PIK

Potsdam Institute for Climate Impact Research

ANNUAL REPORT 2019

Leibniz Association

ANNUAL REPORT

2019

Contents

Foreword

While it is already very clear that 2020 will go down in history as the year of coronavirus, it is equally clear that 2019 was the year of climate change. Global warming and climate policy were at the focus of public attention last year more than ever before. Inspired by the Fridays for Future movement, hundreds of thousands of young people took to the streets in Germany and all around the world – prompted by climate research and voicing the message: 'Listen to the science'. Media outlets around the world picked up on PIK's research results more frequently than ever before in the Institute's history. Policymakers took heed of the science and in particular the findings of the Potsdam Institute for Climate Impact Research. Federal Chancellor Angela Merkel, for example, consulted with experts from PIK at various times during discussions on the coal phase-out and climate policy in Germany, especially regarding carbon pricing.

Looking back at 2019 one might say we accomplished quite a lot. From Germany's climate package to the Green Deal in the EU, to the United Nations, scientists across every research department at PIK contributed to efforts to stabilize our climate – and ultimately to safeguard future generations – by delivering research that stood out for its scientific excellence and relevance to society. Our aim is to continue this work with the objective of providing decision-makers in politics, business, and society with the best possible scientific guidance.

At the same time, we still have a great deal of work to do, as is also demonstrated by the pandemic during which this PIK Annual Report was prepared. The challenges we face are becoming more complex and international. From Planetary Boundaries to Global Commons, our long-term prosperity in the twenty-first century and beyond depends on our ability to manage common goods across borders – and this applies to climate stability as well as to protecting human health. Global warming remains a factor that could multiply other risks, also with respect to health. This is one of the most pressing issues of our time. And overcoming the climate problem presents an unparalleled opportunity to secure a good future for us all.

To keep on delivering robust and relevant scientific findings in an ever-changing world, we at PIK aim to keep on improving. We started this development process over a year ago with the restructuring of the Institute. By now, our pioneering FutureLabs have begun their work, with small teams pushing forward new topics across research department boundaries. We continually develop new ways to transfer the results of our work into politics and society, both in terms of scientific policy advice and in our communication efforts. And we continue to work on strengthening the connections between the natural and the social sciences, in order to provide even better solutions-orientated research – not as an end in itself, but for the benefit of the people.

Johan Rockström

Ottmar Edenhofer

01
HIGHLIGHTS

The findings of PIK's climate research reached a wide audience in 2019 – from Greta Thunberg to Angela Merkel, and from people in the street to Members of Parliament. Climate change made its way to the very top of the political agenda in a year that was shaped by the global Fridays for Future movement, both in Germany and around the world. But despite Germany's climate package and the EU's Green Deal, the UN's COP25 climate conference in Madrid demonstrated once again that governments have yet to take decisive steps to rapidly stabilize the climate.

United in Science

Climate research debated in the streets and in Parliament

From the coal commission to the climate package

Germany is phasing out the use of coal: The year 2019 began with recommendations from a Federal Government commission that aimed to gradually phase out the most emissions-intensive fossil fuels. Experts from the Potsdam Institute for Climate Impact Research (PIK) were closely involved in the tough negotiations leading up to the recommendations. They included commission member Hans Joachim Schellnhuber and PIK Director Ottmar Edenhofer, who spoke as an adviser to the committee concerned with carbon pricing. Shortly before the decision of the commission, the magazine Der Spiegel published a detailed proposal for carbon pricing reform by Edenhofer and his fellow economist Christoph Schmidt of the RWI Leibniz Institute for Economic Research.

Chancellor commissions Ottmar Edenhofer with report on carbon pricing

As part of the preparations for Germany's climate package, Chancellor Angela Merkel asked economist Ottmar Edenhofer to lend his expertise to a key special report on climate protection published by the German Council of Economic Experts (SVR). In their comprehensive working paper titled 'Optionen für eine CO_2-Preisreform' ('Options for a Carbon Pricing Reform'), Edenhofer and his team – consisting of a close-knit group from PIK and the Mercator Research Institute on Global Commons and Climate Change (MCC) – point out specific ways how Germany's government can achieve the 2030 targets for reducing emissions, which are laid down in the EU's Effort Sharing Regulation. The central idea is to establish a socially balanced pricing system for carbon emissions that extends across all sectors. Based on the special assessment, the 'Climate Cabinet', which is headed by the Federal Chancellery and six line ministries, discussed a fundamental realignment of the measures to prevent carbon emissions.

Federal Chancellor Angela Merkel visits PIK for briefing

In the run-up to this process, Chancellor Angela Merkel visited PIK in June and consulted closely with scientists here. The focal point of her fact-finding visit was also an exchange regarding the options for a fair, effective carbon pricing system. Besides Mrs Merkel, the Head of the Federal Chancellery and Federal Minister for Special Tasks Helge Braun, spokesman Steffen Seibert, and experts from the Chancellery also took part. More than two dozen researchers from PIK were involved in the roundtable discussion in the Institute's Great Cupola and presented research results on climate risks and possible solutions to the climate crisis.

Link to MCC/PIK expertise

Federal Chancellor Angela Merkel in conversation with Ottmar Edenhofer at PIK. Photo: BPA Guido Bergmann

Ottmar Edenhofer in conversation with Federal Minister for Economic Affairs Peter Altmaier, Chair of the Green Party Annalena Baerbock, and other guests on the Anne Will show

Link to programme

Amendments on the way to the climate package

The outcomes of PIK's research were only incorporated to a limited extent in the climate package presented by the Federal Government in September. While the heads of the grand coalition had agreed to a starting price for carbon emissions in the Climate Cabinet, Edenhofer objected that a starting price of 10 euros to be gradually increased would be insufficient to reach the climate targets Germany has set for itself for 2030. Speaking in the Anne Will talk show, for example, he argued the climate package was a 'document that demonstrates a lack of political courage'.

This assessment was also reflected in the detailed evaluation of the climate package, which Edenhofer and his team from PIK and MCC Berlin presented a short time later and that followed up on the expertise they had provided for the report published by the Council of Economic Experts. The report demonstrated that policymakers needed to make readjustments in four aspects in particular: First, carbon pricing levels should be made more ambitious, second, a better social balance must be achieved, third, the transfer to the EU level must be organized in greater detail and fourth, an effective monitoring process should be introduced.

Link to report

The ongoing recommendations Edenhofer and his team made to the Federal Government proved effective: After the Bundesrat initially halted the climate package due to the fact that its targets lacked ambition, the Mediation Committee consisting of representatives from the federal and state levels subsequently increased the carbon price by a significant amount.

The Federal Government has also brought Edenhofer on board to provide scientific support for the Climate Action Plan 2050, where he will serve as a member of the Climate Protection Science Platform.

As the voice of science, the platform will advise the government independently and on its own initiative on the implementation and further development of the German climate strategy and contribute to the achievement of climate goals. The platform will be overseen by a steering committee consisting of representatives of outstanding research institutions, with Ottmar Edenhofer as co-chair.

A new quality: Fridays for Future movement based on science

'Listen to the science' is one of the key messages of the young people in the Fridays for Future movement who are protesting for greater climate protection. This is also one of the reasons that PIK scientists including Stefan Rahmstorf and Wolfgang Lucht, along with numerous other researchers, were among the signatories of a statement on the current state of climate knowledge published by Scientists for Future. Johan Rockström, Ottmar Edenhofer, and Leonie Wenz were among those speaking to and with the young people at the March for Science and other large events hosted by the movement in Potsdam and Berlin. There were more than one hundred thousand attendees at the largest event.
YouTube stars and podcasters including Rezo ('the guy with the blue hair'), Mai Thi Nguyen-Kim (MaiLab), Thilo Jung (Jung und Naiv), Philip Banse (Lage der Nation) also spoke with researchers from PIK or referred to PIK's research in their videos or posts.

YouTuber Mai Thi Nguyen-Kim interviews Ottmar Edenhofer in 'MaiLab' (in German). Photo: Screenshot

Together with Luisa Neubauer, an activist in Germany's Fridays for Future movement, Swedish pupil Greta Thunberg visited PIK in the summer to discuss the current state of science. Thunberg and Johan Rockström, who is also a native of Sweden, had already met at the World Economic Forum in Davos at the beginning of the year. Thunberg visited Potsdam for a discussion deliberately without television cameras with Rockström, Ottmar Edenhofer as well as other experts from PIK such as Director Emeritus Hans Joachim Schellnhuber, Stefan Rahmstorf, Ricarda Winkelmann, and Jessica Strefler.

From Germany to Europe and into the world

PIK's expertise globally in demand

Johan Rockström at the Petersberg Climate Dialogue

'Fulfilling the promise of Paris' was the title of the Petersberg Climate Dialogue in May, at which PIK Director Johan Rockström was one of the guest speakers. The two-day event is one of the highest-ranking meetings in terms of climate policy on the German and international political agenda, bringing together ministers and high-level representatives from 35 countries. The conference was co-hosted by the German Environment Minister, Svenja Schulze, and the UN COP25 Climate Conference. 'The science is clear: If we want to stabilize our climate, we need a fundamental change in all sectors of society,' Rockström told the international decision-makers present.

Link to report

Angela Merkel, Svenja Schulze, and Chilean Minister of the Environment Carolina Schmidt at the Petersberg Climate Dialogue. Photo: BMU/photothek/Thomas Köhler

Edenhofer: 'The European Green Deal is a bold plan'

In Brussels, the President of the EU Commission, Ursula von der Leyen, presented the European Green Deal, which contains comprehensive tax reforms as its central instrument. PIK's leadership maintains an ongoing exchange with the Commission. PIK Director Ottmar Edenhofer praised the European Green Deal as 'a bold plan that must now be followed by concrete action'.

UN Climate Action Summit: Rockström speaks in New York

Hosted by UN Secretary-General António Guterres, the UN Climate Action Summit in New York was attended by world leaders including Federal Chancellor Angela Merkel along with other decision-makers from the fields of politics, business, and civil society. Ottmar Edenhofer and Johan Rockström made significant contributions to a synthesis report titled 'United in Science', which discusses the current state of climate research. Leading players in the field of climate science joined forces on the landmark report with the aim of delivering facts for necessary decisions. The report was published on behalf of the UN Climate Summit's scientific advisory group and focuses on the gap between agreed targets to tackle global warming and the reality of continually increasing emissions.

Johan Rockström also introduced the Exponential Roadmap Report in New York. This report highlights the most feasible options for solutions that could accelerate a reduction in greenhouse gas emissions. Rockström also presented the Planetary Emergency Plan at a high-level event immediately following the UN Climate Summit. The so-called Leaders Event was organized by and for heads of states and governments in order to discuss current issues and make preparations for COP25.

Link to report

Johan Rockström at the presentation of the '10 Insights in Climate Science' together with UNFCCC Executive Secretary Patricia Espinosa and others. Photo: PIK

COP25: PIK experts in Madrid

More than 25,000 delegates from all over the world attended COP25, which was held in December in Madrid, Spain. Experts from PIK also travelled to the conference, among them Fred Hattermann, Christoph Gornott, Jürgen Kropp, and Kira Vinke, who contributed their scientific expertise during joint side events with the United Nations Framework Convention on Climate Change (UNFCCC), the EU Commission, Federal Ministries, and, for example, the German development agency Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The topics they addressed ranged from the water sector, to adaptation strategies for small-scale farmers in sub-Saharan Africa, to the role of research and innovation.

Link to the 10 insights

Scientific update for climate negotiators

From food security to biodiversity and extreme weather as the 'new normal': Together with UNFCCC's Executive Secretary Patricia Espinosa and colleagues from Future Earth and the Earth League, PIK Director Johan Rockström presented the '10 New Insights in Climate Science' at COP25. The brief overview is intended to provide negotiators at the Climate Summit with key facts regarding the current state of research. Initiated by PIK, this was the third time in a row that the report was published.

At a high-level event focusing on the planetary state of emergency, Johan Rockström also gave a direct report on the current state of science to the plenary of international delegates in an 'update from science'. In addition to Rockström, those speaking at the plenary meeting prior to the final and conclusive rounds of negotiations at COP25 included Greta Thunberg, the Minister for Ecological Transformation of Spain, Teresa Ribeira, as well as representatives from the World Bank and the EU Commission.

The outcomes of COP25, which were reached following several delays and intense negotiations between the countries, were criticized by both Ottmar Edenhofer and Johan Rockström as a 'weak result', which, though disappointing, did not come as a surprise. This showed once again, they noted, that the United Nations Climate Change Summit that was to be held in Glasgow in 2020 must truly serve as the turning point as set out in the timeline of the Paris Agreement.

Since then, it has become clear that the Glasgow summit will be postponed to 2021 due to the coronavirus crisis – which represents a significant challenge for international climate policy. From the perspective of stabilizing the climate, it is crucial that we do not lose an entire year.

Photo: Screenshot

To video of high-level event

'Follow the science – that's something I heard many times in Madrid. And the science is clear: If we heat up our planet beyond 1.5°C, we might enter a danger zone of climate destabilization. This is our planetary boundary for a safe and just future for humanity on Earth. Crossing boundaries naturally doesn't mean all is lost yet; however, it does mean losing control and driving up risks for our children and future generations with each tenth of a degree of warming.'

Johan Rockström

'A great deal of hope now rests on the European Commission, which laid out the bold Green Deal plan to establish a new growth model for our economy; a growth model that contributes to stabilizing our climate. If put into action, this plan would include robust tools such as a just and fair minimum pricing scheme for carbon and smart, balanced tax reforms. From an economist's perspective, this is the right way forwards.'

Ottmar Edenhofer

Research highlights

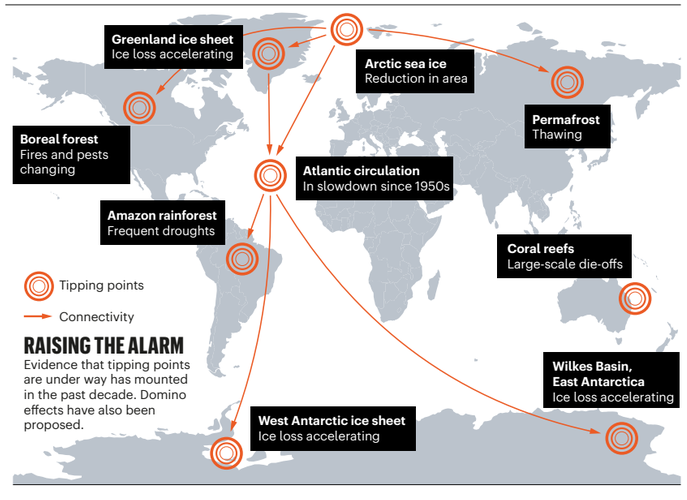
In 2019, more than 260 peer-reviewed studies by researchers at PIK were published in leading scientific journals – on subjects ranging from Earth system analysis, to climate resilience, to transformation pathways and complexity science. Here are a few highlights:

Climate tipping points – an underestimated risk in the Earth system

A large number of critical elements in the Earth system could be more likely to tip than was previously thought, a group of leading scientists has warned in the highly renowned journal Nature. This holds true for the Greenland and West-Antarctic ice sheets, just as it does for coral reefs and the Amazon rainforest. Evidence is also mounting that these events are not only becoming more likely but that they are also more interconnected than previously thought. This could lead to domino effects that would put the livelihoods of many people around the world at significant risk. In their commentary, the authors propose a formula to investigate a state of planetary emergency as a product of risk and urgency.

They highlight nine of the tipping elements as particularly critical: The Arctic sea ice, the Greenland ice sheet, the boreal forests, permafrost soils, the Atlantic meridional overturning circulation, the Amazon rainforest, tropical coral reefs, the West Antarctic ice sheet, and parts of East Antarctica – the urgency of the situation is particularly acute here.

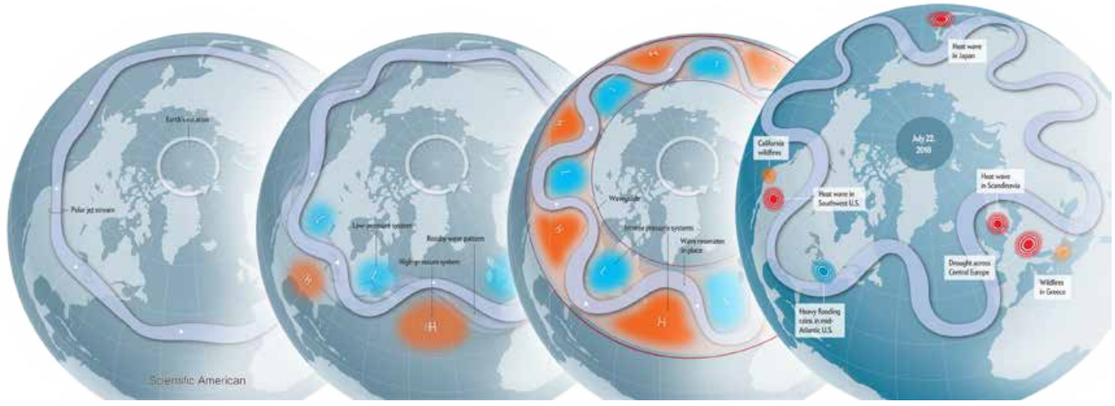
Lenton, T. M., Rockström, J., Gaffney, O., Rahmstorf, S., Richardson, K., Steffen, W., Schellnhuber, H. J. (2019): Climate tipping points – too risky to bet against. – Nature, 575, 7784 [Comment] – DOI 10.1038/d41586-019-03595-0



SOURCE: T. M. LENTON *ET AL.*

Map of identified tipping elements in the Earth system: Disturbances in these interconnected systems could reinforce each other and trigger yet-unknown impacts with potentially severe consequences for humanity.

Reprinted by permission from Nature: Climate tipping points – too risky to bet against – Lenton, T. M., Rockström, J., Gaffney, O., Rahmstorf, S., Richardson, K., Steffen, W., Schellnhuber, H. J., COPYRIGHT (2019)



Effects of what are known as Rossby waves: The wave pattern in the jet stream becomes more pronounced, and air masses move more slowly. Areas of high or low pressure stall for longer periods, which can cause extreme weather events. Kornhuber, K., Osprey, S., Coumou, D., Petri, S., Petoukhov, V., Rahmstorf, S., Gray, L. (2019): Extreme weather events in early summer 2018 connected by a recurrent hemispheric wave-7 pattern. Environmental Research Letters, 14, 5 – DOI: 10.1088/1748-9326/ab13bf (Reproduced with permission. Copyright © (2019) SCIENTIFIC AMERICAN, a Division of Springer Nature America, Inc. All rights reserved.)

What did record-breaking heatwaves and droughts in Western Europe and North America have in common with torrential rainfall and floods in Southeast Europe and Japan?

The summer of 2018 brought a series of extreme weather events that occurred almost simultaneously around the Northern Hemisphere in June and July. An international team of researchers has found that these extremes were connected by a specific pattern of the jet stream encircling the Earth. The jet stream formed a stalled wave pattern in the atmosphere which made weather conditions more persistent and thus extreme in the affected regions. The scientists have been observing a clear increase of these patterns in recent years.

Kornhuber, K., Osprey, S., Coumou, D., Petri, S., Petoukhov, V., Rahmstorf, S., Gray, L. (2019): Extreme weather events in early summer 2018 connected by a recurrent hemispheric wave-7 pattern. Environmental Research Letters, 14, 5 – DOI: 10.1088/1748-9326/ab13bf

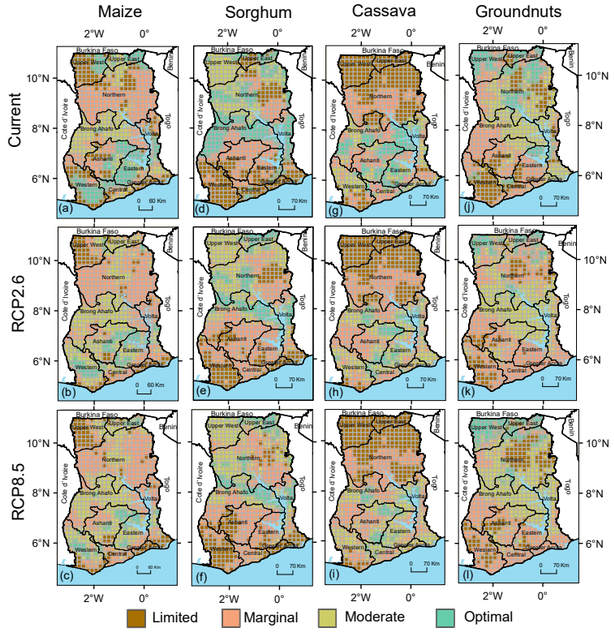
Feeding the world without damaging the planet

Almost half of current food production is harmful to our planet – causing biodiversity loss, ecosystem degradation, and increased water scarcity. In a study, PIK investigated how many people could be fed while maintaining a strict standard of environmental sustainability worldwide. The researchers' findings were encouraging, as they suggest that it is theoretically possible to feed a global population of 10 billion people without placing the Earth system at risk. However, this will require no less than a technological and socio-cultural U-turn – and includes consistently adopting methods of farming that conserve resources, reducing food waste, and ultimately changing the way we eat. As a positive side effect, more sustainable agricultural practices can increase overall climate resilience while also limiting global warming.

Gerten, D., Heck, V., Jägermeyr, J., Bodirsky, B.L., Fetzer, I., Jalava, M., Kummu, M., Lucht, W., Rockström, J., Schaphoff, S., Schellnhuber, H.J. (2020): Feeding ten billion people is possible within four terrestrial planetary boundaries. – Nature Sustainability 3 – DOI 10.1038/s41893-019-0465-1.

Comprehensive study on climate risks and adaptation strategies in Ghana

Which strategies can a country like Ghana use to address climate risks for agriculture? A study commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and conducted by PIK sought to answer this question. In cooperation with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and with the involvement of stakeholders in Ghana, an interdisciplinary team from the Climate Resilience research department examined risks and strategies for adapting the country's agricultural sector to a changing climate. From factors ranging from water availability to extreme events and crop yields – results of the study have already been incorporated



The models show that the average temperature in Ghana will increase significantly by the middle of this century, with precipitation patterns and future water resources altering from region to region. This will make it more difficult, for example, to produce maize in northern and central Ghana, but growing sorghum will still be possible there to a large extent. The figure shows the suitability of various regions in Ghana for growing maize, sorghum, cassava, and groundnuts under current conditions (top row), under a moderate climate change scenario (RCP2.6, middle row), and under an extreme climate change scenario (RCP8.5, bottom row). (Murken et al., 2019).

in the Ghanaian National Adaptation Planning (NAP) process. The study was also presented by experts and project partners during a side event at COP25 in Madrid, where it attracted a great deal of attention.

Murken, L., Aschenbrenner, P., Chemura, A., Hattermann, F., Koch, H., Lehmann, J., Liersch, S., Röhrig, F., Schauberger, B., Yalew, A., Gornott, C. (2019): Climate Risk Analysis for Identifying and Weighing Adaptation Strategies in Ghana's Agricultural Sector. Potsdam: Potsdam Institute for Climate Impact Research, 81 p. – DOI: 10.2312/pik.2020.001

Modelling cropping periods of grain crops at a global scale

Crop yields are largely determined by the decisions that farmers make regarding sowing dates and varieties. As a result, this factor is a key piece of information when it comes to being able to estimate future crop yields by means of simulation models. However, yield simulations so far have often assumed that farmers do not make any changes to their agricultural management practices. Researchers in the Land Use and Resilience working group have responded by developing a new modelling approach to take more effectively into account farmers' decision making to adapt growing seasons to local conditions. Their results show how farmers select cropping periods under current climate, accounting for the current climatic conditions as well as those relating to plant physiology. Importantly, it is shown how growing periods are selected in order to match the crop cycle with the most favourable conditions, particularly during the grain yield formation. The model thus provides an effective approach for improving global plant growth models and for projecting farmers' choices under future climate changes.

Minoli, S., Egli, D. B., Rolinski, S., Müller, C. (2019): Modelling cropping periods of grain crops at a global scale. – Global and Planetary Change, 174, 35-46. – DOI: 10.1016/j.gloplacha.2018.12.013

Transitioning to wind and solar-based electricity significantly reduces damage to the environment and health

Power generation is one of the biggest emitters of climate-damaging greenhouse gases globally. To keep global warming well below 2°C, the energy sector must become carbon neutral. Several paths lead towards this goal, and each has its potential environmental impacts – such as air and water pollution, land-use and water demand. For the first time, a team of researchers led by PIK has now quantified the actual benefits and downsides of three main pathways to decarbonization. The researchers used complex simulations sketching out the possible options for decarbonizing the electricity supply and combined their calculations with life cycle analyses for power plants. Their results show that transitioning to electricity produced with wind and solar energy would bring the most benefits for the health of people and planet. Maintaining a predominantly conventional power plant structure and switching to carbon capture and storage in combination with fossil and biomass resources, in turn, is likely to incur significant environmental costs.

