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Beijer Discussion Papers

The Beijer Discussion Paper Series provide a forum for unpublished scientific papers with content that should be subjected to discussion and comments. The discussion papers can be downloaded from the Beijer website. A total of 276 discussion papers have been produced since 1991. Those published in the past year were:

- » van der Leeuw, S. and C. Folke. 2020. Beijer Discussion Paper 273: The social dynamics of basins of attraction. *Beijer Discussion Paper Series*.
- » Galaz, V. et al. 2021. Beijer Discussion Paper 274: Machine intelligence, systemic risks, and sustainability. *Beijer Discussion Paper Series*.
- » Crépin, A.-S. and J.C. Rocha. 2021. Beijer Discussion Paper 275: Cascading regime shifts in pollution recipients and resource systems. *Beijer Discussion Paper Series*.
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