Luderer, G., Pehl, M., Arvesen, A., Gibon, T., Bodirsky, B. L., Sytze de Boer, H., Fricko, O., Hejazi, M., Humpenöder, F., Iyer, G., Mima, S., Mouratiadou, I., Pietzcker, R. C., Popp, A., van den Berg, M., van Vuuren, D., Hertwich, E. G. (2019): Environmental co-benefits and adverse side-effects of alternative power sector decarbonization strategies. – Nature Communications. – DOI: 10.1038/s41467-019-13067-8

Just 15 years of emissions could lock in 20 cm of sea-level rise

A study conducted by researchers from PIK and Climate Analytics in Berlin shows for the first time the concrete impacts that the emission reduction targets for 2030 agreed for individual countries in the Paris Agreement will have on sea-level rise. Unless governments significantly scale up their nationally determined contributions (NDCs), the next 15 years' worth of emissions released under their current Paris Agreement pledges alone would trigger 20 cm of sea-level rise by 2300.

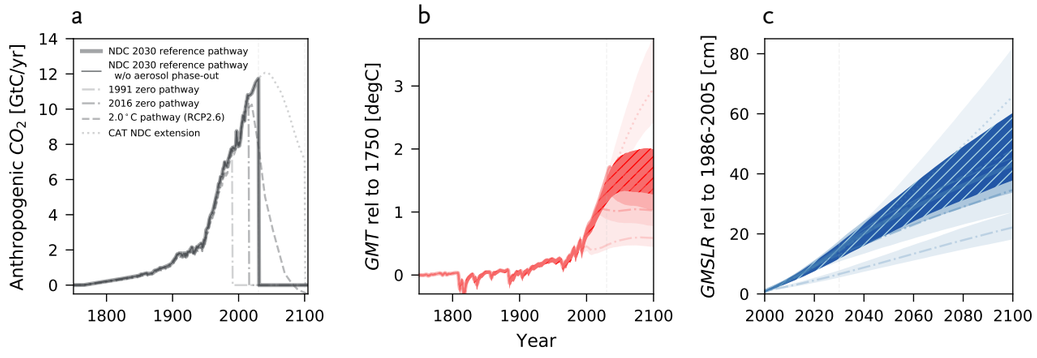
More than half of the expected sea-level rise can be attributed to the top five emitters of greenhouse gases – China, the US, the EU, India, and Russia. The emissions released by these five economies alone under their NDCs would cause seas to rise by 12 cm by 2300. The findings show that our emissions today will inevitably cause seas to rise a long way into the future. As a result, governments urgently need to put forward much more ambitious climate action plans in the form of their NDCs in order to limit global warming to well below 2°C.

Nauels, A., Gütschow, J., Mengel, M., Meinshausen, M., Clark, P. U., Schleussner, C.-F. (2019): Attributing long-term sea-level rise to Paris Agreement emission pledges. – Proceedings of the National Academy of Sciences of the United States of America (PNAS), 116, 47, 23487-23492

Amazon rainforest can be trained by variable rainfall – but it's no match for climate change

A PIK study published in Nature Geoscience finds that regions of the Amazon rainforest with generally higher rainfall variability are more resilient to current and future climate disturbances. However, despite this 'training effect', the Amazon rainforest will likely be unable to keep up with the pace of ongoing climate change, the researchers show in their analysis. The quantification of this previously hidden dynamic stability behaviour was made possible by combining innovative mathematical methods for analysing nonlinear systems with state-of-the-art observation data.

The Amazon rainforest has evolved over millions of years and even withstood ice ages. Yet today, human influences and global climate change put this huge ecosystem at risk of large-scale dieback – with major



Panel a shows CO2 emissions in the various scenarios under consideration at the global level. The CO2 emissions from 1991, 2016, and 2031 are reduced to zero in order to determine the influence of emissions from the periods 1991–2030 and 2016–2030. A 2-degree compatible emissions pathway and an emissions pathway that carries current NDCs forward to 2100 are also shown as a means of comparison. Panel b illustrates the global temperatures resulting from these emissions pathways including their degree of uncertainty (shaded areas). The sea-level rise for these scenarios is presented in panel c. (Nauels et al., 2019, PNAS)

consequences for its function as a global carbon sink. The new research approach makes it possible to identify regions that could be more vulnerable to future precipitation changes. This shows that if climate change were to continue unabated, a large, coherent region in the southern Amazon might be at risk of transitioning from forest to savannah.

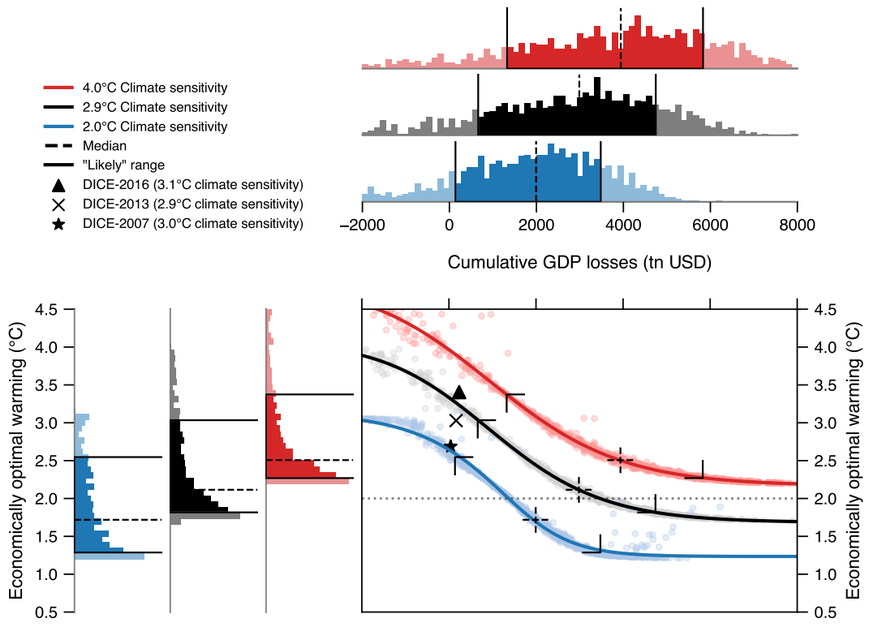
Ciemer, C., Boers, N., Hirota, M., Kurths, J., Müller-Hansen, F., Oliveira, R. S., Winkelmann, R., (2019): Higher resilience to climatic disturbances in tropical vegetation exposed to more variable rainfall. – Nature Geoscience – DOI: 10.1038/s41561-019-0312-z

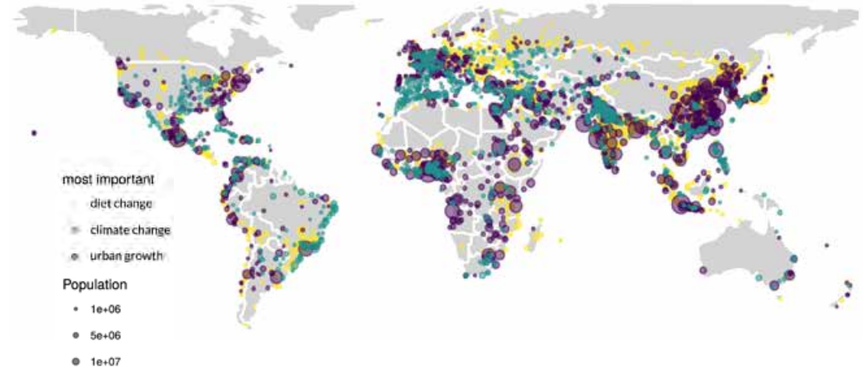
Climate costs smallest if warming is limited to 2°C

The politically negotiated climate target of the Paris Agreement, which is based on scientific findings, is also the economically sensible one, as demonstrated by a study conducted by researchers at PIK. Using computer simulations of a model by US Nobel Laureate William Nordhaus, they weighed climate-related damage from, for instance, increasing weather extremes or decreasing labour productivity against the costs of cutting greenhouse gas emissions. The team's research showed that the most cost-effective level of global warming is in fact the one that more than 190 nations signed as the Paris Agreement: 2°C.

Glanemann, N., Willner, S. N., Levermann, A. (accepted 2019): Paris Climate Agreement passes the cost-benefit test. – Nature Communications, 11 – DOI 10.1038/s41467-019-13961-1

Correlation between cumulative GDP losses in this century if we fail to protect the climate and economically optimal global warming in 2100. The points were drawn from an uncertainty distribution over the economic losses depending on climate change. The different colours indicate various climate sensitivities (warming if the atmospheric content of CO2 is doubled), of which '2.9', the black line, is generally assumed. A cross marks the median of the distributions, while black corners mark the 'likely' uncertainty. (Glanemann, N. et al. 2020, Nature Communications)





Key factors influencing future potential for local food demand in urban areas.
Figure modified from S. Kriewald et al., 2019, Environmental Research Letters, 14, 9, DOI 10.1088/1748-9326/ab2d56

Potential of regional agriculture to supply cities

Apples from New Zealand, steaks from Argentina – these are examples of agricultural commodities that are transported to our cities from around the globe. PIK has examined how much food could be produced in close proximity to cities and the volumes of emissions that could be saved due to the reduced demand for transport. The results show that around 35 per cent of city dwellers could be supplied by local agriculture globally. Countries such as India would benefit greatly – over 80 per cent of its city dwellers could theoretically be fed by local agriculture. Factors that would influence future demand for food include the growth of cities, increasing meat consumption, and climate change due to the impacts it has on production conditions. In South Asia, for example, urban growth could cause local food self-sufficiency to decrease by approximately 30 per cent by 2050. In North Africa, the reduction in the local potential is due to a combination of climate change and urban growth. The analyses looked at 4,000 cities with more than 100,000 residents. Optimal local production could reduce transport-based emissions in the agricultural sector by 1–1.3 Gt of CO_2 – around 14–18 per cent of global transport-based emissions.

Kriewald, S., Pradhan, P. Costa, L., Cantu Ros, A., Kropp, J. P. (2019): Hungry cities: how local food self-sufficiency relates to climate change, diets, and urbanisation. – Environmental Research Letters 14, 9 – DOI 10.1088/1748-9326/ab2d56

Artificial intelligence: Applying 'deep reinforcement learning' for sustainable development

For the first time, a special type of machine learning has been used to find novel pathways for sustainable development. One example of these pathways could be a specific mix of taxing CO_2 emissions and subsidies for renewable energies. To this end, scientists at PIK developed a mathematical framework combining recently developed machine learning techniques with more classical analysis of trajectories in computer simulations of the global climate system and the global economy. So far, 'deep reinforcement learning' has mostly been used to make computers excel in certain games, such as AlphaGo, or navigate robots through rough terrain. The results cannot be transferred directly to the real world as the analyses were conducted using a highly simplified model of the Earth system. However, the findings do demonstrate that the application of machine learning identify pathways that are innovative compared to the outcomes of classical analyses. The study is therefore of substantial methodological value and shows great potential.

Strnad, F. M., Barfuss, W., Donges, J. F., Heitzig, J. (2019): Deep reinforcement learning in World-Earth system models to discover sustainable management strategies. – Chaos, 29, 12 – DOI: 10.1063/1.5124673

Johan Rockström, photo: M. Axelsson/Azote

News from inside PIK

Johan Rockström appointed Professor of Earth System Science at the University of Potsdam

PIK Director Johan Rockström has been appointed Professor of Earth System Science. The professorship is at the Institute of Environmental Science and Geography at the University of Potsdam and is jointly funded by PIK. In his inaugural lecture, Rockström discussed 'Our future on Earth – Redefining Sustainable Development in the Anthropocene'.

Gunnar Luderer appointed Professor for Global Energy Systems Analysis at TU Berlin

Gunnar Luderer has been appointed to the newly created Chair of Global Energy Systems Analysis at Technische Universität Berlin. The chair is jointly funded by PIK and the Institute for Energy Technology at Technische Universität Berlin. Luderer will work primarily in the field of energy transition and the worldwide transformation towards sustainable energy systems.

Gunnar Luderer, photo: Photothek

Sabine Gabrysch, Photo: Greb

Sabine Gabrysch appointed first Professor for Climate Change and Health

Charité – Universitätsmedizin Berlin and PIK have joined forces to create the first-ever Professorship for Climate Change and Health in any German medical school. Its purpose will be to study the links between climate change and population health. Physician Sabine Gabrysch has been appointed to the new position and is also jointly heading PIK's research department on Climate Resilience together with agricultural economist Hermann Lotze-Campen.

Detlef Sprinz wins award for innovative university teaching

Detlef Sprinz, KHK/GCR21, photo: krischer-fotografie

Together with the University of Potsdam and the Hasso-Plattner-Institute (HPI), PIK has been awarded the 'Fellowship for innovation and higher education teaching' for their jointly developed university programme. The course 'Sustainable and collaborative decision-making in business and politics – an interdisciplinary and simulation-based course' will be funded over the next two years by the Baden-Württemberg Foundation and the Stifterverband.

Edenhofer one of the ten most influential economists in Germany

PIK Director Ottmar Edenhofer has been named one of Germany's top 10 economic researchers in the ranking published by daily newspaper Frankfurter Allgemeine Zeitung (FAZ) and thus achieved an excellent result again in 2019. Edenhofer rose five places in comparison to the previous year, improving his position to seventh place. In addition to the number of scientific citations, the FAZ also, for example, takes surveys of parliamentarians and mentions in print, online, and social media into account in its ranking.

Ten PIK researchers among the most influential scientists worldwide

According to a new ranking, ten scientists from all research departments at PIK are among the most cited researchers worldwide. This places them among the most influential scientists in the world, and their studies rank among the top 1 per cent of scientific literature. The ranking shows that PIK is among the most renowned research institutions in Germany and worldwide, whether in the natural or social sciences.

PIK one of the world's most influential climate thinktanks

PIK has once again achieved a top spot among the world's leading thinktanks for environmental policy in the Global Go To Think Tank Ranking Index Report. Published by the University of Pennsylvania in the US, the ranking has listed PIK in second place in the 'Top Environment Policy Think Tank' category. PIK also achieved a spot among the 'Top Think Tanks Worldwide', the 'Top Energy and Resource Policy Think Tanks', the 'Best Government Affiliated Think Tanks' and the 'Think Tanks with the Most Significant Impact on Public Policy'.

Lancet report among the most-discussed papers of the year

Written by international experts including Johan Rockström, the pioneering Lancet report on how a global population of 10 billion people can be fed in a sustainable manner received an enormous amount of attention in the media and online according to Altmetric, which specializes in scientific statistics. This PIK study ranked 18th among the top 100 science stories across all disciplines in 2019, putting it in the top 5 per cent of all research findings scored by Altmetric. When taking only scientific publications on climate change into account, the study took fourth place among the 'Top 10 climate papers' of the year according to an analysis by Carbon Brief.

Outstanding young researchers

Jonathan Donges, Photo: Karkow

Niklas Boers, Photo: P. Bartz

Kira Vinke, Photo: Annette Koroll

Catrin Ciemer, Photo: Leibniz Association

Kai Kornhuber, Photo: Climate Media Factory

Jonathan Donges receives Heinz Maier-Leibnitz Prize

The Deutsche Forschungsgemeinschaft (German Research Foundation) and the Federal Ministry of Education and Research have awarded Jonathan Donges Germany's top distinction for researchers in their early careers. Donges was awarded the Heinz Maier-Leibnitz-Preis in recognition of his exceptional research results and for introducing innovative methods from statistical physics into climate and Earth system research.

Postdoc Prize of the State of Brandenburg for Niklas Boers

Niklas Boers has been awarded the Postdoc Prize of the State of Brandenburg. The prize is awarded by the state of Brandenburg in recognition of excellent research achievements by young scientists from universities and non-university research institutions. The Volkswagen Foundation also awarded Boers the lucrative Freigeist Fellowship for 2019.

Kira Vinke awarded Potsdam Young Scientist Award

Kira Vinke from PIK is the first political scientist to receive the Potsdam Young Scientist Award for her dissertation on 'Unsettling Settlements: Cities, Migrants, Climate Change. Rural-Urban Climate Migration as Effective Adaptation?'. The award was presented to her by Lord Mayor Mike Schubert

Catrin Ciemer wins Leibniz Dissertation Award

Physicist Catrin Ciemer has been awarded the Leibniz Dissertation Award for her outstanding doctoral thesis on changes in precipitation patterns in the Amazon rainforest. The prize is awarded annually for the best PhD dissertations from Leibniz Institutes in the categories of Humanities & Social Sciences and Natural & Technical Sciences.

Physikalische Gesellschaft zu Berlin honours Kai Kornhuber

Kai Kornhuber was presented the Carl Ramsauer Award by the Physikalische Gesellschaft zu Berlin (PGzB) society for his dissertation on the mechanisms and impacts of simultaneous extreme weather events. The Carl Ramsauer Award recognizes the best PhD theses in physics or related sciences each year.

Allianz Climate Risk Research Award for Sven Willer

Sven Willner has received the Allianz Climate Risk Research Award for his work on 'Higher-order economic losses and damages due to extreme weather events along the global supply network'. With this award, the insurance company supports young scientists whose research promotes a better understanding of the risks posed by climate change.

Ronja Reese receives multiple awards

Ronja Reese has received a number of recognitions for her dissertation titled 'The far reach of ice-shelf thinning in Antarctica'. The Faculty of Science at the University of Potsdam awarded her the Michelson Prize for the best PhD dissertation of the year for her 'excellent and innovative research results with high practical relevance'. The Leibniz-Kolleg Potsdam recognized Reese for her doctoral thesis by awarding her its publication prize. She also received the dissertation prize of the Society of Friends and Promoters of PIK.

Marlene Kretschmer awarded grant by the German Meteorological Society

Marlene Kretschmer has been awarded the German Meteorological Society grant for her dissertation on extreme winter weather events and climate change. The award honours outstanding scientific achievements in the field of meteorology.

Leibniz PhD General Assembly gathers at PIK

PIK hosted the two-day Leibniz PhD Network General Assembly. Doctoral candidates from all disciplines across the Leibniz Association come together at the annual assembly to discuss their research, exchange ideas, and network.

A day for postdocs

For the first time, the Institute hosted a Postdoc Day for its postdoctoral researchers in addition to the annual PhD Day at PIK. Topics covered in the day's workshops included pathways to professorships or career opportunities in the private sector. Former colleagues from PIK's alumni network offered insights into various careers at the event.

Sven Willner, photo: personal collection

Ronja Reese, photo: R. Winkelmann

Marlene Kretschmer, photo: PIK

LeibnizPhDDay, photo: PIK

Hans Joachim Schellnhuber (third from right) at the ceremony. Photo: Entega

ZEIT Wissen prize for Stefan Rahmstorf

Stefan Rahmstorf has been awarded the 'ZEIT Wissen Prize Mut zur Nachhaltigkeit' (Courage for Sustainability) for his achievements in communicating climate change. With this award, the magazine of the ZEIT publishing group honours pioneers from science, industry, and civil society who make outstanding contributions to closing the gap between knowledge and action in the area of sustainable development.

Outstanding courage for sustainability: Stefan Rahmstorf. Photo: Screenshot

Johan Rockström receives honorary doctorate from the University of Amsterdam

Johan Rockström has received an honorary doctorate of the University of Amsterdam. The honorary doctorate was awarded to Rockström for his pioneering scientific contributions in the area of global sustainability and for his research into planetary boundaries in particular.

Link to YouTube video

Hans Joachim Schellnhuber wins Erasmus Kittler Prize

PIK Director Emeritus Hans Joachim Schellnhuber has been honoured with the Erasmus Kittler Prize for his contributions to advancing the climate debate. The prize is awarded every two years by the foundation of the Entega Group, a regional energy service provider, to individuals or initiatives who work for the common good.

Distinction for E-quality and diversity

PIK has been awarded the 'Total E-Quality' distinction for what is now the fourth time in a row. The distinction is awarded for a period of three years to organizations from business, science, and administration for their 'exemplary personnel policy based on equal opportunities'. For the first time, PIK was also awarded the additional 'Diversity' distinction. Christine von Bloh, who serves as the Equal Opportunities Officer at PIK, spokesperson for the Leibniz working group on equal opportunities and diversity and deputy spokesperson for the Alliance of Gender Equality Officers of non-university research organizations, also actively participated in meetings, panel discussions, and discussions with policymakers.

A tweet from Georg Schütte, State Secretary at the BMBF, regarding his meeting with Christine von Bloh and other equal opportunities officers at the Ministry.

Scientific policy advice

Conference on climate and security hosted by the Federal Foreign Office

Link to Berlin Call for Action

Climate change is a foreign policy issue with impacts ranging from food security, to furthering violent conflicts and displacement, to an increasing number of natural disasters. In cooperation with the Federal Foreign Office and the thinktank adelphi, PIK initiated the Berlin Climate and Security Conference. The outcome of the summit, which included speakers such as German Foreign Minister Heiko Maas, former US Secretary of State John Kerry, as well as Ottmar Edenhofer and Johan Rockström, is the 'Berlin Call for Action', which urges every foreign policy institution to step up efforts to address one of the greatest global security and foreign policy challenges of the twenty-first century: climate change.

Participants at the high-level conference included PIK Directors Ottmar Edenhofer (first from left), Johan Rockström (second from left), German Foreign Minister Heiko Maas (centre) and former US Secretary of State John Kerry (to the right of Mr Maas). Photo: PIK

Link to book (in German)

A compact look at climate policy: Handbook authored by Edenhofer in new expanded edition

The new expanded edition of the handbook titled 'Klimapolitik kompakt – Ziele, Konflikte, Lösungen' (A compact look at climate policy – targets, conflicts, and solutions) by Ottmar Edenhofer and Michael Jakob (MCC) offers concise information regarding climate policy options in just 144 pages. Those working in the field and interested members of the public can learn about the current state of research into how we can overcome what might be the greatest challenge of our time: climate change. The handbook also introduces and discusses the tools that are most important from the perspective of economic research.

Johan Rockström chairs newly established Earth Commission

The new Earth Commission has the task of defining the scientific framework for a stable Earth system – in simple terms, the equivalent of the 2 degrees Celsius limit of global warming for all of the planet's systems essential to human well-being. The Earth Commission's findings are to serve as the basis for developing practical goals for sustainably managing land, water, oceans, and biodiversity. The initiative consisting of 20 globally renowned scientists in the field of Earth systems is headed by PIK Director Johan Rockström; Ricarda Winkelmann is also a member of the Commission.

Keynote by Hans Joachim Schellnhuber on the risks climate change presents in terms of security. Photo: Munich Security Conference

Schellnhuber speaks at Munich Security Conference

For the first time, security risks arising from human-made climate change were a centre-stage topic at the Munich Security Conference in 2019. This one-of-a-kind meeting of global security experts, including heads of states and high-ranking military officials, invited Hans Joachim Schellnhuber to present his assessment of the state of the climate crisis and its consequences for international policy making in a keynote speech. Schellnhuber's presentation kicked off the panel discussion on the topic of climate change and security.

Oil and financial corporations meet at the Vatican

Several of the biggest oil and financial corporations in the world met with Pope Francis in Rome at the invitation of the Pontifical Academy of Science (PAS) for a dialogue on 'The Energy Transition and Care for Our Common Home'. Those in attendance agreed to join the efforts of science and society to contain the climate crisis. John Schellnhuber, Director Emeritus of PIK and member of PAS, was the only climate scientist invited to attend the dialogue. He gave the opening lecture and played a crucial role in the drafting of the declarations signed by almost all participants.

Link to full report

New IPCC Special Report on land use and climate change

Today, almost a quarter of anthropogenic greenhouse gas emissions arise from agriculture, forestry, and other land use. The Special Report on Climate Change and Land (SRCCL) published by the IPCC describes the current situation and maps and analyses potential future scenarios and the risks presented by climate change as well as potential solutions for sustainable land use and food security. PIK led key studies that formed major contributions to the IPCC Special Report. Alexander Popp and Prajal Pradhan from PIK are also the lead authors of the chapters on food security and relations between land and climate.

Link to full report

German National Academy of Sciences Leopoldina presents 'Clean air' statement

The National Academy of Sciences Leopoldina has published a statement on 'Clean air –Nitrogen oxides and particulate matter in ambient air: Basic principles and recommendations' calling for a federal strategy on clean air and a sustainable transport transition. Ottmar Edenhofer is a member of the interdisciplinary Leopoldina expert group and one of the authors of the statement. The climate economist said: 'The German auto industry can profit if, rather than holding back, companies make purposeful investments in clean drive systems such as electromobility.'

Link to full report

German Advisory Council on Global Change issues report on digital change

In its report titled 'Towards Our Common Digital Future', the German Advisory Council on Global Change (WBGU) clearly states that ongoing digitalization and the transformation towards more sustainability and climate protection can only succeed in concert and not in competition with one another. If digitalization is not used to promote sustainable development, digital transformation could instead exacerbate climate and environmental problems further, for example by increasing resource and energy consumption. Hans Joachim Schellnhuber is one of the authors of the report, which was presented to the German Federal Minister of Education and Research Anja Karliczek and the German Federal Minister of the Environment Svenja Schulze.

Link to full report

Environment Council presents new special report on the legitimation of environmental policy to Minister Schulze

The German Advisory Council on the Environment (SRU) has published a special report discussing the rationale for legitimizing environmental policy and proposing institutional developments for policy and administration. In the report entitled 'Demokratisch regieren in ökologischen Grenzen – zur Legimitation von Umweltpolitik' (Democratic governance within ecological boundaries – on the legitimation of environmental policy), the Council's members explain how the state is not only legitimized to act but is also obliged to do so in order to preserve people's livelihoods, taking into account long-term and systemic environmental problems. The report was presented to Federal Minister of the Environment Svenja Schulze in Berlin by Council member Wolfgang Lucht, among others.

Link to full report

Lancet report: Policy brief for Germany

What does the pioneering Lancet report mean for Germany? The 'Policy brief for Germany' was developed as part of the Lancet Countdown on Health and Climate Change in cooperation with the German Medical Association, Charité – Universitätsmedizin Berlin, Helmholtz Zentrum München and Sabine Gabrysch from PIK and presented to the public in Berlin.

Link to full report

Lancet report: Comprehensive research report on climate change and health

Feeding a growing population of 10 billion by 2050 in a sustainable, healthy manner is possible but will require substantial changes in our diet, a major new report by the EAT Lancet commission shows. For the first time, a group of international experts led by Johan Rockström teamed up with the leading medical journal to present comprehensive and detailed science-based targets for a food system that safeguards the health of both people and the planet.

Media highlights 2019

1 ZEIT ONLINE: Forest fires, melting ice,extreme weather: People are feeling the impacts of global warming. Climate researcher Stefan Rahmstorf discusses how climate change is impacting our world

2 BILD newspaper: Heatwaves, droughts, and difficult conditions for farmers: Hermann Lotze-Campen discusses the extreme heat Europe experienced in June 2019

3 New York Times: What will climate change cost? The New York Times reports on Ottmar Edenhofer's research on the economy and climate policy in relation to carbon pricing

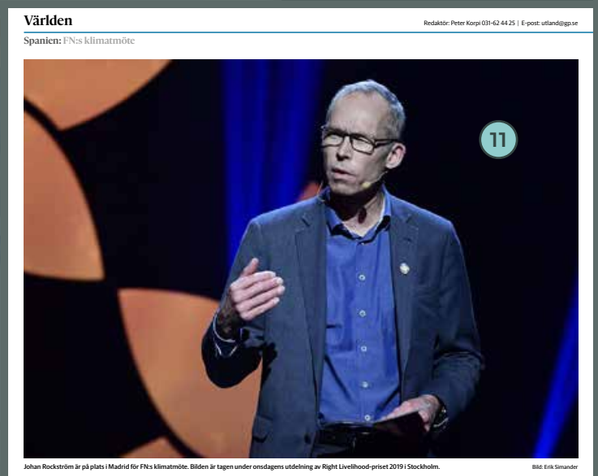
4 Frankfurter Allgemeine Zeitung: An uphill struggle for compromises in the Carbon Commission: Hans Joachim Schellnhuber discusses Germany's climate policy in a joint interview with Deutsche Bahn Infrastructure Director Ronald Pofalla

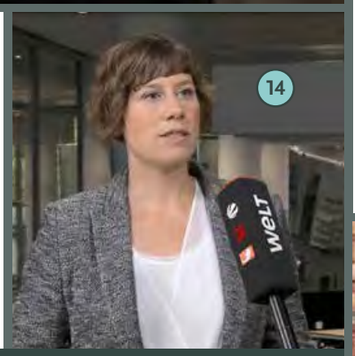
5 Rundfunk Berlin-Brandenburg: Students across Europe are taking to the streets to protest for better climate policies. Wolfgang Lucht speaks with Jörg Thadeusz about Fridays for Future on the 'Talk aus Berlin' show

6 Der SPIEGEL: How bad is climate change for our health? Spiegel Magazine published a two-page interview with physician Sabine Gabrysch to coincide with her new appointment as Professor of Climate Change and Health

7 WirtschaftsWoche magazine: Expensive carbon emissions? In a report for WirtschaftsWoche business magazine, Ottmar Edenhofer offers an in-depth explanation of how carbon pricing can be designed to be socially equitable

8 Rundfunk Berlin-Brandenburg: A cookbook to go with the Lancet Report: The 'At Home in Berlin & Brandenburg' show interviews Johan Rockström on what's behind the planetary health diet





9 ZDF Fernsehen: In the 'Lesch's Cosmos' programme, Anders Levermann joints host Harald Lesch for a discussion on the impacts of rising sea levels

10 Süddeutsche Zeitung: Stefan Rahmstorf and Federal Minister for Economic Affairs and Energy Peter Altmaier discuss climate policy and findings from climate research

11 Göteborgs-Posten: Johan Rockström speaks about COP25 in Madrid and what's behind the '10 insights' from climate science that negotiators should be familiar with

12 ZDF Fernsehen: Is the Federal Government's climate package a great success or a big disappointment? Ottmar Edenhofer speaks with Federal Minister for Economic Affairs Peter Altmaier, Annalena Baerbock, and other guests on the Anne Will show

13 Le Monde: A hot summer with numerous forest fires in Europe: The French daily speaks with Christopher Reyer about forests, fires, and the role of climate change

14 N24: Ambitious climate targets? The EU summit also met to discuss the climate in June. Jessica Strefler lists the requirements for meeting climate targets

15 NHK World TV: Japanese broadcaster NHK interviews Fred Hattermann on the heatwave in Europe

16 Spiegel: The magazine reports on Kai Kornhuber and research into planetary waves and changes in the jet stream in response to the heatwaves in Europe

17 ARD: On the ARD Brisant show, Kirsten Thonicke explains the relation between climate change and the devastating fires in the Amazon region

18 Süddeutsche Zeitung newspaper: A series on the impacts of sea-level rise incorporates research led by Ricarda Winkelmann on glacial melt in Greenland and tipping elements in the Earth system

Visits to PIK

Delegation from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety at PIK. Photo: PIK

Federal Chancellor Angela Merkel was briefed by Ottmar Edenhofer and other researchers at PIK and discussed subjects including extreme weather and carbon pricing. Photo: BPA/Guido Bergmann

Officers and non-commissioned officers in the German Armed Forces Anti-Aircraft unit spoke with Jacob Schewe about climate change and conflicts. Photo: PIK

Parliamentarians from Luxembourg with Johan Rockström and Daniel Klingenfeld visiting in the run-up to discussions in the Federal Chancellery and Bundestag. Photo: PIK

A delegation of indigenous representatives from the Amazon region met with Kirsten Thonicke and Boris Sakschewski to discuss PIK's research on the Amazon rainforest. Photo: PIK

From extreme weather events to migration: A group from the German Armed Forces was briefed by Kira Vinke about the security risks presented by climate change. Photo: PIK

A meeting with Wolfgang Ischinger, Chair of the Munich Security Conference, on climate change and security. Photo: PIK

King Willem-Alexander and Queen Máxima of the Netherlands during an informational visit on Telegrafenberg hill. Photo: Anja Kliese de Souza

Together with Luisa Neubauer, an activist in Germany's Fridays for Future movement, Swedish school student Greta Thunberg visited PIK to discuss the current state of science. Photo: Greb

Young Foreign Office diplomats from Brazil, China, India, Indonesia, Mexico, South Africa, and Germany with host Fred Hattermann. Photo: PIK

Broad-scale impact

Long Night of the Sciences in Potsdam and Berlin

Some 20,000 people attended the Long Night of the Sciences in Berlin and Potsdam again in 2019. A group of more than 50 employees from every area of PIK presented topics ranging from the climate over Earth's history, to how climate change affects our diets, to potential tools for limiting climate change. In their respective presentations, PIK Directors Johan Rockström and Ottmar Edenhofer discussed issues such as planetary boundaries and fair carbon pricing with those in attendance.

PIK opened its doors to visitors during the Long Night of the Sciences. Photo: PIK

‘Our Planet” documentary series on Netflix

Covering topics ranging from Antarctic ice, to the rainforest, to our planet's deserts, the eight-part documentary series ‘Our Planet’ was produced as part of a one-of-a-kind collaboration between Netflix, film producer Silverback Films, and WWF. In addition to David Attenborough, who narrated the documentary, PIK Director Johan Rockström was among international experts advising the film team during the production of the series for the Netflix streaming platform. The documentary's launch was also accompanied by the film ‘Our Planet: Our Business,’ which was released by WWF International and featured PIK Director Rockström, among others.

Insights into day-to-day research work at Girls’ Day. Photo: PIK

Girls’ Day at PIK

Each year, PIK hosts an event for schoolgirls with the aim of sparking their interest in day-to-day work in research and providing them with insights into various fields that PIK addresses in its research. At the Girls' Day event, researchers in areas from meteorology to climatology, from physics to mathematics and from economics to sociology share their perspectives on what a researcher's daily work is like and what career opportunities lie ahead.

Climate research at re;publica19

In 2019, over 25,000 people took part in re:publica, a digital conference that addresses current issues while looking to the future. In response to the Fridays for Future movement, the conference focused on climate change and sustainability. A number of researchers from PIK had already participated in years past, and PIK Director Johan Rockström spoke at this year's festival about a safe future for humanity on a healthy planet as he discussed digital society from an inside perspective. PIK researcher Jessica Strefler and other researchers from the Institute also presented at re:publica on topics including the causes and impacts of climate change, particularly in terms of the economy.

Johan Rockström's keynote at re:publica can be accessed in full via the QR code

The ‘Our Planet’ series on Netflix incorporated expertise from PIK Photo: Screenshot

Does climate change mean a dry outlook for agriculture? PIK Director Ottmar Edenhofer and representatives from federal ministries and businesses discussed this question during an interactive panel discussion held at the Leibniz Association in Berlin. The discussion was supplemented by keynotes from the Leibniz Institutes, including a talk by agricultural expert Christoph Gornott from PIK. Also focusing on the future of agriculture is the new German-language Leibniz blog www.quer-feld-ein.blog, which compiles facts, news, and ideas relating to this topic and invites readers to be part of the dialogue. PIK is a partner in the project, which was initiated by the Leibniz Centre for Agricultural Landscape Research (ZALF).

PIK climate research at the German Protestant Kirchentag

PIK also played a prominent part in the thirty-seventh German Protestant Kirchentag in Dortmund. In his keynote, Johan Rockström spoke about a diet that is healthy for people as well as the planet. Together with Federal Minister of the Environment Svenja Schulze and others taking part in the conversation, PIK Director Emeritus Hans Joachim Schellnhuber discussed the climate transition – from energy production, to roads and railways, to farms. The Kirchentag is the most important public forum hosted by the Evangelical Church in Germany, with more than 100,000 participants.

Small Gases, Big Effect: This is climate change

Many young people are worried about climate change, and two students have responded by writing a book titled ‘Kleine Gase – Große Wirkung’ (‘Small Gases, Big Effect’), which uses brief texts and clear diagrams to discuss the causes and effects behind this issue. Over 100 scientists supported and advised them in the book's preparation, including Stefan Rahmstorf, Georg Feulner, Hermann Lotze-Campen, Peter Hoffmann, Kira Vinke, and Benjamin Bodirsky. The book is available from the Federal Agency for Civic Education.

Eat Good: The cookbook with a background in research

Unhealthy eating habits are already one of the biggest factors behind health risks worldwide and also place the stability of the climate at risk. What we eat can play a decisive role in our health and that of our planet, as demonstrated by the Lancet report published in 2019. PIK Director Johan Rockström, one of the study's co-authors, combined recipes and findings from research in a book titled ‘Eat Good – The cookbook that can change the world’. The book has been published by Gerstenberg Verlag.

Young people demonstrating for climate protection at the Global Climate Strike in Potsdam. Photo: A. Schlums

Scientists for Future look at the state of science

From Greta Thunberg's visit to PIK to YouTube videos – PIK's research findings played a leading role in the discussions surrounding the Fridays for Future movement last year. A number of PIK researchers were also involved in Scientists for Future. One of them was Wolfgang Lucht, who was among the coordinating authors of a statement regarding the state of science that was signed by more than 26,000 researchers in German-speaking countries and won the GAIA Best Paper Award 2019.

Stefan Rahmstorf tweets about his new column in Spiegel magazine. Photo: Screenshot

New Spiegel column and climate research in Welt reader chat

Its co-authors also included Stefan Rahmstorf, who addressed a wide range of topics in public debate and discussed their scientific context on Twitter and in his blog, Klimalounge, as well as via other channels. Rahmstorf was subsequently offered his own op-ed column by Spiegel magazine and has been writing regular articles regarding the climate crisis there since August 2019. Die Welt newspaper also reached out to PIK. In response to an invitation from Editor-in-Chief Ulf Poschardt, Georg Feulner responded to readers' questions on climate change in the paper's online chat.

Tweet from Welt Editor-in-Chief Ulf Poschardt regarding the chat with Georg Feulner. Photo: Screenshot

Summer school for Fridays for Future with Natural History Museum Berlin

PIK also organized a summer school and workshops relating to this topic together with the Natural History Museum Berlin. The museum offered free admission on Friday afternoons, and Maria Martin, Jascha Lehmann, and other PIK researchers were among those who spoke with school students about subjects such as extreme weather due to climate change as well as responding to statements regarding global warming with scientific facts.

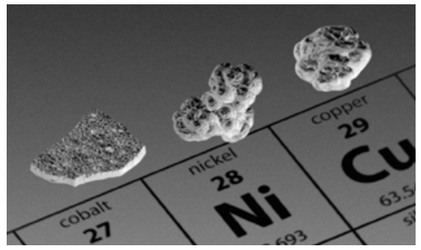
Leibniz Institute cooperation: the Natural History Museum references a workshop with PIK in a tweet. Photo: Screenshot

Climate, culture and the arts

Berlinale artist talk on documentary film 'Anthropocene: The Human Epoch'

The Berlinale international film festival attracts hundreds of thousands of film and documentary fans every year. In the programme accompanying the artistic documentary 'Anthropocene: The Human Epoch', Anders Levermann from PIK joined Canadian artist Edward Burtynsky at Galerie Springer in Berlin for a discussion on the state of the Earth and its future. Burtynsky, who has earned a reputation for his large-format industrial photographs and has exhibited his work at locations including the Guggenheim Museum in New York, is one of the directors of the film exploring the influence humans have on nature.

Artists in residence video platform



Copper, cobalt, nickel – topics addressed in the artists' 'Deep Sea Mining' series include mapping the extraction of strategically important metals from a geopolitical and economical perspective. Photo: Courtesy of the artists

Artists in Residence focus on the Anthropocene

Exhibits, art projects, and cultural events convey research findings to a larger audience in a clear, accessible manner. One of the ways PIK brings climate, the arts, and culture together is its Artist in Residence Programme, which is jointly organized with the state capital of Potsdam and the Berliner Künstlerprogramm – Artists-in-Berlin programme hosted by the German Academic Exchange Service (DAAD). In 2019, Portuguese artist duo Mariana Simoes Vitoria da Silva and Pedro Neves Marques, who are based on New York, spent several weeks at the Institute working on content for their exploratory documentary formats addressing the Anthropocene, environmental protection, and social justice.

Illustrated book for children on mathematics

What role does mathematics play in research and everyday life? Mathematicians Ricarda Winkelmann and Ronja Reese from PIK contributed experiences and expertise they gained from their research on climate change, Antarctic ice, and sea-level rise to the publication of a new, illustrated children's book on the history of mathematics. The book by Hinrich Sachs is called 'Who Invented One and Zero?' and is published by Humboldt Books.

Climate change takes the stage

Theatre and climate change were the topics of the strategy meeting held last year by the German Federal Cultural Foundation in Halle an der Saale. Fritz Reusswig from PIK gave a keynote speech and took part in discussions with creative professionals from the German Theatre Technical Society and theatres such as the Schaubühne Berlin. Theatre professionals also visited PIK once more to obtain advice regarding their productions. Ronja Reese from PIK discussed climate impacts and sea-level rise with representatives from the Theater an der Parkaue – Junges Staatstheater Berlin. The 'Theatre Fragile' theatre company in Detmold spoke with Jobst Heitzig, Levke Caesar, and Bernd Hezel from PIK about insights into climate research and ways of communicating the topic on the stage.

Fritz Reusswig discusses climate change and the cultural sector. Photo: German Federal Cultural Foundation

Berlin and Brandenburg
PIK's local involvement

The Potsdam Institute for Climate Impact Research bears its home city in its name, and it shares its research with the world under this name. PIK is also involved in a wide range of activities in Berlin and Brandenburg.

Two high-ranking visits at once as ministers visit Telegrafenberg hill

Federal Minister of Education and Research Anja Karliczek was briefed during her first official visit to the State of Brandenburg together with her hostess, State Minister of Science and Research Martina Münch, on current results from research conducted by PIK and the other institutes on Telegrafenberg hill, GFZ, AWI, and AIP. The directors of all four institutes gave presentations, with Director Ottmar Edenhofer speaking on behalf of PIK. 'This is a place where science speaks,' said Federal Minister Karliczek in praise of the institutes, noting that Telegrafenberg hill is a place where 'outstanding research is conducted on the universe and our Earth.' She emphasized research on climate change in particular. 'These four are among the best in the world,' State Minister Münch said of the institutes on Telegrafenberg hill, noting that they 'make a significant contribution to the international standing' of Brandenburg.

Federal Minister of Education and Research Anja Karliczek and Brandenburg's Minister of Science and Research Martina Münch during an informational visit to Telegrafenberg hill. Photo: GFZ

Potsdam Climate Council appoints Fritz Reusswig

Many municipalities and districts have already been taking active steps to protect the climate for many years and have set themselves ambitious goals such as the 'master plan municipalities', of which the City of Potsdam is one. Fritz Reusswig is among the eight experts appointed to the city's new Climate Council. The honorary body aims to support the implementation of the master plan and provide impetus for climate protection policies in Potsdam.

Lord Mayor Mike Schubert briefed at PIK

Potsdam's Lord Mayor Mike Schubert visited PIK for a workshop on climate change and mobility joined by experts from transport companies, urban development, and climate protection. Besides PIK Directors Ottmar Edenhofer and Johan Rockström, Jürgen Kropp, Fritz Reusswig, and Daniel Klingenfeld from PIK as well as Felix Creutzig from MCC-Berlin shared ideas and laid the groundwork for discussions regarding innovations to promote environmentally friendly means of transport.

Potsdam's Lord Mayor Mike Schubert and the team at PIK during discussions regarding mobility issues. Photo: PIK

Municipal workshop on the PIK living lab 'Climate-Neutral Living in Berlin'

Mayors and other representatives of municipalities and districts in Germany met with PIK experts to discuss how citizens can become actively involved in protecting the climate as a community. During the two-day municipal workshop hosted by the Climate-Neutral Living in Berlin project, the participants discussed how experiences gained in the real-world lab could also be transferred to other municipalities and districts.

Participants and experts of the Potsdam Summer School 2019 share their impressions

Leibniz im Bundestag

Initiating a dialogue between scientists and members of the Bundestag – this is the goal of the Leibniz im Bundestag initiative, in which PIK also regularly participates as an institute in the Leibniz Association. From sea-level rise, to extreme weather and agriculture, to carbon pricing: Scientists from all research departments at PIK met individually with members of the different parliamentary groups to brief them on the current state of research.

Potsdam Summer School

'Communicating Research on Sustainability and Global Change' was the topic of the Potsdam Summer School, which brought together outstanding young scientists from around the world to discuss the latest research issues, exchange ideas, and network. In cooperation with the Geo.X geosciences network and the City of Potsdam, the Potsdam Summer School is organized by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, the Institute for Advanced Sustainability Studies (IASS), the University of Potsdam, and PIK.

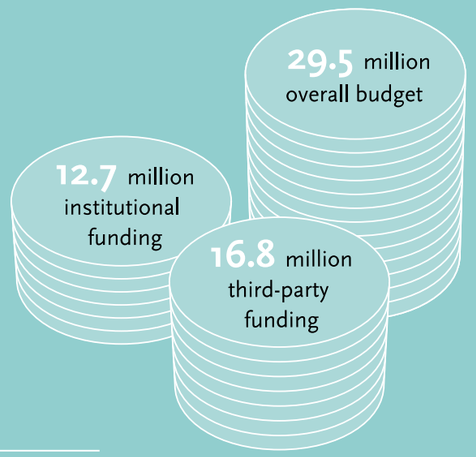
Communicating climate change on the street

'Who owns the sky?' – this was the title of PIK's presentation at the Science in the Centre exhibition, where the Institute presented its research on planetary boundaries and global commons. Scientific institutions in Potsdam and the surrounding region teamed up with Netzwerk ProWissen e.V to provide information regarding their research via the Bauzaun-Ausstellung (Site Fence Exhibition) between the state parliament and city centre. PIK experts also took part in the accompanying programme, attending Potsdam Day of the Sciences and other events to present their research.

PIK teamed up with other research institutions in Potsdam and the region to create an exhibition between the state parliament and city centre. Photo: ProWissen

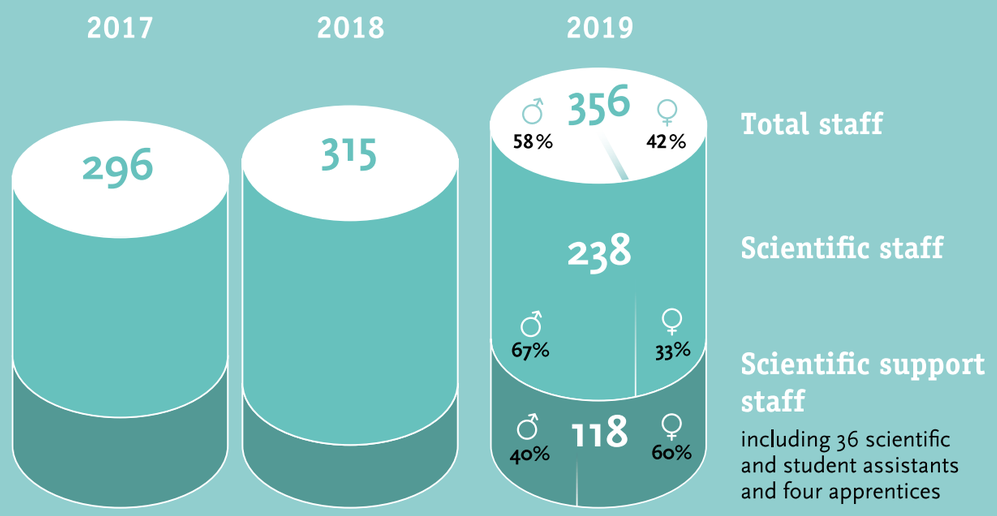
02
KEY DATA

As of: 31.12.2019



FUNDING

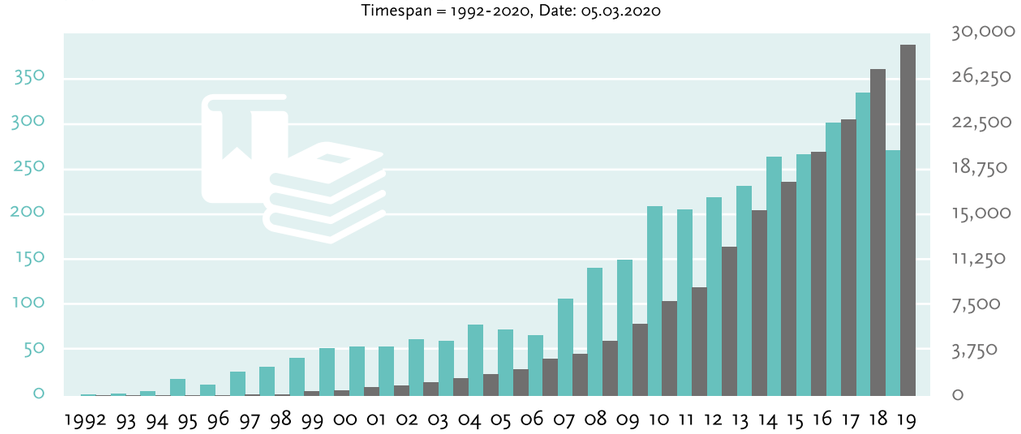
STAFF DEVELOPMENT

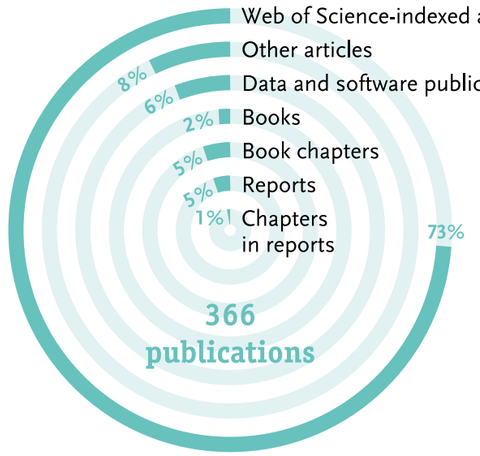


PUBLICATIONS

Publications and citations development

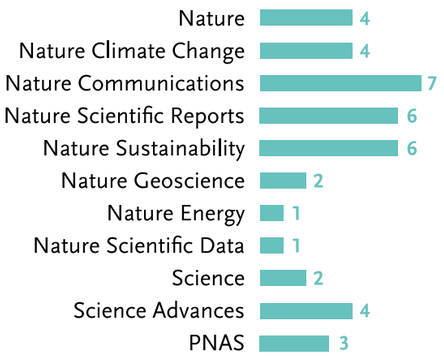
Source: Web of Science (WoS) Core Collection, Indexes: SCI-EXPANDED, SSCI
Timespan = 1992-2020, Date: 05.03.2020



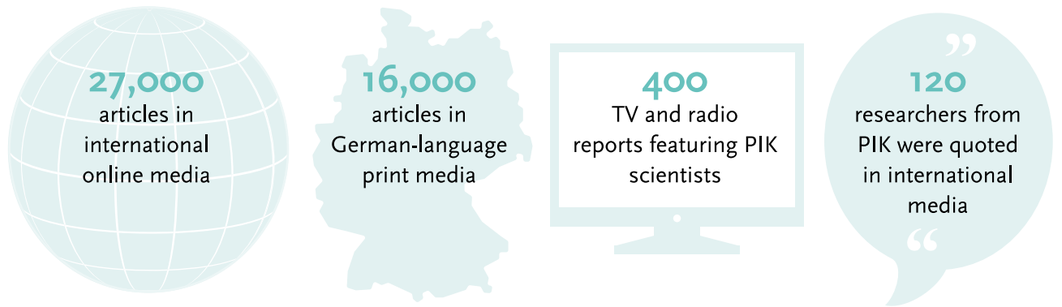


269 Web of Science-indexed articles, 35% of which were lead-authored by scientists from PIK

Articles in leading scientific journals:



PIK IN THE MEDIA



LECTURES, TEACHING, AND EVENTS

1,015 lectures

457
scientific target groups

558
non-scientific target groups

- Industry and business: **144**
- Education: **219**
- Politics: **195**

69 university classes

> 140
semester lecture hours/week at **10** universities

127 scientific events

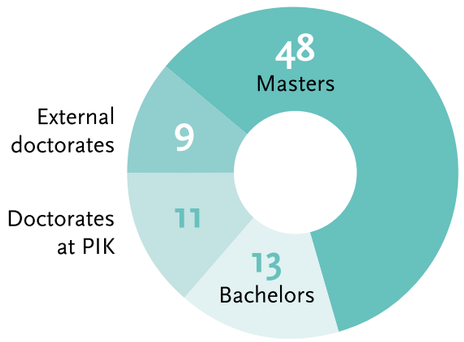
with **> 9,000** attendees

YOUNG SCIENTISTS

77 doctoral candidates

- **35%** proportion of women
- **47%** from abroad
- **22%** scholarship holders

Number of theses supervised



03 RESEARCH DEPARTMENTS

‘We look at the stability of the Earth system and its tipping elements – including ice masses, ocean currents, and ecosystems. We do this by not only using our models to simulate potential future developments but also natural climatic changes extending millions of years into the past – including earlier ice ages as well as warm ages. Based on this approach, we can test our models, compare them with data from the past, and learn from Earth’s history.’

Stefan Rahmstorf.

‘The Earth's planetary boundaries are not just about global warming, but also concern the ongoing destruction of the ecological foundations of life. That’s why we use our models and data to not only analyse the climate system but also the Earth system as a whole. This includes the Earth’s biosphere in particular, as its integrity is crucial for the future development of humanity.’

Wolfgang Lucht

Research Department 1 – Earth System Analysis

RD1 Earth System Analysis

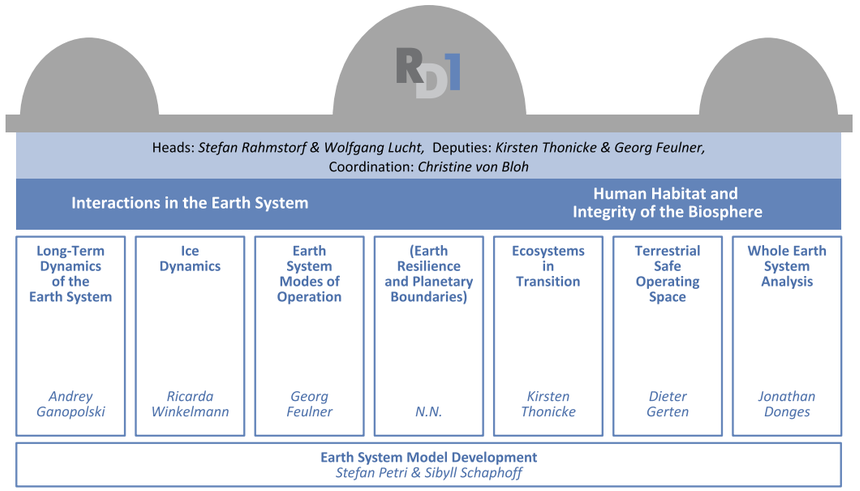
Heads: Stefan Rahmstorf & Wolfgang Lucht
Deputies: Kirsten Thonicke & Georg Feulner

What can we learn about the current and future dynamics of the Earth system by studying the climatic history of Earth and new measurement data ?

The research department’s key topics and goals are:

- **Tipping points**. Basic research on nonlinear Earth system processes and potentially critical thresholds.
- **Planetary boundaries**. Policy-related research with the aim of defining, quantifying, and operationalizing planetary boundaries and their interactions.
- **Earth trajectories**. Research on the dynamics and modes of operation of the Earth system under natural and human forcing, and the resulting long-term and short-term trajectories.
- **Extreme events**. Research into the dynamic mechanisms and changing statistics of extreme weather events on a warming Earth.

Structure of Research Department 1



Research conducted in Research Department 1 (RD1) comprises seven working groups (eight in future), each headed by experienced scientists. These working groups are grouped in two thematic research areas. The objective of ‘Interactions in the Earth system’, coordinated by Stefan Rahmstorf, is to improve our understanding of the Earth system in the light of the planetary boundaries. The ‘Human Habitat and Integrity of the Biosphere’ research area is coordinated by Wolfgang Lucht and aims at coherently investigating the central role of the ecosphere for Earth’s biogeochemical and hydrological cycles and its integrity in the light of planetary boundaries. These two research areas represent two of the central pillars on which the Earth system state depends. The ‘Earth System Resilience in the Anthropocene’

FutureLab, which is hosted in RD1, also drives this research forward with the goal of outlining the properties of, and pathways towards, a stabilized Earth system in the Anthropocene.

Selected results

RESEARCH AREA: 'INTERACTIONS IN THE EARTH SYSTEM'

Working group – Long-term Dynamics of the Earth System

Progress continues on the development of CLIMBER-X. This Earth system model of intermediate complexity will soon replace the CLIMBER-2 model, which was used over the past 20 years (e.g. Willeit et al. 2019). We have carried out final testing and calibration of the climate component of CLIMBER-X, which consists of the SESAM (atmosphere), PALADYN (land) and GOLDSTEIN (ocean) components. Modelling output has been validated against results of the state-of-the-art climate models produced within the framework of the CMIP6 project. We have successfully coupled the VILMA solid earth model developed at the German Research Centre for Geosciences (GFZ Postdam) with the latest version of the SICOPOLIS ice-sheet model. In the run-up to the second phase of the national palaeoclimate modelling initiative funded by the Federal Ministry for Education and Research (PalMod II), we used the stand-alone HAMOCC ocean carbon cycle model to examine the mechanisms behind glacial lowering of carbon dioxide.

Working group – Ice Dynamics

New results in the area of ice dynamic analyses, glacial cycle simulations of the Antarctic Ice Sheet, model intercomparison projects, and sea-level projections. In the past year, the working group continued its work towards a deeper understanding of ice dynamics in Greenland and the Antarctic (Schlemm & Levermann 2019; Feldmann et al. 2019; Feldmann & Levermann 2019). Considerable progress was made in the development of the Parallel Ice-Sheet Model (PISM) and the Potsdam Ice-shelf Cavity Model (PICO). The working group achieved a milestone by preparing and publishing the first comprehensive ensemble of glacial cycle simulations of the Antarctic Ice Sheet (Albrecht et al. 2019 online first, a,b). Furthermore, with PISM, the group contributed to several major model intercomparison projects, including the Linear Antarctic Response Model Intercomparison Project LARMIP-2 (Levermann et al. 2019 online first), led by PIK, and the Ice-Sheet Model Intercomparison Project ISMIP6 (Seroussi et al. 2019, 2020). This demonstrated that the historical trajectory and strength of oceanic forcing play a decisive role for sea-level projections and the long-term stability of the Antarctic ice sheet (Reese et al., submitted in 2019).

Working group – Earth System Modes of Operation

New insights into forecasting the Indian summer monsoon, Arctic amplification, and extreme weather events at middle latitudes. New methods for seasonal forecasting of the Indian summer monsoon rains delivered useful results up to four months in advance (Di Capua et al. 2019). The causal interactions between mid-latitude circulation and the Indian summer monsoon rainfall were also quantified (Di Capua et al. 2020). An overview of the various mechanisms behind how Arctic amplification affects mid-latitude weather was published (Cohen et al. 2019). The results showed that recurrent atmospheric circulation patterns in the summer can induce simultaneous periods of extreme heat in regions that are important for global food production (Kornhuber et al. 2020).

Updated assessments of oceanic and terrestrial tipping point processes. On behalf of the Federal Chancellery, the working group prepared an Update Summary on tipping points, which amended the 'burning embers' diagram illustrating the risks. It also contributed to a commentary on climate tipping points in the leading journal Nature which included a discussion of domino effects (Lenton et al. 2019).

CDR as a strategy for fighting ocean acidification. We examined the potential of CDR (carbon-dioxide removal) technologies as a strategy for fighting both global warming and ocean acidification. We established that CDR technologies are only effective when included as part of aggressive and rapid climate action, undermining the idea of CDR as a panacea (Hofmann et al. 2019; see Fig. 1).

CO2 is the main cause of climate change in the Devonian. In the area of palaeoclimate research, we conducted a comprehensive sensitivity study exploring the drivers of climate change during the Devonian (419–359 million years ago). In doing so,

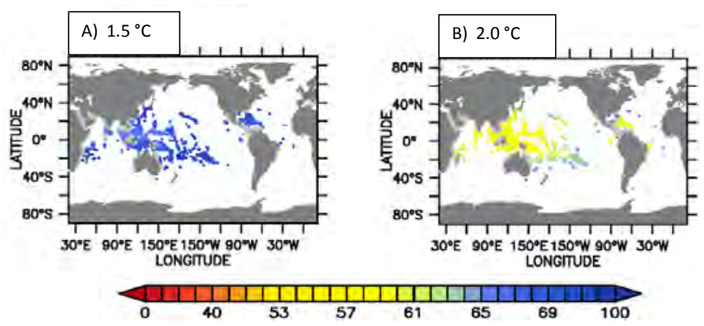


Fig. 1: Relative calcification rates in tropical coral reefs in the period from 2070–2080 in relation to pre-industrial values in % for A) a 1.5°C and B) a 2.0°C scenario (Hofmann et al., Nat. Commun., 2019). Low calcification rates indicate a more compromised condition of coral reefs.

we established that the major driving force was decreasing carbon-dioxide levels due to land being colonized by plants (Brugger et al. 2019).

RESEARCH AREA: 'HUMAN HABITAT AND INTEGRITY OF THE BIOSPHERE'

Working group – Ecosystems in Transition

The role of functional diversity in the stability of European forests was examined using the LPJmL-FIT model. Thonicke et al. (2020) adapted the LPJmL-FIT model, a RD1 development from previous years that was initially created for the Amazon rainforest biome,to suit European biomes. Their work showed firstly that the bioclimatic limits of the plant functional types – which have formed the basis for the biome-type vegetation models for nearly 30 years – can be eliminated if phenology and plant economics are combined with forest growth dynamics. This eliminates a previously deep-seated restriction caused by process-based analysis and represents a significant breakthrough. Second, the study demonstrated that the coexistence of functionally diverse trees is the result of plant economics, disturbance, and tree demography. The paper additionally advances the concept of interpreting functional diversity along climatic gradients from Mediterranean to boreal climate conditions (Fig. 2).

New findings on land use and the dynamics of fires in South America. Parameter optimization techniques based on Earth observation datasets can improve simulated global vegetation dynamics and, moreover, emphasize the need for improved model formulations to capture climate effects on vegetation turnover and tree mortality (Forkel et al. 2019). This methodology of optimizing parameters helped to significantly improve the simulated interannual variability of burned area ranging from Amazon rainforest to seasonally-dry biomes in South America (Drüke et al. 2019).

Working group – Terrestrial Safe Operating Space

The production of negative CO2 emissions via biomass (BECCS) requires large quantities of fresh water. Stenzel et al. (2019) quantified the water

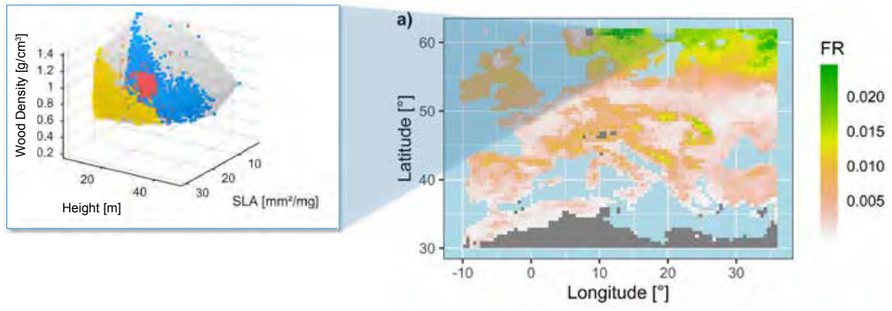


Fig. 2: Simulation of functional richness using the dynamic vegetation model for flexible individual trees (LPJmL-FIT) for European natural forests. Individual trees with varying functional plant characteristics (yellow – deciduous broadleaf trees, red – temperate conifers, blue – boreal conifers) are simulated in terms of competition for light and water for each cell of the grid and predominate under certain climatic conditions. Each tree therefore has its own ecological niche in its trait space, which is described by wood density, height, and specific leaf area (SLA). The volume (grey cloud) of all trees describes the functional richness (FR) at a location. The geographical gradients of the simulated FR under current climate conditions are a result of the changing coexistence of the trees along climatic gradients, which were successfully quantified using a dynamic vegetation model for the first time in this study. (As per Thonicke et al. – Journal of Biogeography, 2020)

demand associated with biomass plantations (BECCS) in order to limit mean global warming to 1.5°C. Based on a wide range of simulations reflecting different combinations of water management approaches, protection of river ecosystems, and targets for negative emissions, we found that plantations of this type would need to use approximately 400 to 3,000 km3 of water per year depending on different levels of water management. As a result, in some of the scenarios the additional water demand is as high as the entire current demand for water in the agricultural sector (Fig. 3).

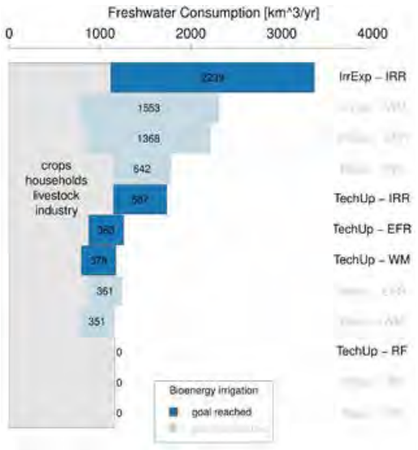


Fig. 3: Annual water consumption simulated with LPJmL (average 2090–2099) for twelve scenarios to achieve a global carbon sequestration target of 255 GtC based on varying assumptions with respect to carbon storage efficiency (Basic and IrrExp 50%, TechUp 70% efficiency) and water availability/management (RF: rainwater only, IRR: unlimited availability, EFR: ecosystem water requirements considered, WM: optimal water management; with Basic and TechUP one third of the area considered is irrigated at maximum, and with IrrExp the entire area considered is irrigated at maximum). (As per Stenzel et al. – Environmental Research Letters, 2019)

Working group – Whole Earth System Analysis

Analysis conducted on safe operating spaces in the Earth system. We moved forward with the ongoing development of multi-layer adaptive network models of socio-ecological interactions in the Earth system (copan:CORE modelling framework with Research Department 4 and GaNe FutureLab in the COPAN collaboration). Two of our focal points were emerging critical transitions and tipping points in the context of polycentric governance (Geier et al. 2019) and the deforestation of the Amazon rainforest due to cattle ranching (Müller-Hansen et al. 2019). The group developed a novel multi-agent environment framework and conducted mathematical analyses to determine how agents in these types of models learn to navigate to safe operating spaces that are defined by planetary boundaries (Barfuss et al. 2019).

Highlighting the necessity of an in-depth examination of social structures and dynamics when analysing the whole Earth system. Otto et al. (2019) highlighted the necessity of conducting a closer examination of the wide disparities that exist in the size of carbon footprints and in the responsibilities of various social groups. The potential that social innovation dynamics offer for scaling up climate mitigation, such as community energy, were also elaborated (Hewitt et al., 2019). In addition, a major study was concluded on social tipping elements with the potential of driving rapid decarbonization in order to stabilize the climate (Otto et al. 2020).

Working group – Earth System Model Development

Development work on the Potsdam Earth Model (POEM) was pursued via multiple pathways. During POEM's first development phase, the focus was preparing components and interfaces for coupled setups. With the new fast Aeolus atmosphere model we explored the sensitivity of Northern Hemisphere atmospheric circulation to different surface temperature forcing, as can be expected under climate change (Totz et al. 2019). We also continued work aimed at improving the atmospheric dynamics, cloud cover, and precipitation patterns for both the stand-alone version of Aeolus and the coupled atmosphere-ocean system. The core version of POEM for phase 2 will consist of the AM2 atmosphere model, the MOM5 ocean model, and the LPJmL dynamic vegetation model. Significant progress was made in coupling LPJmL into this setup, which facilitated initial experiments aimed at tuning the model.

Furthermore, work has started to port the marine biogeochemistry model developed at PIK from MOM3 to MOM5. Finally, the technical base for coupling MOM5 to PISM-PICO was implemented (Kreuzer, 2019), and tools to model dynamic sea-level changes with the upcoming ocean model generation MOM6 are under development.

Completed doctorates

Name	Institution	Topic
Barfuss, Wolfram	Humboldt-Universität zu Berlin	Learning dynamics and decision paradigms in social-ecological dilemmas
Caesar, Levke	University of Potsdam	The evolution of the Atlantic Meridional Overturning Circulation and its implications for surface warming

SELECTED PUBLICATIONS

Albrecht, T., Winkelmann, R., Levermann, A. (2019, online first): Glacial-cycle simulations of the Antarctic Ice Sheet with PISM – Part 1: Boundary conditions and climatic forcing / Part 2: Parameter ensemble analysis. – The Cryosphere

Gerten, D., Heck, V., Jägermeyr, J., Bodirsky, B.L., Fetzer, I., Jalava, M., Kummu, M., Lucht, W., Rockström, J., Schaphoff, S., Schellnhuber, H.J. (accepted 2019): Feeding ten billion people is possible within four terrestrial planetary boundaries. – Nature Sustainability

Hofmann, M., Mathesius, S., Kriegler, E., van Vuuren D. P., Schellnhuber H. J. (2019): Strong time dependence of ocean acidification mitigation by atmospheric carbon-dioxide removal. – Nature Communications

Kornhuber, K., Osprey, S., Coumou, D., Petri, S., Petoukhov, V., Rahmstorf, S., Gray, L. (2019): Extreme weather events in early summer 2018 connected by a recurrent hemispheric wave-7 pattern. – Environmental Review Letters

Müller-Hansen, F., Heitzig, J., Donges, J.F., Cardoso, M.F., Dalla-Nora, E.L., Andrade, P., Kurths, J., Thonicke, K. (2019): Can Intensification of Cattle Ranching Reduce Deforestation in the Amazon? Insights From an Agent-based Social-Ecological Model. – Ecological Economics

Otto, I.M., Donges, J.F., Cremades, R., Bhowmik, A., Lucht, W., Rockström, J., Allerberger, F., Doe, S., Hewitt, R., Lenferna, A., McCaffrey, M., Moran, M., van Vuuren, D.P., Schellnhuber, H.J. (accepted 2019): Social tipping dynamics for stabilizing Earth's climate by 2050. – Proceeding of the National Academy of Sciences of the United States of America (PNAS)

Reese, R., Levermann, A., Albrecht, T., Seroussi, H., Winkelmann, R. (2019 assumed): The role of history and strength of the oceanic forcing in sea-level projections from Antarctica with the Parallel Ice-Sheet Model. – The Cryosphere Discussions

Stenzel, F., Gerten, D., Werner, C., Jägermeyr, J. (2019): Freshwater requirements of large-scale bioenergy plantations for limiting global warming to 1.5°C. – Environmental Research Letters

Thonicke, K., Billing, M., von Bloh, W., Sakschewski, B., Niinemets, Ü., Peñuelas, J., Cornelissen, H., Onoda, Y., van Bodegom, P., Schaepman, M., Schneider, F., Walz, A. (2020): Simulating functional diversity of European natural forests along climatic gradients. – Journal of Biogeography

Willeit, M., Ganopolski, A., Calov, R., Brovkin, V. (2019): Mid-Pleistocene transition in glacial cycles explained by declining CO2 and regolith removal. – Science Advances

‘Climate change endangers the foundations of our existence, from harvests to water supply – and therefore our health. At the same time, many solutions also offer short-term benefits for health. We are, for instance, evaluating options for the much-needed transformation towards climate-resilient, sustainable, and healthy food systems.’

Sabine Gabrysch

‘The Paris Agreement aims to limit global warming to well below 2 degrees. But even a limited climate change still has consequences for society and ecosystems at both the global and regional levels. Climate resilience is at the heart of our research, so we can get a better idea of the challenges that lie ahead for various sectors and regions and the adaptation options that are available.’

Hermann Lotze-Campen

Research Department 2 – Climate Resilience

RD2 Climate Resilience

Heads: Sabine Gabrysch & Hermann Lotze-Campen
Deputies: Fred Hattermann & Jürgen Kropp

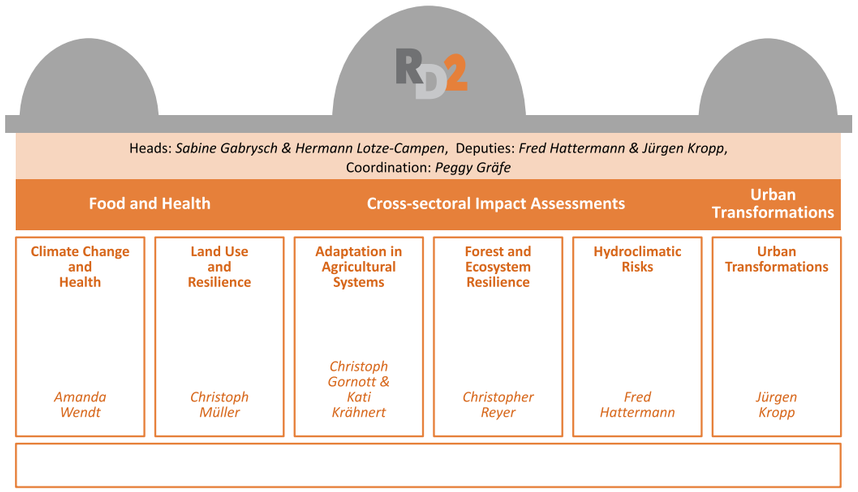
How can we make societies climate-resilient?

Climate change affects every sector of society and has serious consequences at the local, regional, and global levels. We integrate climate impacts across all sectors and scales in a new way while factoring in climate extremes, as well as damages and costs to society and the economy. We evaluate sector-specific options for adaptation and explore synergies between adaptation, mitigation, and social development.

Our research goals are:

- Assessing climate impacts, socio-economic implications, and uncertainties at various stages of global warming (1.5°, 2°, 3°, 4 °C).
- Aggregating multi-sectoral climate impacts across various spatial scales.
- Analysing social resilience in relation to changes in climatic variability and extreme events.
- Gaining a better understanding of transformation dynamics and climate resilience and of urban development as a driver and approach for solving problems associated with climate change.
- Working alongside other groups to develop the Potsdam Integrated Assessment Modelling Framework (PIAM).

Structure of Research Department 2



Research Department 2 (RD2) comprises six working groups in three research areas. In the research area focusing on ‘Food and Health’, the Climate Change and Health working group analyses the impacts that climate and agriculture have on human nutrition and health and evaluates solutions that aim to establish climate-resilient, sustainable, and healthy food systems. The Land Use and Resilience

working group examines the driving forces, feedbacks, and climate-induced changes in land use. This work is carried out in close collaboration with the Land Use Management working group in Research Department 3. The 'Cross-sectoral Impact Assessments' research area is addressed by a special focus on Adaptation in Agricultural Systems, Forest and Ecosystem Resilience, and Hydroclimatic Risks. These three working groups collaborate closely to improve integrated assessments regarding climate impacts at the regional to the continental level; they do so based on a range of regional case studies in Europe, Africa, Latin America, and Asia. The Urban Transformations group uses innovative models and methods to understand future transformations of cities, with a focus on resilience to climate change and sustainable urban livelihoods. The 'Inequality, Human Well-Being and Development' FutureLab is integrated in the structure of Research Department 2 and will concentrate on socio-scientific research on sustainable development, inequality, and human well-being. These research activities will form the scientific basis for the next generation of integrated assessment models and contribute to PIAM.

Peter Bobbert (German Medical Association), Annette Peters (Helmholtz Zentrum München), Sabine Gabrysch (PIK & Charité) and Klaus Reinhardt (German Medical Association) at the presentation of the Policy Brief for Germany. Photo: PIK

Selected results

RESEARCH AREA: 'FOOD AND HEALTH'

Working group – Climate Change and Health

The new group has begun its work and contributes to establishing climate change as a key topic in the health sector. Key components of this were the launch of the Lancet Countdown on Health and Climate Change, which was presented for the first time in Germany, and the Policy Brief for Germany published in relation to the Lancet report (Matthies-Wieler et al. 2019). At the World Health Summit in Berlin, Sabine Gabrysch contributed to a session on 'Climate and Health' and a press conference following the event. She also gave a keynote speech on Planetary Health during a conference at the Federal Foreign Office and participated in a workshop on climate change and health at the Nobel Prize Dialogue and at the Futurium in Berlin. Media interest in the topic has remained consistently high.

An innovative research project on agriculture, food, and health in Bangladesh is about to be completed. The Food and Agricultural Approaches to Reducing Malnutrition (FAARM) intervention study, underway since 2013 and awarded the 'Preis für mutige Wissenschaft' (Award for Bold Research), aims to evaluate the impact of a complex intervention with women's groups – comprising home gardening, chicken rearing and training on nutrition, hygiene and child care – can improve the nutritional status of the women and their young children (Wendt et al. 2019). The endline survey included 2,700 women and their children in 96 villages and collected data on anthropometry, socio-economic, and nutrition indicators, as well as taking blood, urine, and stool samples.

Working group – Land Use and Resilience

Ozone pollution reduces agricultural yields. In a detailed, process-based analysis, Schauberger et al. (2019) demonstrate that yields of wheat and soybeans are significantly decreased by near-surface ozone. This is particularly true for areas that are farmed intensively or irrigated. The resulting loss in wheat yields is estimated at approximately 15 per cent in Germany. There are uncertainties regarding the actual concentrations of near-surface ozone and model parameters, so further research is required in this area (Fig. 4).

The consumption of meat depends heavily on the level of urbanization and income. This has been demonstrated by a study conducted by Milford et al. (2019), which evaluated data from 137 countries. Meat consumption is a major driver behind the negative impacts of agricultural production on the environment but is difficult to influence via policy instruments. Informational and educational campaigns represent a promising approach in this area.

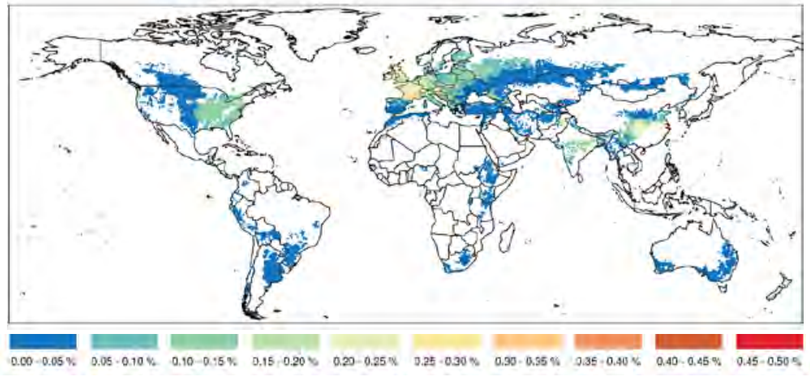


Fig. 4: Reduced yields due to ozone (fractional amounts, no unit) in wheat production (western variety). (Figure modified from Agricultural and Forest Meteorology 265: Schauberger et al., Global historical soybean and wheat yield loss estimates from ozone pollution considering water and temperature as modifying effects, 1-15, Copyright (2019), with permission from Elsevier).

RESEARCH AREA: 'CROSS-SECTORAL IMPACT ASSESSMENTS'

Working group – Adaptation in Agricultural Systems

Science-based selection of adaptation measures is being integrated in national implementation plans (NDC: Nationally Determined Contributions and NAP: National Adaptation Plans). The working group has developed a scientific approach that is used to evaluate and weight national adaptation measures based on bio-physical and socio-economic indicators (Murken et al. 2019). In addition, the different agricultural systems (Shukla et al. 2019) as well as the perception of climate impacts and preferences on the part of farmers must be taken into consideration (Brüssow, Gornott et al. 2019) in order to successfully implement adaptation measures. The group's work was presented at COP25 during a UNFCCC side event and at the UNFCCC Africa Climate Week as well as in numerous policy workshops together with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Federal Ministry of Economic Cooperation and Development (BMZ), receiving a great deal of attention at these events.

Working group – Forest and Ecosystem Resilience

New data infrastructure for modelling climate impacts on forest ecosystems in Europe is freely available. The working group has published a new dataset for the modelling of climate impacts on forest ecosystems (Reyer et al. 2019a). The PROFOUND database provides data for complex vegetation models and forms the basis for the regional forest sector in the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). It is freely available and can be explored via an R package (Silveyra-Gonzalez et al. 2019). Testing of the database was carried out based on the open access process for PIK's 4C forest model (Lasch-Born et al. 2019) and was used to compare the mortality sub-models of 15 vegetation models (Bugmann et al. 2019). This model comparison showed that the mortality of trees represents one of the greatest uncertainties with respect to assessing climate impacts on forests.

Working group – Hydroclimatic Risks

Water conflicts in sub-Saharan Africa are likely to increase significantly due to the influence of climate change and in light of current rates of population growth. Liersch et al. (2019) show that irrigation demand in 2045, as planned by the local authorities, corresponds to one third of the water available in the Upper Niger river. The Niger river is seen as a lifeline flowing across the Sahel, and the upstream water consumption may not only endanger downstream water use and human well-being but also reduce the ecologically important wetland area of the Inner Niger Delta by 20 per cent (Fig. 5).

A majority of climate models assume decreased availability of water due to the influence of climate change in Central and Eastern Europe. Didovets et al. (2019) show that the number and severity of floods in the region could increase despite conditions that will potentially be drier overall. Their study examines how extreme flooding will develop under the conditions of various scenarios. Depending on the warming signal, a smaller or greater increase in the 30-year flood level is forecast in the Carpathian region.

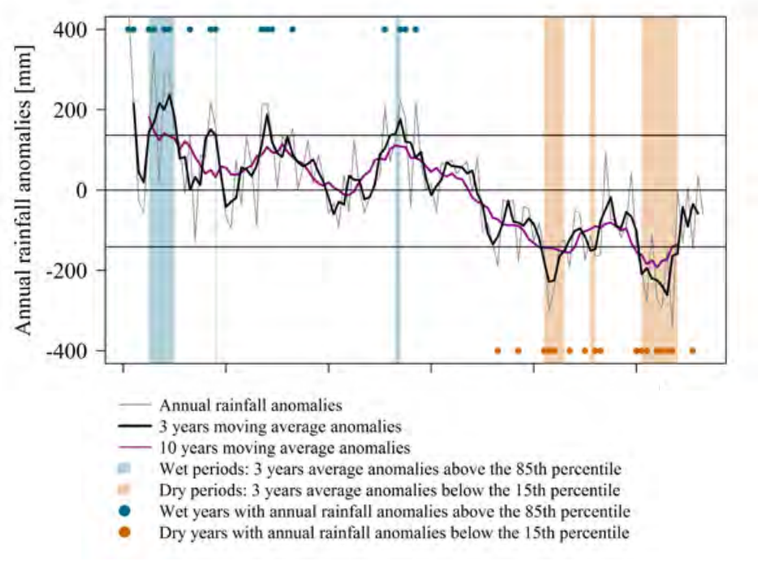


Fig. 5: Observed precipitation anomalies in the Upper Niger Basin from 1910 to 2013 (data: GPCC Full Data Reanalysis Version 7.0 at 0.5°). Horizontal black lines relate to the 15th percentile (lower), the 50th percentile (zero line), and the 85th percentile (upper) of the annual precipitation anomalies. (Liersch et al. 2019 – Journal of Hydrology: Regional Studies)

RESEARCH AREA: ‘URBAN TRANSFORMATIONS’

Working group – Urban Transformations

A city’s expansion always has a stronger influence on urban emissions than population density does. Ribeiro et al. (2019) came to this conclusion based on a scaling analysis for cities of different sizes. To this end, the group compared agglomeration effects with the influence of population density and developed a formalism that is analogous to the familiar Cobb-Douglas production function. Based on this approach, the results can be used to draw conclusions (e.g. for planning purposes) on how density needs to decrease as a city grows so that emissions do not increase accordingly.

However, the group demonstrated that significant potential also exists on an individual basis for Berlin, among other cities. **Targeted intervention measures in households could decrease the individual CO_{2eq} footprint (lifecycle emissions) within a year by approx. 11 per cent** (Reusswig et al. 2020). This demonstrates that consumer behaviour offers significant scope in terms of making climate policies more ambitious.

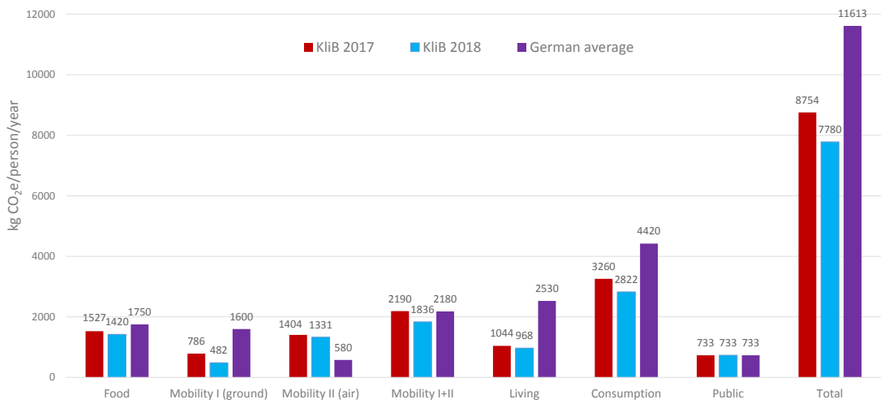


Fig. 6: Carbon footprint of households in the Climate-Neutral Living in Berlin project for 2017 and 2018 in comparison to the national average by sectors (Fig. by S. Bock, PIK)

Doctorates

Name	Institution	Topic
Xiaoxi Wang	Humboldt-Universität zu Berlin	Political Economy and Land Use Dynamics: Quantifying Impacts of Land Governance on Deforestation, Food Prices and Trade Patterns
Wei Weng	Humboldt-Universität zu Berlin	Aerial river management for future water in the context of land use change in Amazonia

SELECTED PUBLICATIONS

Belesova, K., Gornott, C., Milner, J., Sié, A., Sauerborn, R., Wilkinson, P. (2019): Mortality Impact of Low Annual Crop Yields in a Subsistence Farming Population of Burkina Faso under the Current and a 1.5°C Warmer Climate in 2100. – Science of the Total Environment

Gabrysch, S., Nesbitt, R. C., Schoeps, A., Hurt, L., Soremekun, S., Edmond, K., Manu, A., Lohela, T. J., Danso, S., Tomlin, K., Kirkwood, B., Campbell, O. M. R. (2019): Does facility birth reduce maternal and perinatal mortality in Brong Ahafo, Ghana? A secondary analysis using data on 119 244 pregnancies from two cluster-randomised controlled trials. – The Lancet Global Health

Krähnert, K., Brück, T., Di Maio, M., Nistico, R. (2019): The effects of conflict on fertility: Evidence from the genocide in Rwanda. – Demography

Kriewald, S., Pradhan, P., Costa, L., Cantu Ros, A., Kropp, J.P. (2019): Hungry cities: how local food self-sufficiency relates to climate change, life styles and urbanization. – Environmental Research Letters

Müller, C., Elliott, J., Kelly, D., Arneth, A., Balkovic, J., Ciais, P., Deryng, D., Folberth, C., Hoek, S., Izaurralde, R.C., Jones, C.D., Khabarov, N., Lawrence, P., Liu, W., Olin, S., Pugh, T.A.M., Reddy, A., Rosenzweig, C., Ruane, A.C., Sakurai, G., Schmid, E., Skalsky. R., Wang, X., de Wit, A., Yang, H. (2019): The Global Gridded Crop Model Intercomparison phase 1 simulation dataset. – Scientific Data

Murken, L., Aschenbrenner, P., Chemura, A., Hattermann, F., Koch, H., Lehmann, J., Liersch, S., Roehrig, F., Schauberger, B., Yalew, A., Gornott, C. (2019): Climate risk analysis for identifying and weighing adaptation strategies in Ghana’s agricultural sector. A report prepared by the Potsdam Institute for Climate Impact Research for the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development

Petr, M., Vacchiano, G., Thom, D., Mairota, P., Kautz, M., Gonzalves, L., Yousefpour, R., Kaloudis, S., Reyer, C.P.O. (2019): Inconsistent recognition of uncertainty in studies of climate change impacts on forests. – Environmental Research Letters Reviews

Ribeiro, H.V., Rybski, D., Kropp, J.P. (2019): Effects of changing population or density on urban carbon-dioxide emissions. – Nature Communications

Shukla, R., Agarwal, A., Gornott. C., Sachdeva, K., Joshi, P.K. (2019): Farmer typology to understand differentiated climate change adaptation in Himalaya. – Nature Scientific Reports

Wortmann, M., Bolch, T., Su, B., Krysanova, V., (2019): An efficient representation of glacier dynamics in a semi-distributed hydrological model to bridge glacier and river catchment scales. – Journal of Hydrology

‘Climate change will influence societies in very complex ways. The changes we’re already experiencing today can help us better understand the consequences we have to expect at 2°C or 3°C of global warming. For example, we see that extreme events often have longer-lasting economic repercussions than we would expect based on previous standard model assumptions. We aim at updating these assumptions to further improve our understanding of future risks.’

Katja Frieler

‘Political and social action requires an integrated perspective of the risks presented by climate change as well as the opportunities and challenges involved in climate protection. We describe these risks, opportunities, and challenges in computer simulations of transformation pathways. Comparing these pathways with political and social targets for climate protection allows us to provide decision-makers with important insights that may serve as guidance for their decisions.’

Elmar Kriegler

Research Department 3 – Transformation Pathways

RD3 Transformation Pathways

Heads: Katja Frieler & Elmar Kriegler
Deputies: Gunnar Luderer & Matthias Mengel

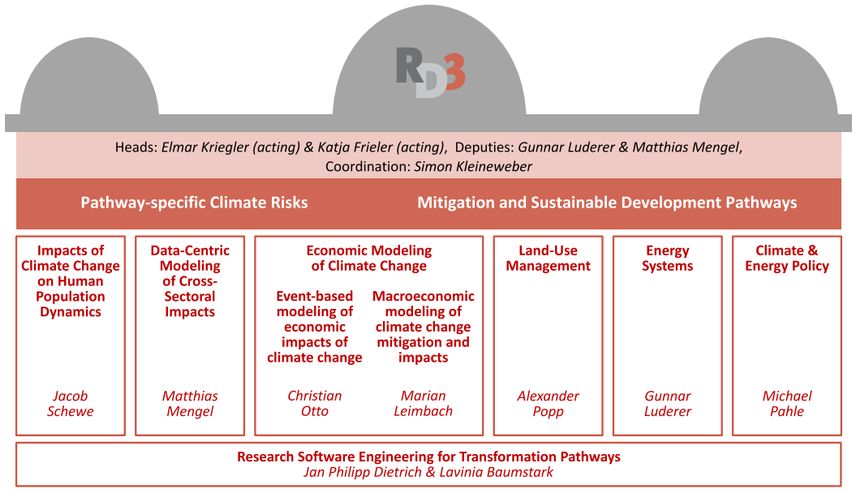
How can climate protection scenarios and climate change risks be researched in an integrated manner?

Climate change will affect every area of society. We are developing integrated analyses of strategies to prevent emissions and residual climate impacts, embedding these in the context of sustainable development.

The research department’s key topics and goals are:

- Analysing the requirements, costs, and options involved in long-term climate protection pathways as well as ways of combining and comparing them with the corresponding biophysical and social consequences of climate change.
- Central areas of the integrated analyses are the transition of energy and land use as well as the impact on macro-economic development and migration.
- Analysing the political and economic instruments for preventing climate change and carrying out the necessary transformation of energy and land use systems around the world.
- Examining interactions between climate protection, climate impacts, and sustainable development, including the extent that sustainable development goals (SDGs) can be achieved.

Structure of Research Department 3



Research Department 3 (RD3) comprises two research areas: ‘Pathway-specific Climate Risks’, headed by Katja Frieler and ‘Mitigation and Sustainable Development Pathways’, headed by Elmar Kriegler. Seven working groups examine transformation pathways to protect the climate and the risks, benefits, challenges, and opportunities associated with them. A cross-cutting group is dedicated to studying ‘Research Software Engineering for Transformation Pathway Analysis’. Moreover, two FutureLabs are

associated with the department: one conducts research on 'Security, Ethnic Conflicts, and Migration', the other research on 'Public Economics and Climate Finance' in close cooperation with the MCC.

Selected results

RESEARCH AREA: 'PATHWAY-SPECIFIC CLIMATE RISKS'

Working group – Data-centric Modelling of Cross-sectoral Impacts

ISIMIP advances harmonization of climate impact modelling. ISIMIP3, the third phase of ISIMIP, has recently started. Historical climate forcing data now includes a climate counterfactual to facilitate impact attribution. Future climate forcing has been updated to the latest generation of climate models. A machine-readable protocol improves transparency and automates validation of curated impact model results. ISIMIP3 also includes a new sector on wildfires. Furthermore, the group develops the new ISIpedia Internet portal, a platform (currently available as a prototype) that broadcasts ISIMIP findings to a non-scientific audience.

Model-based attribution of historic impacts of climate change. A counterfactual with estimated impacts in a world that would have been without climate change is necessary to address impact attribution. ISIMIP has now laid the groundwork for this type of attribution by providing counterfactual climate data and making an attribution experiment first priority in ISIMIP3.

Working group – Impacts of Climate Change on Human Population Dynamics

Assessing the impacts that climate change has on migration patterns. A computer model that was newly developed in the department makes it possible to simulate the global network of international migration in a dynamic manner. The model makes a distinction between emigration, transit migration, and return migration and considers the key role played by diaspora. Using this approach, the model is capable of reproducing net migration rates over the past 25 years for many major countries based only on national differences in income levels (Rikani & Schewe, submitted). Climate change is expected to influence the development of national income, and the new model is designed to be able to quantify this indirect effect of climate change on migration patterns.

Disaster-induced displacement influences population dynamics. Based on hydrological simulations generated within the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP), a study involving RD3 demonstrated that the global risk of internal displacement due to river flooding would roughly double if the world's temperature increased by 2°C above pre-industrial levels. This research was conducted in collaboration with the Internal Displacement Monitoring Center in the run-up to COP25 (Ginnetti et al. 2019) and is to be extended to other natural risks represented in ISIMIP.

Working group – Event-based Modelling of Economic Impacts of Climate Change

Tropical cyclones and river flooding have long-term negative impacts on economic growth. An RD3 study analysed how countries' economic growth responded to tropical cyclones and river floods and how these responses depend on the stage of development. Both types of events have significant negative impacts on economic growth which are still evident 15 years later. Tropical cyclones have approximately double the impact of river floods in terms of impeding economic growth. The study shows that the stage of economic development does not – as is often assumed – offer protection against the long-term consequences of these extreme events in all cases. As a result, tropical cyclones, for instance, impede economic growth in developed countries more severely than in least developed countries. Lower investment rates and a deterioration of trade balances are the key channels via which tropical cyclones and river floods inhibit economic growth in the affected countries, regardless of their stage of development (Krichene et al., in preparation).

RESEARCH AREA: MITIGATION AND SUSTAINABLE DEVELOPMENT PATHWAYS

Working group – Macroeconomic Modelling of Climate Change Mitigation and Impacts

Analysing long-term effects of climate-related loss events on economic development. The study conducted by Piontek et al. (2019) compares the long-term effects of climate-related loss events, which impact the production system via various channels, including the loss of GDP, capital, labour supply, and productivity (see Fig. 7). The study found that the long-term effects and particularly the time the economy takes to recover heavily depend on the channel through which the loss occurred. The typical case in literature (direct loss of production in the GDP) has by far the least effect. Depending on their persistence, loss events that continually recur can potentially entail very large declines in prosperity. System-internal options for adaptation are limited and can be overpowered. For this reason, it is important to quantify channel-specific losses and consider them in integrated analyses so losses can be realistically assessed.

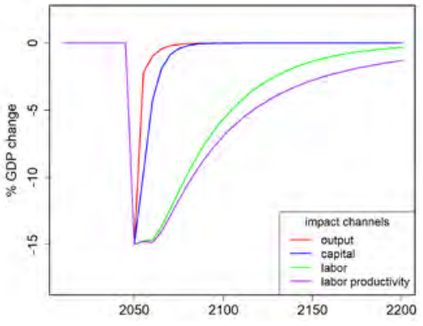


Fig.7: The diagram shows the changes in the aggregated gross domestic product for 150 years after the initial shock (in 2050). The lines in different colours show the dynamics that are triggered through various loss channels. The direct shock to the GDP (red line) is the typical case in literature regarding losses. Losses in productivity have the longest recovery times in the economy. (Reprinted by permission from Springer Nature: Environmental and Resource Economics: Economic Growth Effects of Alternative Climate Change Impact Channels in Economic Modelling, F. Piontek et al., copyright 2019)

Working group – Land Use Management

Models and scenarios for biodiversity and ecosystem services. By collaborating in an IPBES expert group, researchers from RD3 contributed to one of the first comparisons of scenarios and models relating to biodiversity and ecosystem services (Rosa et al. 2019, Pereira et al., submitted).

Improved understanding of land-based climate protection measures. A bottom-up assessment of strategies to reduce emissions in the agricultural sector showed that climate protection measures in the agricultural and forestry industries could contribute approximately 30 per cent of the global emissions reductions that are required by 2050 to achieve the 1.5°C-degree target. In this context, scenario analyses with the MAgPIE integrated land-use model also highlighted the significant role played by targeted conservation of peatlands and by peatland regeneration (Humpenöder et al., submitted).

Working group – Energy Systems

The reduced damage to health and the environment outweighs the additional economic burden associated with an accelerated coal phase-out(Rauner et al., 2019 accepted). An accelerated phase-out of coal offers significant benefits for local environments and health that outweigh the direct economic costs. At the same time, an accelerated coal phase-out will lead to a considerable reduction in the carbon emissions gap, particularly for key regions such as India and China (see Fig. 8). The effects on the environment and human health can be felt immediately in both spatial and temporal terms, in contrast to climate losses. Including these effects can therefore contribute significantly to resolving the tragedy of the global commons in climate policy that is caused by the discrepancy between the national burden involved in decarbonization costs and the benefits from reducing the impacts of climate change, which are shared internationally.

Development of a version of the integrated energy-economy-climate model REMIND geared towards Germany and Europe. The REMIND-EU version of the model describes Germany and other key EU Member States as individual model regions, enabling a detailed climate policy analysis as well as a more in-depth analysis of the German and European transformation pathways towards emissions neutrality in the global context. A key feature of REMIND-EU is its high resolution with respect to policies and sectors, which permits a more detailed climate policy assessment.

Working group – Climate and Energy Policies

An effective phase-out of coal can only succeed if carbon allowances are cancelled. If Germany phases out coal without cancelling allowances in the EU Emissions Trading Scheme, there is a risk that no additional emissions savings will be made at the EU level. This analysis was published in May in the journal Energiewirtschaftliche Tagesfragen (Pahle et al. 2019 ; see Fig. 9) and also formed part of the report published by the MCC and PIK on options for reforming carbon pricing, which was commissioned by the German Advisory Council on the Environment. It was covered extensively by the German

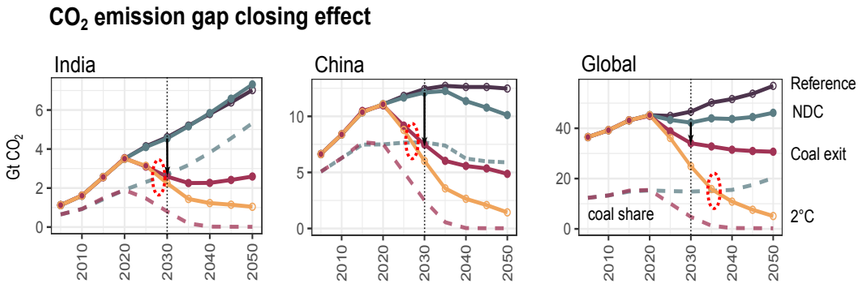


Fig. 8: The figure shows carbon emissions reduction effects for China, India, and the world as a whole. (Reprinted by permission from Springer Nature: Nature Climate Change: Coal exit health and environmental damage reductions outweigh economic impacts, S. Rauner et al., copyright 2020)

media (including Der Spiegel, FAZ, Die Zeit, and Süddeutsche Zeitung newspapers) and triggered a debate that ultimately prompted the German government to approve the deletion of allowances in its law regulating the country's phase-out of coal.

Rising interest rates could jeopardize the energy transition and the continued expansion of renewable energies. Capital costs for renewable energies will increase significantly if interest rates in Europe rise to 'pre-crisis levels'. Political decision-makers have scarcely been aware of this macroeconomic risk to the energy transition prior to this. In order to prevent a reduction of investments in renewable energies due to changes in interest policies, it is essential to introduce an innovative regulation framework that aims, for example, to increase capacities for renewable energies (Schmidt et al. 2019).

Working group – Research Software Engineering for Transformation Pathway Analysis

The REMIND energy-economy model is now open source on GitHub. This model calculates optimal investments for regions around the world, both in the macroeconomic sector as well as in various energy sectors, taking into account international trade of resources, goods, and emissions allowances. It thus enables a detailed analysis of technological

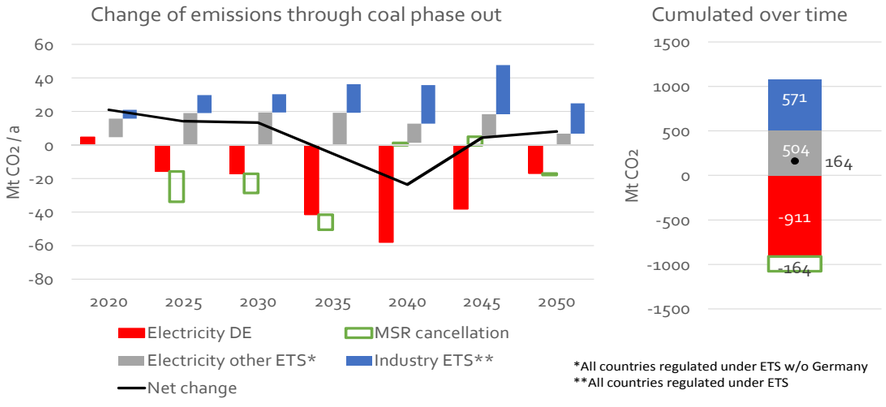


Fig. 9: The diagram shows the reductions in emissions that would be achieved if Germany phased out coal (red bar) in comparison to a reference scenario without a coal phase-out. The blue and grey bars also refer to the additional emissions that would be emitted elsewhere in the EU if Germany phased out coal. (Pahle, M. et al.: Die unterschätzten Risiken des Kohleausstiegs. Energiewirtschaftliche Tagesfragen 69. Year (2019), issue 6)

options and policy measures to prevent climate change. A range of tools for preparing input data, documenting code, and analysing results was published alongside the model. All these steps further increase the transparency of the models, enhance the visibility of the research behind them, and promote open science. In this same context, current developments in the MAgPIE global land-use model (which was transferred to an open source format last year; see Dietrich, et al., 2019). Supported by an initial introduction workshop on the model that was open to the public, new collaborations with international partners from the UK, India, and Brazil came together in a very short space of time.

Completed doctorates

Name	Institution	Topic
Gambardella, Christian	Technische Universität Berlin	A Renewable Energy Dominated Power Market: Challenges and Solutions for Market Design and Policy Instruments

SELECTED PUBLICATIONS

Dietrich, J., Bodirsky, B., Humpenöder, F., Weindl, I., Stevanović, M., Karstens, K., Kreidenweis, U., Wang, X., Mishra, A., Klein, D., Ambrósio, G., Araujo, E., Yalew, A., Baumstark, L., Wirth, S., Giannousakis, A., Beier, F., Mengchuen Chen, D., Lotze-Campen, H., Popp, A. (2019): MAgPIE 4 – A modular open source framework for modelling global land-systems. – Geoscientific Model Development

Friedrich, M., Smeekes, S., Urbain, J.-P. (2019 accepted): Autoregressive wild bootstrap inference for nonparametric trends. – Journal of Econometrics

Gidden, M. J., Riahi, K., Smith, S. J., Fujimori, S., Luderer, G., Kriegler, E., Vuuren, D. P. van, Berg, M. van den, Feng, L., Klein, D., Calvin, K., Doelman, J. C., Frank, S., Fricko, O., Harmsen, M., Hasegawa, T., Havlik, P., Hilaire, J., Hoesly, R., Horing, J., Popp, A., Stehfest, E., Takahashi, K. (2019): Global emissions pathways under different socioeconomic scenarios for use in CMIP6: a dataset of harmonized emissions trajectories through the end of the century. – Geoscientific Model Development

Lange, S. (2019): Trend-preserving bias adjustment and statistical downscaling with ISIMIP3BASD (v1.0). – Geoscientific Model Development

Luderer, G.; Pehl, M.; Arvesen, A.; Gibon, T.; Bodirsky, B. L.; Sytze de Boer, H.; Fricko, O.; Hejazi, M.; Humpenöder, F.; Iyer, G.; Mima, S.; Mouratiadou, I.; Pietzcker, R. C.; Popp, A.; Berg, M. van den; Vuuren, D. van; Hertwich, E. G. (2019): Environmental co-benefits and adverse side-effects of alternative power sector decarbonization strategies. – Nature Communications

Nauels, A., Gütschow, J., Mengel, M., Meinshausen, M., Clark, P. U., Schleussner, C.-F. (2019): Attributing long-term sea-level rise to Paris Agreement emission pledges. – Proceedings of the National Academy of Sciences of the United States of America (PNAS)

Piontek, F., Kalkuhl, M., Kriegler, E., Schultes, A., Leimbach, M., Edenhofer, O., Bauer, N. (2019): Economic Growth Effects of Alternative Climate Change Impact Channels in Economic Modelling. – Environmental and Resource Economics

Rauner, S., Bauer, N., Dirnaichner, A., Van Dingenen, R., Mutel, C. and Luderer, G. (2019 accepted): Coal exit health and environmental damage reductions outweigh economic impacts. – Nature Climate Change

Roe, S., Streck, C., Obersteiner, O., Griscom, B., Harris, N., Hasegawa, T., Hausfather, Z., Havlík, P., House, J., Nabuurs, G., Popp, A., Sanderman, J., Smith, P., Stehfest, E., Lawrence, D. (2019): Contribution of the land sector to a 1.5°C World Nature Climate Change

Schewe, J., et al. (2019): State-of-the-art global models underestimate impacts from climate extremes. – Nature Communications

‘Climate change is causing extreme events to occur more frequently in a wide spectrum of areas that are essential for our lives – from severe weather to mega outages in the energy system. We are responding by developing innovative methods based on a combination of complexity science with machine learning and data science to gain a more detailed understanding of Earth as a complex system and substantially improve our ability to predict a diverse range of extreme events.’

Jürgen Kurths

‘Every day people make decisions that are relevant for the climate problem – both to prevent carbon emissions, but also to adapt. We try to find principles that govern these decisions in data and then use them in numerical models to understand possible future evolutions of our society. We are searching for the next generation of equations for a more stable and sustainable society.’

Anders Levermann

Research Department 4 – Complexity Science

RD4 Complexity Science

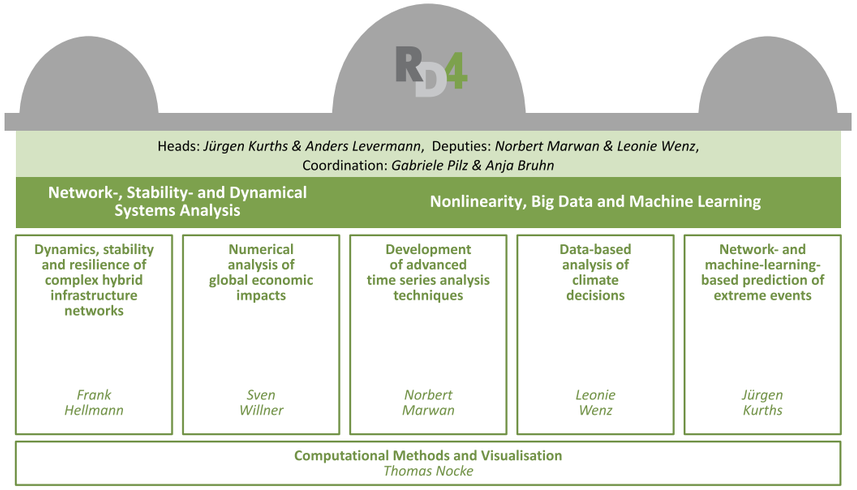
Heads: Jürgen Kurths & Anders Levermann
Deputies: Norbert Marwan & Leonie Wenz

How can we gain insights from the theory of complex systems for climate and sustainability research?

We focus on the following research areas:

- Analysing the emergence of structures in complex networks as a novel approach in order to model heterogeneous climate impacts and the interactions in socio-economic systems.
- Data-based modelling of climate-related decisions, global cascades of damage, and analysis of economic impacts.
- Developing methods of nonlinear time series analysis, machine learning, and visualization techniques and their application to observations of the Earth system with a focus on extreme events.

Structure of Research Department 4



Research Department 4 (RD4) comprises two research areas with a total of five working groups that continually develop and apply the theory of complex systems in research on the climate and sustainability. Each working group is involved in a number of projects that receive third-party funding. Visualization techniques and methods of applying them to the Earth system are supportive activities within the department. Two FutureLabs are also hosted by the department so the methods and expertise developed in RD4 can be incorporated in cross-departmental projects and particularly to promote research on machine learning and game theory. Particularly noteworthy is the research department’s active involvement in major projects led by the Deutsche Forschungsgemeinschaft (German Research Foundation), including the 1984 Hybrid and Multimodal Energy Systems priority programme, the 1740 International Research Training Group, the 2043 NatRiskChange research training group, and the Math+ cluster of excellence.

Selected results

RESEARCH AREA: 'NETWORK, STABILITY, AND DYNAMICAL SYSTEMS ANALYSIS'

Working group – Dynamics, Stability, and Resilience of Complex Hybrid Infrastructure Networks

Progress on the resilience and stability of network systems. The working group arrived at a wide range of important findings on the resilience and stability of network systems last year. This included deriving general equations that reflect the propagation of complex disturbances on networks. Work on the surprising influence that line losses have on the stability of power grids as well as a publication on delays were completed and will be published in early 2020.

elena international GmbH spin-off. Direct current networks were also addressed in the group's research. Initial results on the resilience of larger organizational units were achieved in the 1984 (CoCo-Hype) priority programme led by the DFG. Funded by an EXIST grant and a SAW transfer project, the elena international GmbH spin-off was founded during the course of the year and is co-developing an open source library for stability analyses with our research group. New exploratory projects that address the application of statistical physics methods in the infrastructure context are already showing high potential (Lindner et al. 2019).

Working group – Numerical Analysis of Global Economic Impacts

Integrating future climatic and economic scenarios into the Acclimate model. The Acclimate model simulates cascades of production outages and pricing signals in the global supply network (see Fig. 10). The working group extended the model, allowing the underlying 'baseline state' to follow economic scenarios, such as those taken from equilibrium models. Also, it now incorporates climate impacts caused by river flooding, tropical cyclones, and heatwaves as shocks. This allowed the analysis of the interactions between shocks caused by various extreme weather events. Such interactions – both temporal and spatial – significantly enhance the severity of the overall damage caused. Preparations have been made for the publication of these findings.

Integrated assessment on climate impacts from a 'bird's eye perspective' Simple, global models that use an integrated approach to consider both the economic as well as the climate system are ideal when it comes to understanding the interplay of mitigation and climate impacts. The working group consistently integrated a relationship between temperature and economic growth that was established using empirical methods into such an integrated assessment model. A subsequent cost-benefit calculation clearly indicates that the 2°C target of the Paris Agreement is ideal when comparing costs and benefits.

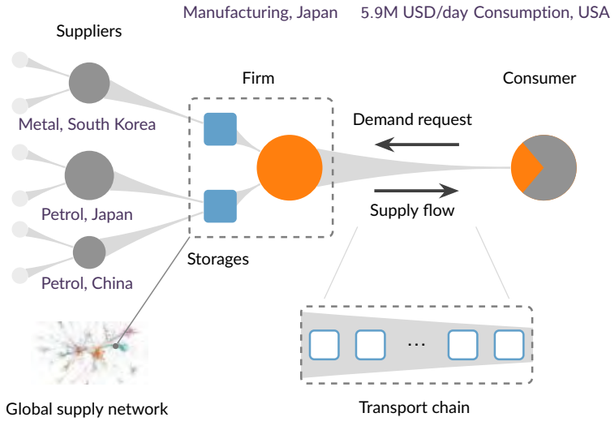


Fig. 10: Example of an economic agent in the Acclimate model. Embedded in the global supply network, the company sources goods required for production from various suppliers and markets the finished goods in response to demand for them. Shocks such as those caused by extreme weather events can impair production and lead to delivery bottlenecks and pricing signals at the local level in the model (Sven Willner, PIK).

RESEARCH AREA: 'NONLINEARITY, BIG DATA, AND MACHINE LEARNING'

Working group – Development of Advanced Time Series Analysis Techniques

Nonlinear time series analysis combined with complex networks. Nonlinear time series analysis methods have improved substantially in recent years based on an original combination with techniques that were developed for complex networks. Time series can be transformed into networks by their recurrence properties, transition probabilities, cycles, and local rank orders. In a study, these different approaches were compared, summarized, and illustrated with examples of application (Zou et al. 2019).

Robust methods for recurrence analysis. The group's methodological research focused on important unsolved questions in the field of recurrence analysis, particularly regarding artefacts caused by oversampling and boundary effects. It proposed new techniques that enable more robust and reliable recurrence analyses, especially for the oscillating behaviour of complex systems (Kraemer & Marwan 2019). These methods enabled the detection of key regime transitions in the climate in East Africa within the last 45,000 years (Trauth et al. 2019).

Successful application to palaeoclimate data. An approach developed in recent years for the time series analysis of palaeoclimate data with irregular sampling and dating uncertainties was successfully applied to the analysis of palaeoclimate datasets. By comparing the variability in the palaeoclimate data at two different locations in Germany, the group succeeded in reconstructing the migration of the border between the (western) maritime and (eastern) continental climate zone for the past 4,000 years (Breitenbach et al. 2019).

Working group – Data-based Analysis of Climate Decisions

Impact of temperature changes on economic power. In a joint effort with MCC, the group analysed how temperature changes affect economic productivity in the short and long term. Detailed economic data (~1,500 regions worldwide, in part from 1900) were combined with climate observations for this purpose. The identified relationship was used to calculate economic damages under future warming to determine a global damage function, and estimate the social cost of carbon (Kalkuhl & Wenz, submitted in 2019).

Economically optimal climate target and algorithm for projecting the trade network. Recent empirical findings on the impacts of climate on economic growth were weighed against state-of-the-art mitigation costs from the REMIND model in a cost-benefit analysis. In line with Glanemann et al. 2020, this analysis showed that the 2°C target is also optimal from an economic perspective (Ueckerdt et al. 2019). With regard to the indirect economic impacts of weather extremes that can occur due to repercussions in today's closely interlinked global trade network, an algorithm was developed to provide scenario-based projections of how this network might likely evolve in the coming decades.

Working group – Network- and Machine-learning-based Prediction of Extreme Events

Efficient strategies for controlling epidemics. The group developed a system of evolutionary algorithms for handling the immunization problem, which is currently one of the main problems in the network sciences. The new model exhibits significant advantages in almost all networks compared to standard modern strategies, both in terms of the optimal immunization threshold as well as the average size of the largest cluster. This yields promising prospects for developing efficient strategies for controlling epidemics as well as for improving the resilience of infrastructure and protecting existing networks against cyberattacks (Liu et al. 2019).

Long-term forecasting of the El Niño–Southern Oscillation (ENSO) as a fundamental climate phenomenon. Forecasting ENSO as early and reliably as possible is still a highly relevant challenge. The 'spring predictability barrier' remains a challenging problem for long-lead-time forecasting (> 6 months). In order to overcome this barrier, the group developed an analysis tool called System-Sample-Entropy (SysSampEn). For the first time, this technique makes it possible to predict El Niño events with a forecasting period of one year and a high degree of accuracy (Meng et al. 2019). Another new data-driven model for analysing and forecasting the sea-surface temperature is based on linear dynamic mode (LDM) decomposition of observation data and was derived from a recently developed

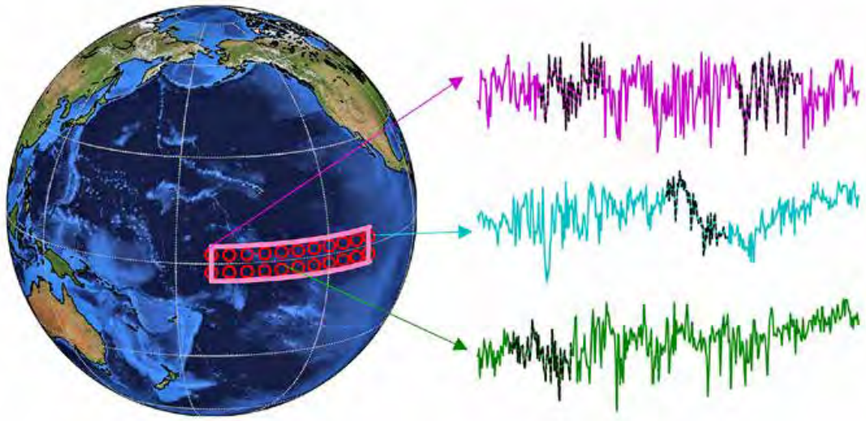


Fig. 11: Long-term El Niño forecasting via SysSampEn. The red circles indicate the 22 nodes in the Niño 3.4 region with a spatial resolution of 5° × 5°. The curves are examples of the temperature anomaly time series for three nodes in the Niño 3.4 region for one specific year, and several examples of their sub-sequences are marked in black. SysSampEn is roughly equal to the negative natural logarithm of the conditional probability that two originally similar sub-sequences (within a specific tolerance range) remain the same for the next p points for m sequential data points. The sub-sequences may be taken from either the same or from different time series. (Meng, J.; Fan, J.; Ludescher, J.; Agarwal, A.; Chen, X.; Bunde, A.; Kurths, J.; Schellnhuber, H. J. (2019): Complexity-based approach for El Niño magnitude forecasting before the spring predictability barrier. In: Proceedings of the National Academy of Sciences of the United States of America (PNAS), 10.1073/pnas.1917007117)

approach for reducing nonlinear dimensionality. At the heart of this machine learning approach is the ability to consider simple dynamic characteristics of the observed system by identifying its dominant timescales. The method is being applied to the anomaly field of the sea-surface temperature in the tropical belt, in which ENSO plays the dominant role with respect to variability. A critical comparison shows that the new model has a high forecasting capability in comparison to established ENSO models (Gavrilov et al. 2019).

Development of a new structured machine learning approach for identifying partial differential equations (PDEs) from data. Identifying reliable physical models, often in the form of PDEs, is of major significance for many applications. Data-driven methods for discovering PDEs have attracted a great deal of attention recently along with the explosive increase of high-resolution data and computing resources. We used structured machine learning to develop a novel approach for identifying PDEs with both constant as well as spatially varied coefficients. In doing so, we formulated the identification problem of parametric PDEs as a mixed optimization problem in which block structures are explicitly utilized. Examples of paradigmatic nonlinear systems demonstrate that the proposed algorithm is highly effective even when used for a limited number of measurements (Li et al. 2019).

Cross-cutting activity: 'Computational Methods and Visualization'

Development of data visualizations. In the topic area visual analytics, scalable information visualization techniques for multi-variant, regional climate ensemble data were tested and implemented for the specific application of Peruvian regional model simulations (EPICC project). A completely revised version of the KlimafolgenOnline (Climate Impacts Online) web portal was designed, implemented, and tested (with RD2) with a focus on presenting regional climate data visually. We conducted a study on the characteristics of hockey stick visualizations in various web contexts (e.g. IPCC, climate change denier blogs) as part of a mixed methods project. The successful work that is being carried out in the area of big data-based climate services for the financial sector was continued in cooperation with the Swiss fintech CarbonDelta (now MSCI) in the Climate-KIC projects (with RD3).

Adjoint associate professorship with Chalmers University of Technology in Sweden. We stepped up our cooperation with Chalmers University of Technology through an adjoint associate professorship position. Together with Université catholique de Louvain (UCL), we expanded the IdrisLib library to include verified methods for discrete monadic systems and for Bayesian inference in preparation for the TiPES project.

Completed doctorates

Name	Institution	Topic
Agarwal, Ankit	University of Potsdam	Unravelling spatio-temporal climatic patterns via multi-scale complex networks
Ciemer, Catrin	Humboldt-Universität zu Berlin	Complex systems analysis of changing rainfall regimes in South America and their implications for the Amazon rainforest
Ekhtiari, Nikoo	Humboldt-Universität zu Berlin	Interactions between water-bodies and atmosphere at regional to global scales
Franke, Jasper	Humboldt-Universität zu Berlin	Networks of the Late Quaternary – Case Studies on Complex Network Approaches on Palaeoclimate Time Series
Oztürk, Ugur	University of Potsdam	Learning more to predict Landslides
Vinke, Kira	Humboldt-Universität zu Berlin	Unsettling Settlements: Cities, Migrants, Climate Change – Rural-Urban Climate Migration as Effective Adaptation?

SELECTED PUBLICATIONS

Breitenbach, S.F.M., B. Plessen, S. Waltgenbach, R. Tjallingii, J. Leonhardt, K. P. Jochum, H. Meyer, B. Goswami, N. Marwan, D. Scholz (2019): Holocene interaction of maritime and continental climate in Central Europe: New speleothem evidence from Central Germany. – Global and Planetary Change

Ciemer, C., Boers, N., Hirota, M., Kurths, J., Müller-Hansen, F., Oliveira, R. S., Winkelmann, R. (2019): Higher resilience to climatic disturbances in tropical vegetation exposed to more variable rainfall. – Nature Geoscience

Glanemann, N., Willner, S. N., Levermann, A. (accepted 2019): Paris Climate Agreement passes the cost-benefit test. – Nature Communications

Levermann, A., Feldmann, J. (2019): Scaling of instability time-scales of Antarctic outlet glaciers based on one-dimensional similitude analysis. – The Cryosphere

Levermann, A., Winkelmann, R., Albrecht, T., Goelzer, H., Golledge, N. R., Greve, R., Huybrechts, P., Jordan, J., Leguy, G., Martin, D., Morlighem, M., Pattyn, F., Pollard, D., Quiquet, A., Rodehacke, C., Seroussi, H., Sutter, J., Zhang, T., Van Breedam, J., DeConto, R., Dumas, C., Garbe, J., Gudmundsson, G. H., Hoffman, M. J., Humbert, A., Kleiner, T., Lipscomb, W., Meinshausen, M., Ng, E., Perego, M., Price, S. F., Saito, F., Schlegel, N.-J., Sun, S., Wal, R. S. W. van de (accepted 2019): Projecting Antarctica's contribution to future sea-level rise from basal ice-shelf melt using linear response functions of 16 ice-sheet models (LARMIP-2). – Earth System Dynamics

Li, X., Li, L., Yue, Z., Tang, X., Voss, H. U., Kurths, J., Yuan, Y. (2019): Sparse learning of partial differential equations with structured dictionary matrix. – Chaos

Liu, Y., Wang, X., Kurths, J. (2019): Framework of evolutionary algorithm for investigation of influential nodes in complex networks. – IEEE Transactions on Evolutionary Computation

Meng, J., Fan, J., Ludescher, J., Agarwal, A., Chen, X., Bunde, A., Kurths, J., Schellnhuber, H. J. (2019): Complexity-based approach for El Niño magnitude forecasting before the spring predictability barrier. – Proceedings of the National Academy of Sciences of the United States of America (PNAS)

Strnad, F. M., Barfuss, W., Donges, J. F., Heitzig, J. (2019): Deep reinforcement learning in World-Earth system models to discover sustainable management strategies. – Chaos

Zou, Y., Donner, R. V., Marwan, N., Donges, J. F., Kurths, J. (2019): Complex network approaches to nonlinear time series analysis. – Physics Reports

04
FUTURELABS

A new research format was initiated at PIK in 2019 in the form of seven cross-departmental FutureLabs. These entities focus on ambitious research topics of strategic significance. The FutureLabs are exploratory, interdisciplinary research initiatives that aim to respond more rapidly to a continually changing research landscape with emerging research questions.

FutureLab

Social Metabolism and Impacts

How can human well-being be achieved within planetary boundaries? Headed by Helga Weisz, this FutureLab seeks to understand the metabolism – the material and energy streams – of various social systems (countries, economic sectors, cities, households, etc.) and what it contributes to global warming and other environmental impacts.

A recent finding by the FutureLab shows that healthcare systems around the world account for between 2 per cent and 5 per cent of global damage to the environment and human health. The first global study of the environmental footprint of healthcare systems examined airborne pollutants in the form of greenhouse gas emissions, particulates, nitrogen and sulphur dioxides, and malaria risks due to deforestation as well as the environmental indicators of reactive nitrogen and water scarcity. The selection of environmental indicators considers not only the environmental impact but also the adverse consequences for health and demonstrate the extent to which the provision of health services is damaging to the environment and health in and of itself. For this reason, one key challenge for health services consists of reducing their environmental impact while maintaining or enhancing the well-being of the population.

FutureLab

Earth Resilience in the Anthropocene

What are critical thresholds for tipping elements in the Earth system? How can the resilience of the Earth system as a whole be defined, characterized, modelled, and measured? These are the key questions addressed by the FutureLab headed by Ricarda Winkelmann and Jonathan F. Donges.

In order to gain a more detailed understanding of the interactions between tipping elements in the Earth system based on new mathematical approaches, the FutureLab looked at areas such as the stability of the ice sheets in Greenland and the Antarctic and presented its initial findings in 2019. By using the PISM computer simulation model for ice dynamics, the group conducted the first comprehensive analysis of the hysteresis behaviour of the Antarctic ice sheet, identifying the critical temperature values for individual regions and corresponding early warning signals. An analysis of the stability of Greenland's ice sheet demonstrated that the influence of the prescribed flow law in ice-sheet models was generally underestimated in earlier studies. This could result in a doubling of the surface speeds in ice flows, which would have far-reaching consequences for future sea-level projections.

FutureLab

Inequality, Human Well-Being and Development

How do climate impacts and climate policies affect the most vulnerable population groups? How is adaptation to and mitigation of the impacts of climate change affected by inequality? These questions are being addressed by the FutureLab dedicated to Inequality, Human Well-Being, and Development starting in 2020.

This FutureLab will study inequality, human well-being and development from an economic perspective, applying complementary macro- and micro-economic approaches. Policy analysis will be based on innovative, state-of-the-art economic modelling that explicitly considers the design of policies. The distributional impacts of shocks and policies will be assessed through the econometric analysis of empirical micro data from low- and middle-income countries.

FutureLab

Public Economics and Climate Finance

Which policy instruments can create a balance between necessary measures to protect the climate and rising prosperity? This is the focus of the FutureLab headed by Kai Lessmann and Matthias Kalkuhl (MCC).

Among other things, the research work conducted by the FutureLab last year established that non-binding climate policies place fixed assets at risk. If a government revises a climate policy it has previously adopted, it decreases the value of the investments made in response to the policy. However, investors who foresee that such stranded assets will occur will refrain from these investments – so the climate policy wouldn't have an incentive effect. A theoretical analysis of governments that are unable to determine binding climate policies shows that their policy options are only 'all or nothing': either a prohibitively high carbon tax or no carbon pricing.

FutureLab

Security, Ethnic Conflicts and Migration

How does climate change affect human security, conflict risks, migration, and the interaction between those phenomena? The FutureLab headed by Jacob Schewe addresses this question in its research.

By applying an innovative method, process-based computer models from the ISIMIP project can be used to calculate climate-dependent variables that are presumed to play a role in local conflicts. Such variables include agricultural yields and the occurrence of droughts or floods. Together with relevant socio-economic and political data, these variables can then be tested with the help of machine learning to determine their significance with respect to violent conflicts that occurred in the past.

FutureLab

Artificial Intelligence in the Anthropocene

How can machine learning methods complement process-based models to improve our understanding of abrupt transitions, extreme events, and their consequences in the Earth system and help us predict them more effectively? The FutureLab headed by Niklas Boers examines these questions.

This FutureLab primarily uses methods from the areas of complexity science and machine learning to conduct data-driven analyses of nonlinear and extreme behaviours in the Earth system. Complex networks are used to identify dependencies in large volumes of data relating to the Earth system. The FutureLab aims to use neural networks and related machine learning methods to capture emergent phenomena that are challenging to model using process-based methods. Its main objective is to analyse abrupt climatic transitions in the Earth system like those documented in palaeoclimatic archives as well as extreme events such as heatwaves, droughts, and floods.

FutureLab

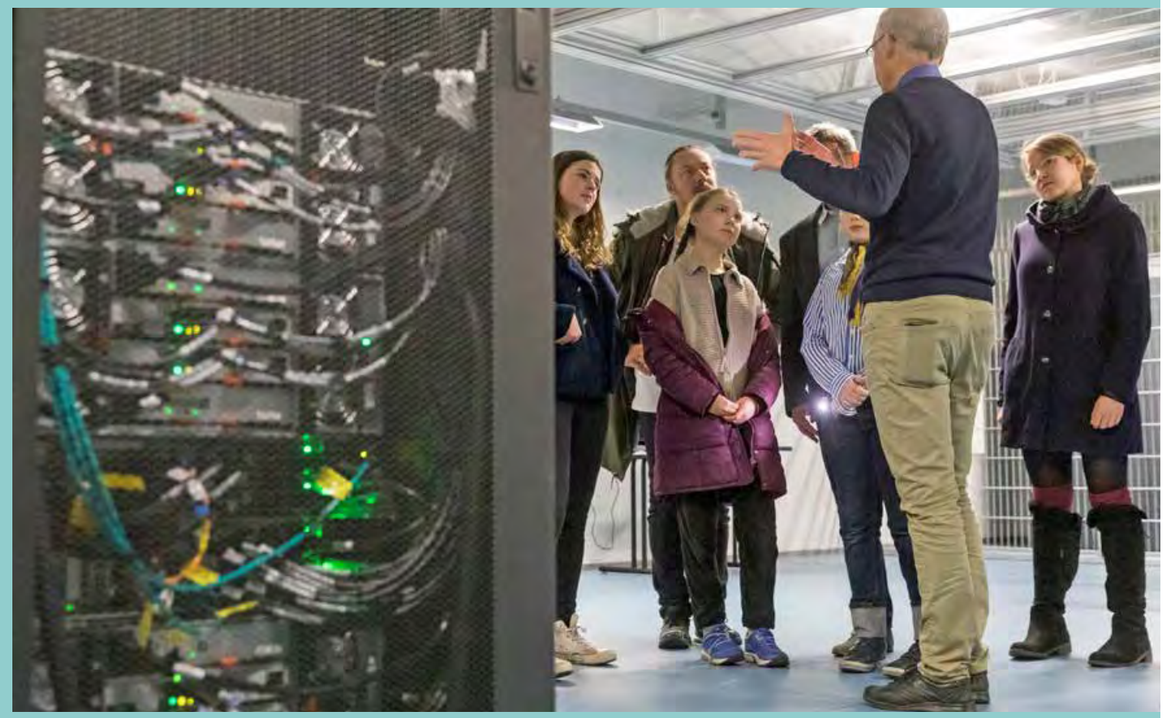
Game Theory & Networks of Interacting Agents

What are effective mechanisms and incentives for cooperative climate protection by agents interacting on various levels? The FutureLab headed by Jobst Heitzig and Ulrike Kornek (MCC) is exploring this question.

Initial findings from a game theory model show that an international compensation fund can significantly enhance incentives for countries to take part in ambitious efforts to protect the climate. The distribution principle of the compensation fund is determined according to a specific formula that balances the countries' different emissions avoidance costs. In another study, the FutureLab identified strategies that succeeded in keeping the model system within the planetary boundaries on a permanent basis and without significant losses of prosperity based on a suitable temporal sequence and combination of political measures. This was done by applying the 'deep reinforcement learning' method to stylized models describing the global correlation between the carbon cycle and economic system.

05 SCIENTIFIC SUPPORT UNITS

- IT Services
- Administration
- Communications Team
- Directors' Staff
- Science Management & Transfer



The heart of PIK is a supercomputer that can be used to conduct experiments – using data only, rather than a lab. Here, PIK Director Johan Rockström explains the key role the computer plays in research at PIK to Greta Thunberg and other guests. Photo: Greb

IT Services

Heads: Karsten Kramer

Nine employees and two trainees in the IT Services department provide high-quality digital services that support the research conducted at PIK. The team plans, installs, and operates the entire IT infrastructure at the Institute. At the heart of the infrastructure is a supercomputer with a hierarchical mass data storage system. The department's portfolio of IT services also includes the provision and maintenance of personal and server computers, software, data networks, cloud services, and web portals along with the Institute's printer fleet, media technology, and data backup system. In 2019, the team provided IT services for over 300 employees as well as over 150 guests.

Helpdesk & PC management

This area groups together tasks like the central management of personal computers (PCs), laptops, public workstations (PC pools) as well as processing the majority of user queries and faults. Nearly 200 PCs were completely reconfigured and handed over to users in 2019. The team successfully processed and documented over 3,600 user queries.

Software & Systems

The spectrum of services in this area ranges from aspects of IT that are readily apparent, such as providing software, to all background services that are indispensable for the operation of the IT infrastructure. Over one hundred server systems are currently deployed and managed internally at the Institute based on a modern, secure visualization platform. Amazon's flexible external EC2 infrastructure was connected as a supplement to the Institute's IT infrastructure in 2019. The first computers and networks were deployed via this cloud infrastructure for projects with specific IT requirements.

Data Networks & Digital Communication

The consolidation of the Institute's data networks has been successfully completed. A new pair of routers ensures the high availability of the Internet connection for all internal data networks. Protection against attacks from the Internet has been completely upgraded. The availability of networks, email, and the website was excellent. In order to support video and web conferences, access was provided to the infrastructure of the German National Research and Education Network (DFN) for cross-institutional authentication of users. Over 100 video conferences were supported directly.

Data Storage & Data Backup

Reliable and secure file systems are provided centrally at the Institute for persistent storage of scientific data. Around 80 per cent of the overall capacity of 4 petabytes was occupied at the end of 2019. All centrally stored data are subject to automated versioning and backup. The tape library has been upgraded by 12 new high-performance tape drives. A private 'sync and share' service has been available for a number of years so data can be securely exchanged around the world.

High-performance Computing

High-performance computing is an indispensable prerequisite for developing and using numerical models and thus for PIK's scientific work. The Institute currently has access to 6,624 processor cores, around 6,000 tensor cores, and 26 terabytes of main memory. The supercomputer has not had any unplanned downtime since its commissioning in 2015. In order to ensure that this high level of availability is maintained in future as well, a maintenance contract was tendered across Europe and awarded in 2019.

Administration

Head: Sven Oliver Arndt
Deputy: Frauke Haneberg

The role of Administration is to facilitate ongoing scientific activities by ensuring that the Institute is operated in an orderly manner. The department carries out a wide range of tasks – from building measures to controlling, business trips, conference management, personnel and project support, and all the way to technical services – thereby ensuring that all the Institute's internal processes run smoothly and that legal regulations and specifications are complied with.

Head of Administration Sven Oliver Arndt receives the award for PIK's successful training work

Appointment processes

An important event for PIK and the Administration in February 2019 was the successful conclusion of the process to appoint a dual scientific leadership to the Institute's Board of Directors. This included the international appointment procedure for Professor Johan Rockström in a joint appointment with the University of Potsdam, and the appointment of Professor Ottmar Edenhofer in cooperation with the Technische Universität Berlin. This was followed by other successful joint appointments with Charité – Universitätsmedizin Berlin (Prof. Sabine Gabrysch), with the University of Potsdam (Prof. Ricarda Winkelmann), and with TU Berlin (Prof. Gunnar Luderer).

Digital Pathways & Processes

The Potsdam Institute's expertise is in high demand. This means a high degree of agility and effectiveness is required of its scientists as well as of its support staff and management. In this context, suitable, digitally supported processes can serve as an important mainstay, making it possible to overcome existing challenges more effectively. PIK has planned the process of digitalizing its administrative processes in three phases. The first phase, which focused on finances, has been completed. The second phase was launched in 2019 and addresses personnel processes. These are to include digitalized application processes, recruitment procedures, personnel administration, personnel management, business trips, and a self-service system for those working at PIK.

Based on the new and agile organizational structure in Administration, existing processes were optimized, open source and IP rules were established, and the management of the 153 ongoing projects with third-party funding was ensured.

Renovation of the historic main building

PIK is fortunate to be able to use various historic buildings on Telegrafenberg hill. Thanks to special funding, the renovation of historic Michelson House – the building on which PIK's logo is based – was begun in 2019. One aspect of this renovation work involves a general overhaul of the windows in line with the regulations for listed buildings. In addition, the area used by the Directors and their staff is being adapted to make it suitable for present needs, and the lounges for employees and guests are being updated to give them a more attractive look.

Professional training

PIK has offered apprenticeships for IT specialists and office managers for many years. In May 2019, the Institute was awarded the 'Euro Apprenticeship' plaque for its successful training work. Sven Oliver Arndt, Head of Administration at PIK, received the certificate from Wolfgang Spieß, Managing Director of the training department at the Chamber of Industry and Commerce Potsdam.

PIK has over 26,000 Twitter followers on its German and English channels. The Institute is also represented on Facebook and YouTube.

Link to Twitter

Communications Team

Head: Jonas Viering

The Communications team oversees the Institute's press and public relations work. It coordinates all PIK activities that aim at reaching journalistic media or a broader public and to this end develops strategies, concepts, and standards. Its tools extend from press releases to direct communication via channels such as social media to briefings for members of parliament. Moreover, it actively advises and supports the Institute's leadership in its communications with policymakers, businesses, and society. The team evaluates the response to its communication measures as a means to refine its impact-oriented PR strategy.

Record coverage in the media

PIK achieved the highest media coverage in its history thus far in 2019. Its researchers' findings were mentioned in more than 27,000 online articles worldwide. This represents an increase of 25 per cent over the previous year, which also saw a very strong performance. More than 16,000 articles referring to PIK with a total circulation of over 280 million copies were published in German print media – which likewise represented an increase of around 25 per cent. There was also a comparable increase in television and radio reports, with a total of over 400 segments. In this process, the Institute also further increased the number of leading media outlets responding to its work, from Süddeutsche Zeitung to the Economist. Once again, more than half of PIK's online coverage was in international outlets – from the Washington Post in the US to Xinhua in China. The Institute's leadership, the Directors, were covered most frequently in the media. However, the press office also communicated results from researchers on all levels across the Institute to the media, and 120 of them were included in reporting in 2019.

Reciprocal communication

Ongoing, active communication on the part of researchers along with growing public awareness of the climate issue has resulted in the media publishing more reports on science. These reciprocal communication dynamics were apparent in the Fridays for Future movement, in Germany's climate package, and in reporting on COP25 in Madrid, for example. Ottmar Edenhofer and his team presented options regarding Germany's climate policy in Der Spiegel and the business news magazine Wirtschaftswoche; upon the request of the Federal Government, Edenhofer contributed his climate economy expertise to the preparation of an assessment by the Council of Economic Experts. Johan Rockström also provided important impetus, including at the official briefing of the German Climate Consortium at the Federal Foreign Office.

Using new digital channels

PIK is also making increased use of digital media. This comprises direct communication to a certain extent, for example in the new querFELDein agricultural blog, in which PIK cooperates with other Leibniz institutes coordinated by the Leibniz Centre for Agricultural Landscape Research. The ongoing and complex process of redesigning the PIK website, which is set to be completed by mid-2020, also aims to enable more and improved direct communication and facilitate access to research findings. PIK doubled its followers on Twitter in 2019. It also cooperates with well-known YouTubers and podcasts. For example, YouTuber Mai Thi Nguyen-Kim explained Ottmar Edenhofer's concept for carbon pricing in two posts, with each of them being clicked on hundreds of thousands of times. Prominent podcasts such as 'Lage der Nation' and 'Aufwachen' also touched on content from PIK on a number of occasions.

From left to right:

Ottmar Edenhofer being interviewed by ARD on carbon pricing.

Johan Rockström on set with a documentary film team from France.

ZDF interviews Stefan Rahmstorf on extreme weather events.

Johanna Beckmann speaks with ZDF about weather data and the climate.

Photos: PIK

Directors' Staff *Head: Daniel Klingenfeld*

The Directors' Staff supports the Institute's leadership with its strategic and operational responsibilities. Among other things, this includes assistance in its scientific work, in preparing presentations, and with committee work, particularly the Board of Trustees of PIK. In addition, the team supports the Director Emeritus and prepares content on his behalf for the German Advisory Council on Global Change (WBGU). Its range of responsibilities also includes representing PIK externally on a case-by-case basis in its exchanges with policymakers, businesses, and society and in its role as a core partner in the Climate-KIC initiative.

PIK Directors Edenhofer and Rockström with high-ranking conference attendees at the Federal Foreign Office Photo: PIK

Talks at PIK and abroad, high-ranking visits to PIK, highlighted publications

The Directors' Staff was involved in the preparation of over 100 talks presented by the Institute's leadership at PIK and abroad in 2019 in addition to supporting a diverse range of other activities carried out by the Directors. It also organized a number of high-ranking visits to PIK by figures from politics, academia, and society, including by the King and Queen of the Netherlands H.M. Willem-Alexander and H.M. Máxima, Chair of the Munich Security Conference Wolfgang Ischinger, and Lord Mayor of Potsdam Mike Schubert. The presentation at the COP25 climate conference of the '10 New Insights in Climate Science 2019', which were developed within the Earth League and in cooperation with Future Earth, received a great deal of attention in particular. The Directors' Staff also provided scientific support for the WMO synthesis report 'United in Science'.

Berlin Climate and Security Conference

The Berlin Climate and Security Conference was hosted in June in cooperation with the Foreign Federal Office and the adelphi think tank with the aim of creating an international, high-profile forum for this topical issue. The Berlin Call for Action was published as the outcome of the summit. Foreign Minister Heiko Maas, former US Secretary of State John Kerry, and the President of Nauru Baron Waqa jointly opened the conference. Eight foreign ministers and more than 25 delegations attended the high-ranking event.

External representation of PIK, Climate-KIC, Conservation International

The Head of the Directors' Staff represented the Institute externally during talks and events at home and abroad. Further activities included university teaching posts as well as involvement in the training of diplomats at the Federal Foreign Office. Another focus of the team's work consisted of activities relating to the Climate-KIC initiative, particularly in its supervisory board. It also supported Johan Rockström's work as chief scientist at Conservation International and furthered a range of joint scientific publications.

Science Management and Transfer

Head: Ingo Bräuer

The Science Management & Transfer unit supports the strategic planning of PIK's research agenda and fulfils various functions at the interface between the research departments, Directors, administration, and supervisory bodies. It organizes knowledge and technology transfer activities and measures for scientific quality assurance,the implementation of open science, and support for young scientists.

Supporting young scientists

The team has been coordinating PIK's activities for the Geo.X geoscientific competence network since 2019. PIK was fortunately able to procure two PhD fellowships in the Geo.X Young Academy. Interactions between science and society were the theme of the Sixth Potsdam Summer School in 2019. The summer school was co-organized by PIK with the University of Potsdam and three other research institutions based in Potsdam (AWI, GFZ, IASS). Our information centre the 'Weather Factory' also provided over 400 pupils from Potsdam with insights into climate research.

Networking

The team represents PIK in a number of working groups in the Leibniz Association or Brandenburg state ministries, and in regional networks such as proWissen. It plays an active role in joint appointment procedures. It also supports internal networking at PIK, for example by organizing the PIK Research Days.

Open science

Open science is a key strategic focus for the Institute. Thanks to the support of the library, nearly 45 per cent of all journal articles published last year are now available on an open access basis via the publication database. The library also maintains the necessary infrastructure to publish research data and scientific software with a DOI number. All of PIK's large-scale models are now available via open access. In order to support quality management, all data used for publications are archived in an internal metadatabase.

Knowledge & Technology Transfer

Again in 2019, PIK pursued various knowledge and technology transfer activities. The PIK spin-off elena international GmbH received the Leibniz Start-Up Prize, which is worth 50,000 euros, for a new application focusing on the expansion of renewable energies in micro and isolated power grids. The patent application that was started together with the Indian Institute of Technology Madras in 2018 was successfully completed in 2019. Two additional and innovative educational models were developed and successfully implemented in 'BePerfekt – Befähigung von Personen und Teams in Transferstrukturen' (BePerfekt – Empowering individuals and teams in transfer structures), a joint project funded by the Federal Ministry for Education and Research. Work is also continuing on the preparation of a web portal that will pool information and qualification offers. As regards partnerships with businesses, the first license agreements for datasets were prepared and concluded.

Participants at a workshop that was a component of the BePerfekt 'Target Group Management' module on 11 April 2019 at the Leibniz Association headquarters in Berlin Photo: U. Sylla

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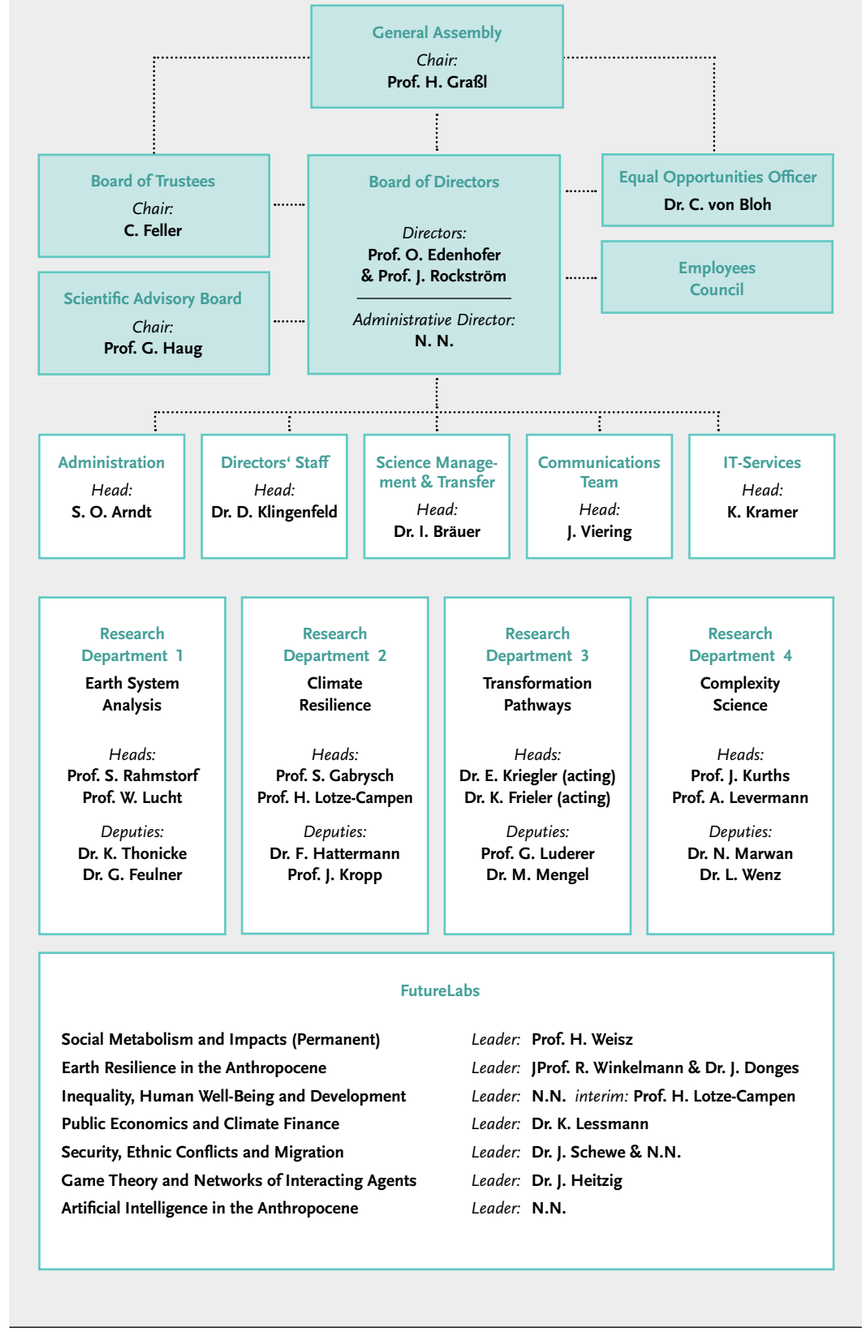
APPENDIX

[6.1] Organizational structure of PIK (as at 31.12.2019)



[6.2] Board of Trustees and Scientific Advisory Board

Board of Trustees (at 31.12.2019)

Name	Institution
Chair: Carsten Feller	Ministerium für Wissenschaft, Forschung und Kultur des Landes Brandenburg
Vice Chair: Professor Dr. René Haak	Bundesministerium für Bildung und Forschung
Vera Gäde-Butzlaff	GASAG Berliner Aktiengesellschaft
Prof. Dr. Hartmut Graßl	Max-Planck-Institut für Meteorologie, Hamburg
Prof. Dr.-Ing. Dr. Sabine Kunst	Humboldt-Universität zu Berlin
Prof. Dr. Peter Lemke	Alfred-Wegener-Institut für Meeresforschung, Bremerhaven
Klaus Milke	Germanwatch e.V., Bonn
Prof. Dr. Klaus Mühlhahn	Freie Universität Berlin
Prof. Dr. Robert Seckler	Universität Potsdam

Scientific Advisory Board (at 31.12.2019)

Name	Institution
Chair: Prof. Gerald H. Haug	Max-Planck-Institut für Chemie, Mainz
Vice Chair: Prof. Katherine Richardson	Sustainability Science Centre, University of Copenhagen, Denmark
Prof. Ginestra Bianconi	Queen Mary University of London, UK
Prof. Marc Fleurbaey	Princeton University, New Jersey, USA
Dr. Heide Hackmann	International Science Council (ISC), Paris, France
Prof. Dr. Vincent Heuveline	Heidelberg Institute for Theoretical Studies, Heidelberg
Prof. Ravi Kanbur	Cornell University, Ithaca, USA
Prof. Tim Lenton	University of Exeter, UK
Prof. Dr. Nebojsa Nakicenovic	International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria
Prof. Penny D. Sackett	Australian National University (ANU), Canberra, Australia
Prof. Dennis Snower, Ph.D.	Global Solutions Initiative, Berlin
Prof. Jessika Trancik	Massachusetts Institute of Technology, Cambridge, USA

[6.3] Awards and board appointments

Name	Award / Honour 2019	RD*
Bertram, Christoph	Outstanding reviewer 2018 in Environmental Research Letters, IOP Publishing	3
Boers, Niklas	Brandenburg Postdoc-Award, Ministerium für Wissenschaft, Forschung und Kultur des Landes Brandenburg	4
Ciemer, Catrin	Leibniz Promotionspreis 2019, Leibniz-Gemeinschaft	1
Donges, Jonathan	Heinz Maier-Leibnitz Preis 2019 Statistische Physik und Klimaforschung, DFG und BMBF	1
Gabrysch, Sabine	Recruiting Grant, Stiftung Charité	2
Gerten, Dieter	Highly Cited Researcher in Cross-Field, Clarivate Analytics	1
Kornhuber, Kai	Carl-Ramsauer-Preis, Physikalische Gesellschaft zu Berlin	1
Kretschmer, Marlene	Förderpreis der Deutsche Meteorologische Gesellschaft (DMG)	1
Kretschmer, Marlene	Wladimir Peter Köppen Preis für herausragende Dissertation, Cluster of Excellence CliSAP	1
Kriegler, Elmar	Highly Cited Researcher in Social Sciences, Clarivate Analytics	3
Kurths, Jürgen	Highly Cited Researcher in Geosciences, Clarivate Analytics	4
Kurths, Jürgen; Agarwal, Ankit; Marwan, Norbert; Cesar, Levke	Nonlinear Processes in Geophysics Paper of the Month for „Unravelling the spatial diversity of Indian precipitation teleconnections via a nonlinear multi-scale approach“	4 & 1
Lotze-Campen, Hermann	Highly Cited Researcher in Social Sciences, Clarivate Analytics	3
Luderer, Gunnar	Highly Cited Researcher in Cross-Field, Clarivate Analytics	3
Meinshausen, Malte	Highly Cited Researcher in Geosciences, Clarivate Analytics	3
Müller, Christoph	Highly Cited Researcher in Agricultural Sciences, Clarivate Analytics	2
Popp, Alexander	Highly Cited Researcher in Cross-Field, Clarivate Analytics	3
Rahmstorf, Stefan	Highly Cited Researcher in Cross-Field, Clarivate Analytics	1
Rahmstorf, Stefan	ZEIT Wissen-Preis Mut zur Nachhaltigkeit, ZEIT Verlagsgruppe	1
Reese, Ronja	Michelson-Preis für die beste Promotion des Jahrgangs (geteilt), Mathematisch-Naturwissenschaftliche Fakultät der Universität Potsdam	1
Reese, Ronja	Preis für die beste Promotion, Freunde und Förderer des PIK	1
Reese, Ronja	Publikationspreis für Nachwuchswissenschaftler/innen (geteilt), Leibniz-Kolleg Potsdam	1
Schauberger, Bernhard	Postdoc Academy for Transformational Leadership, Robert Bosch Foundation	2
Schuster, Antonia	Thaer-Förderpreis Master-Abschluss, Humboldt-Universität zu Berlin	1
Vinke, Kira	Potsdamer Nachwuchswissenschaftler-Preis, Landeshauptstadt Potsdam	FL Metab
Willner, Sven N.	Allianz Climate Risk Research Award 2019, Allianz Global Insurance	4

*RD – Research Department, FL Metab – FutureLab Social Metabolism

Name	Appointments / Election to Boards 2019	RD*
Blocher, Julia	Member of the Advisory Committee of the Platform on Disaster Displacement (PDD)	FL Metab
Blumenthal, Ines	Member of Advisory Board „Berufliche Bildung und BNE/Klimabildung“, Berliner Senatsverwaltung für Bildung, Jugend und Familie	2
Bodirsky, Benjamin Leon	Member of the local advisory board of the INI 2020 conference in Berlin	2
Edenhofer, Ottmar	Member of the Executive Board in the BMBF-funded „Dialog zur Klimaökonomie“	Director
Edenhofer, Ottmar	Member of ESRC Centre for Natural Capital Advisory Board	Director
Edenhofer, Ottmar	Member of Leibniz-Zentrum für Europäische Wirtschaftsforschung (ZEW)	Director
Edenhofer, Ottmar	Member of Advisory Board, Grantham Institutes at Imperial and LSE	Director
Edenhofer, Ottmar	Member of Advisory Board of newly founded Laudato Sí Research Institute	Director
Edenhofer, Ottmar	Member of Scientific Advisory Board of Scientists 4 Future	Director
Edenhofer, Ottmar	Chair des Deutsches Zentrum für Luft- und Raumfahrt e. V. Projektträger, Bereich Umwelt und Nachhaltigkeit, Abt. Klima- und Naturschutz, Internationale Zusammenarbeit	Director
Edenhofer, Ottmar	Member of Wissenschaftsplattform Klimaschutz – Lenkungskreis	Director
Edenhofer, Ottmar	Member of SDG Commission, founded by BMZ	Director
Edenhofer, Ottmar	Member of Deutsch-Chinesische Dialogforum, Robert-Bosch-Stiftung	Director
Edenhofer, Ottmar	Member of Working Group/AG Grenzwerte der Luftverschmutzung, Leopoldina	Director
Edenhofer, Ottmar	Member of Commission „Niedersachsen 2030“	Director
Edenhofer, Ottmar	Spokesperson of newly founded Berlin University Alliance Zentrum zum Klimawandel	Director
Feulner, Georg	Member and deputy speaker of Working Group „Digital Tools: Software and Services“ within the Priority Initiative „Digital Information“ of the German science organisations (for the Leibniz Association)	1
Feulner, Georg	Member of Steering Committee of Geo.X, Selection Committee of the Geo.X Young Academy	1
Krähnert, Kati	Member of the Executive Board in the BMBF-funded „Dialog zur Klimaökonomie“	2
Kriegler, Elmar	Member of the Executive Board in the BMBF-funded „Dialog zur Klimaökonomie“	3
Kriegler, Elmar	Co-Chair of the IAMC Scientific Working Group on Scenarios for Climate-Related Financial Analysis	3
Kropp, Jürgen	Panel Board Member Fundação para a Ciência e a Tecnologia, I.P. (FCT), Portugal	2
Kropp, Jürgen	Evaluator for Horizon 2020 project assessment	2
Kurths, Jürgen	Foreign Director, Wuhan International Joint Lab on Optoelectronics, China	4
Lessmann, Kai	Member of the Executive Board in the BMBF-funded „Dialog zur Klimaökonomie“	3
Lotze-Campen, Hermann	RD2 Representative Member in the Deutschen Agrarforschungsallianz (DAFA)	2
Lucht, Wolfgang	Member of Scientific Advisory Council, Scientists 4 Future Germany	1
Luderer, Gunnar	Scientific Committee Member of the Koperikus Project ENAVI	3
Malik, Aman	PhD Network Speaker for Section E, Leibniz PhD Network	3
Matthias, Vivien	External Reviewer in NASA's Heliophysics Living With a Star Science program	1
Pichler, Peter Paul	Scientific Advisory Board (Rebound Commission), Project #Nutzstoffe	FL Metab
Pietzcker, Robert	DEEDS Coordination Board Member & Task Lead	3
Popp, Alexander	Steering Committee member of Stanford Energy Modelling Forum (EMF33), model comparison study on bioenergy	3
Popp, Alexander	Member of expert commitee on global scenarios for IPBES	3
Reyer, Christopher	Expert Reviewer for the Austrian Climate Research Project Fund	2
Rockström, Johan	Co-Chair Earth Commission	Director
Rockström, Johan	Member of European Commission expert group: Mission Board for adaptation to climate change including societal transformations	Director
Rockström, Johan	Chair of International Advisory Board, Stockholm Resiliance Centre	Director
Rockström, Johan	Board Member REV Ocean	Director
Schellnhuber, Hans Joachim	Full Member of the Academy of Athens	Director Emeritus
Sprinz, Detlef	Advisory Board, Environmental Politics and Governance	FL Metab
Sprinz, Detlef	Advisory Board, EU Conference on Modelling for Policy Support	FL Metab
Stock, Manfred	Mitglied im Wissenschaftlichen Beirat für Klimaschutz und Klimafolgenanpassung des Landes Thüringen	2
Stock, Manfred	Mitglied der Steuerungsgruppe der Nachhaltigkeitsplattform Brandenburg und Leiter der AG Rahmenbedingungen der Transformation zu mehr Nachhaltigkeit im Land Brandenburg	2
Stock, Manfred	Wissenschaftlicher Berater im Kommunalen Nachbarschaftsforum Berlin-Brandenburg zum Jahresthema 2019: Wasser	2
Ueckerdt, Falko	IEA expert group on grid integration of wind and solar power	3
Ueckerdt, Falko	IEA group on Projected Costs of Generating Electricity	3
Vinke, Kira	Co-Chair of the Council on Civilian Crisis Prevention and Peacebuilding of the German Federal Government.	FL Metab
Vinke, Kira	Runder Tisch der Bundesregierung „Internationalisierung von Bildung, Wissenschaft und Forschung“ im Zyklus „Meere und Ozeane.“ Sprecherin der Gruppe Klimawandel und Klimaschutz in Ozean, Küsten und Polarregionen	FL Metab
Weisz, Helga	Chair of the section „socio-economic metabolism“ of the International Society for Industrial Ecology	FL Metab
Weisz, Helga	Member of the IIASA Council and Chair of the German Association for the Advancement of IIASA	FL Metab
Weisz, Helga	Member of UNEP's International Research Panel	FL Metab

*RD – Research Department, FL Metab – FutureLab Social Metabolism

[6.4] Appointments, habilitations and scholarships

Name	Appointment	RD*
Edenhofer, Ottmar	Appointment as Director of PIK	Director
Gabrysch, Sabine	Professor for Climate Change and Health at Charité – Universitätsmedizin Berlin	2
Luderer, Gunnar	Professorship for Global Energy Systems Analysis at Technische Universität Berlin	3
Rockström, Johan	Appointment as Director of PIK	Director
Rockström, Johan	Professorship in Earth System Science at University of Potsdam	Director

Name	Habilitation	RD*
Marwan, Norbert	"Recurrence Plot Techniques for the Investigation of Recurring Phenomena in the System Earth" at University of Potsdam	4

Name	Universities / Fellowships / Scholarships	RD*
Boers, Niklas	Freigeist Fellowship, Volkswagen Stiftung	4
Botta, Nicola	Adjunct Associate Professor in Computer Science (Computing for Sustainability), Chalmers University of Technology, Göteborg, Sweden	4
Brugger, Julia	Abschlussstipendium Promotion, Potsdam Graduate School	1
Donges, Jonathan	Visiting Research Collaborator at Princeton Environment Institute, Princeton University, USA	1
Kitzmann, Niklas	Doctoral Fellowship of Geo.X Young Academy, Geo.X Research Network for Geosciences in Berlin and Potsdam	1
Kitzmann, Niklas	Exposé-Scholarship, Studienstiftung des deutschen Volkes e.V.	1
Kurths, Jürgen	Guest Professor, Chinese Academy of Science, Institute of Atmospheric Physics Peking, China	4
Maskell, Gina	Doctoral Fellowship of Geo.X Young Academy, Geo.X Research Network for Geosciences in Berlin and Potsdam	2
Scheibe, Anne	Doctoral Fellowship of Geo.X Young Academy (unfunded), Geo.X Research Network for Geosciences in Berlin and Potsdam	4
Shukla, Roopam	Doctoral Fellowship of Geo.X Young Academy (unfunded), Geo.X Research Network for Geosciences in Berlin and Potsdam	2
Stenzel, Fabian	Stipendium für 3 monatigen Forschungsaufenthalt im Rahmen des YSSP Programms am IIASA, Laxenburg, Österreich	1
Wenz, Leonie	Ciriacy-Wantrup Postdoctoral Fellowship for the academic year 2018-2019, University of California, Berkeley, USA	4
Wiedermann, Marc	Postdoctoral Fellowship of Geo.X Young Academy (unfunded), Geo.X Research Network for Geosciences in Berlin and Potsdam	4
Zeitz, Maria	Fulbright Stipendium im Doktorandenprogramm 2019-2020, Fulbright Germany	1

*RD – Research Department

[6.5] Third-party projects

Projects started in 2019

Acronym	Name of project	Ref. Nr.	RD*	Funding agency	Duration
COMFORT	Our common future ocean – quantifying coupled cycles of carbon, oxygen, and nutrients for determining and achieving safe operating with respect to tipping points	96129	1	Europäische Union	01.09.2019 – 31.08.2023
DFG Preis	Heinz Maier-Leibniz-Preis	9780	1	Deutsche Forschungsgemeinschaft	01.12.2019 – 30.11.2020
Geo.X RD 1	Komplexe Netzwerke und Tipping Elements im urbanen Kontext	9490	1	Geoforschungszentrum	01.10.2019 – 30.09.2022
HASH	Hysterese des Antarktischen Eisschildes	9776	1	Deutsche Forschungsgemeinschaft	01.04.2020 – 31.03.2023
NZ-PB	New Zealand Planetary Boundaries project – translation of the framework and publication of report	95203	1	Sovereign in Right of New Zealand	27.08.2019 – 29.02.2020
PalMod-2-CC.1	Entwicklung des PICO-Modells zu einem „pop-up"-Modell für transiente Glazialsimulationen	91179	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2019 – 30.09.2022
PalMod-2-WP1.3 TP4	Transiente Rechnungen des Systems Inlandeis, feste Erde und Klima mit CLIMBER-X zur Untersuchung von Prozessen zu Beginn der letzten Eiszeit	91177	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2019 – 30.09.2022
PERSEVERE	Persistente Sommerextreme in Europa aufgrund von Resonanzphänomenen in der Atmosphäre	91178	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2019 – 30.09.2022
Planetary Boundaries	Planetary Boundaries – Planetare Belastungsgrenzen und Bezüge zu NRW	95201	1	Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz NRW	01.04.2019 – 31.03.2020
WS Eisschild	Die Dynamik der polaren Eisschilde im Wandel der Zeit	9097	1	Heraeus-Stiftung	2019
XMELT	Die Auswirkung extremer Schmelzereignisse auf die zukünftige Massenbilanz des grönländischen Eisschildes	9779	1	Deutsche Forschungsgemeinschaft	18.03.2019 – 17.03.2022
CASCADES	Cascading climate risks: towards adaptive and resilient European societies	96126	1,2 & 3	Europäische Union	01.09.2019 – 31.08.2023
TiPACCs	Tipping Points in Antarctic Climate Components	96128	1 & 4	Europäische Union	01.08.2019 – 31.07.2023
AgCLIM50 III	Challenges of global agriculture in a climate change context – Focus on extreme events	95200	2	Wageningen Economic Research	14.02.2019 – 13.10.2019
BioClimaPaths	Bewertung der klimabedingten sozial-ökologischen Auswirkungen und Möglichkeiten resilienter Pfade der EU-Bioökonomie	91182	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.11.2019 – 31.10.2021
CliMobCity	2050 Climate-friendly Mobility in Cities	96131	2	Interreg	01.08.2019 – 31.07.2022
CROSSDRO	Sektoralübergreifende Wirkungsanlayse von Trockenperioden in komplexen europäischen Flusseinzugsgebieten	91171	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2019 – 31.08.2022
Fable India	Contribution to a FABLE land use analysis for India	9491	2	SDSN Association	02.08.2019 – 31.10.2020
Food Economic Commission	Valuing food in the Athropocene: Building the knowledge, data and tools to enable the transformation of the food and land use system	95208	2	EAT Foundation	01.09.2019 – 30.04.2020
GhanAgrica	Durchführung einer Studie auf Distriktebene im Norden Ghanas zur Validierung von Klimarisikoanalyseergebnissen auf nationaler Ebene unter Einbindung lokaler Stakeholder und als Beitrag zur Erstellung von Entwicklungsplänen auf Distrikt-Ebene	9492	2	Deutsche Gesellschaft für Internationale Zusammenarbeit	01.11.2019 – 31.12.2020

RD – Research Department, VB – Vorstandsbereich, FL Metab – FutureLab Social Metabolism

Acronym	Name of project	Ref. Nr.	RD*	Funding agency	Duration
Geo.X RD2	Integrating remote sensing and mixed social science methods for studying climate impact & adaptation in tropical agroecosystems	9489	2	Geoforschungszentrum	01.11.2019 – 31.10.2022
High End	High End Szenarien: Nationale Anpassungsoptionen bei einem starken Klimawandel	95209	2	adelphi resaerch gGmbH	15.10.2019 – 30.11.2022
Konfliktkultur	Eine neue Konfliktkultur für die Energiewende	9225	2	Stiftung Mercator	01.08.2019 – 31.07.2022
FOCUS	Ernährungssicherheit und nachhaltige Existenzgrundlagen in Küstenregionen in der Verbindung von Land- und Ozeanressourcen	91167	2	Bundesministerium für Bildung und Forschung / Forschungszentrum Jülich	01.08.2019 – 31.07.2022
IIASA 2019	Führung der Geschäftsstelle der „Vereinigung zur Förderung des Internationalen Instituts für Angewandte Systemanalyse e.V.“	95198	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	2019
I-MAESTRO	Innovative Waldbewirtschaftungsstrategien für eine resiliente Bioökonomie unter zunehmenden Risiken	91166	2	Bundesanstalt für Landwirtschaft und Ernährung / Fachagentur Nachwachsende Rohstoffe e.V.	01.06.2019 – 31.05.2022
MAPPY	Multisectoral Analysis of climate and land use change impacts on Pollinators, Plant diversity and crop Yields	91174	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2019 – 31.08.2022
MECCA	Entwicklung, Simulation und Analyse von Szenarien zur Abschätzung und Reduzierung von Klimarisiken	91170	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2019 – 30.08.2022
SALBES	Szenarien für Biodiversität und Ökosystemleistungen von Agrarlandschaften	91165	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.05.2019 – 30.04.2022
UmRisk	Ökonomie des Klimawandels – Themenkoordination: Umgang mit Klimarisiken	91181	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2019 – 31.10.2022
SNRD Afrika	Policy brief on the impacts of climate change adaption on youth employment and migration in Africa	9487	2	Deutsche Gesellschaft für Internationale Zusammenarbeit	01.07.2019 – 15.11.2019
DBU-Stipendium	Analyse und Bewertung von Politikinstrumenten zur Sicherstellung einer ökonomisch effizienten, gerechten und ökologisch nachhaltigen Allokation von globalen Süsswasserressourcen	9095	2	Deutsche Bundesstiftung Umwelt	01.01.2019 – 31.12.2019
Ursache-Wirkungsanalyse	Ursache-Wirkungsanalyse von klimarelevanten Ereignissen	95205	2	Deutsche Bahn	01.11.2019 – 31.12.2020
YSSP 2019	Unterstützung des Young Scientist Summer Programme 2019	91161	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	2019
BEST	Bioenergy's role in a sustainable future: An assessment of environment, technology, supply chains and and uncertainty	9488	3	Norges teknisk-naturvitenskapelige universitet (NTNU)	01.03.2019 – 31.08.2022
CHIPS	Klimaschäden und Klimapolitik in heterogenen Gesellschaften	91172	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2019 – 31.08.2022
DIATRANS_PIK	Ökonomie des Klimawandels-Themenkoordination: Klimaschutz und Transformation	91180	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2019 – 31.10.2022
ENGAGE	Exploring National and Global Actions to reduce Greenhouse gas emissions	96130	3	Europäische Union	01.09.2019 – 31.08.2023
FUME	Future Migration Scenarios for Europe	96132	3	Europäische Union	01.12.2019 – 30.11.2022
NAVIGATE	Next generation of advanced integrated assesment modelling to support climate policy making	96125	3	Europäische Union	01.09.2019 – 31.08.2023
IKI-Access	Entwicklung eines Leitsystems zur Nutzung des ISIMIP-Archivs von Klimafolgensimulationen: Neue Ansätze zur formalen und inhaltlichen Qualitätssicherung	91164	3	Bundesministerium für Bildung und Forschung / VDI-VDE	01.04.2019 – 31.03.2022
LAMACLIMA	Landmanagementstrategien zur Klimavermeidung und Klimaanpassung	91168	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2019 – 31.08.2022
LOD-GEOSS	Linked Open Data und Nutzung des Globalen Erdbeobachtungssystems GEOSS in der Energiesystemanalyse	91169	3	Bundesministerium für Bildung und Forschung / Forschungszentrum Jülich	01.08.2019 – 31.07.2022
QTFINANZ	Koordiantion des Querschnittsthemas Finanzmärkte, Finanzwirtschaft und Finanzierung des Dialogs zur Klimaökonomie im Rahmen der Begleitaktivitäten des Förderschwerpunktes Ökonomie des Klimawandels	91176	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2019 – 31.10.2022
SHAPE	Nachhaltige Entwicklungspfade zur Förderung menschlichen Wohlergehens bei gleichzeitigem Schutz des Klimas und des Planeten Erde	91173	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2019 – 31.08.2022
RECEIPT	remote climate effects and their impact on European sustainability, policy and trade	96127	3 & 4	Europäische Union	01.09.2019 – 31.08.2023
BYMARKA	Environmental Footprints of Cities: A New Approach	9486	4	Norges teknisk-naturvitenskapelige universitet (NTNU)	01.07.2019 – 31.12.2021
CAFE	Climate Advanced forecasting of sub-seasonal extremes	96123	4	Europäische Union	01.03.2019 – 28.02.2023
TiPES	Tipping Points in the Eath System	96124	4	Europäische Union	01.09.2019 – 31.08.2023
elena	Electricity Networks Analysis	9484	4	Leibniz-Gemeinschaft	01.01.2019 – 31.12.2022
Complex networks	Dynamical Phenomena in Complex Networks	9751	4	Humboldt-Universität Berlin	01.01.2019 – 31.12.2019
Condynet 2	Kollektive Nichtlineare Dynamik Komplexer Stromnetze: Stabilität, Effizienz und Risiken	91159	4	Bundesministerium für Bildung und Forschung / Forschungszentrum Jülich	01.01.2019 – 30.12.2021
OPTES	Optimierung von Testdesigns zur Darstellung der Freiheit von Populationen von Infektionen	91163	4	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.03.2019 – 28.02.2022
PostDocPreis	PostDoc Preis des Landes Brandenburg	90102	4	Ministerium für Wissenschaft, Forschung und Kultur des Landes Brandenburg	2019/2020
RECAM	Real Estimate Climate Asset Mapping Project	9829	4	EIT – European Institute of Innovation & Technology	01.10.2019 – 31.12.2019
SEM of ISIE	Conference of the Section Socio-economic metabolism of ISIE	9094	4	Deutsche Forschungsgemeinschaft	13. – 15.05.2019
Synchronisation	Generalisierte Synchronisation auf komplexen Netzwerken und dynamische Stabilität in künftigen Stromnetzen	9777	4	Deutsche Forschungsgemeinschaft	01.08.2019 – 31.07.2022
NEMACS	Nichtlineare Empirical Mode-Analyse komplexer Systeme: Entwicklung eines allgemeinen Ansatzes und Anwendung in der Klimaforschung	9778	4	Deutsche Forschungsgemeinschaft	01.06.2019 – 31.05.2022
HMCCC Report	HMCCC Baseline Report Publication	95204	FL Metab	Deutsche Gesellschaft für Internationale Zusammenarbeit	11.10.2019 – 30.11.2019
Cambridge	Services for Cambridge University Press	95202	VB	Cambridge University Press	2019 – 2020
CI-Collaboration	Strategic Collaboration between Conservation International and PIK	9485	VB	Conservation International	01.04.2019 – 30.06.2021
Food System Targets	Operationalizing Food System Targets for Health and Sustaibability	9830	VB	EIT – European Institute of Innovation & Technology	01.10.2019 – 31.12.2019
Lenkungskreis	Lenkungskreis der Wissenschaftsplattform Klimaschutz	95206	VB	Deutsches Luft- und Raumfahrtzentrum Projektträger	18.12.2019 – 04.03.2022
Nobel Summit 2020	Nobel Summit 2020	9098	VB	div.	2019/2020

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Acronym	Name of project	Ref. Nr.	RD*	Funding agency	Duration
Ongoing projects 2019					
AntBase	Systematische Untersuchung der Rolle der Bodentopographie für die Marine Eisschild – Inatabilität	9765	1	Deutsche Forschungsgemeinschaft	01.08.2016 – 30.12.2020
BIBS	BIBS-Verbund: Bridging in Biodiversity Science – Teilprojekt 4: Modellierung Pflanzen-Boden Interaktionen	91119	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.03.2016 – 28.02.2019
BioCAP-CCS	Globales Biomasse-CCS zur Erreichung des 1,5°-Ziels: Analyse von Potenzialen, Nebenwirkungen und Synergieeffekten für atmosphärischen C-Entzug und C-Sequestrierung durch Biomasse-Karbonisierung	91132	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.04.2017 – 30.09.2019
CE-Land II Gerten	Klima-Engineering über Land: Umfassende Evaluierung von Auswirkungen terrestrischer Carbon-Dioxide-Removal-Methoden auf das Erdsystem	9766	1	Deutsche Forschungsgemeinschaft	01.09.2016 – 31.8.2019
CLIMAX_AmaMP	Die Rolle des Amazonasbeckens für den Feuchttransport zur Verbesserung der Niederschlagsvorhersage in Südamerika	91121	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.08.2016 – 31.07.2020
CO-MICC	Unterstützung des Risikomanagements und der Anpassung auf mehreren räumlichen Skalen: Ko-Entwicklung von Methoden zur Nutzung unsicherer multimodellbasierter Informationen zu süsswasserbezogenen Gefahren des Klimawandels	91145	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	18.09.2017 – 17.09.2020
GIS-Tip	Die Rolle schneller dynamischer Prozesse für die Stabilität des Grönländischen Eisschildes	9775	1	Deutsche Forschungsgemeinschaft	01.07.2018 – 30.06.2021
NAGRA	Modeling of long-term future climate evolution using a hierarchy of Earth systems models	9480	1	National Cooperative for the Disposal of Radioactive Waste	01.11.2018 – 31.11.2021
PalMod-1-1-TP5	Kopplung von Eisschildmodellen für Paläo-Simulationen	91116	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2015 – 31.07.2020
PalMod-1-3-TP4	Transiente Klimasimulationen zu glazialen Zyklen und Klimaereignissen	91115	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2015 – 31.08.2019
PalMod-2-1-TP7	Transienste glaziale Simulationen mithilfe des Modells CLIMBER-2 mit einem verbesserten 3-D-Ozean-Kohlenstoffkreislauf	91114	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2015 – 31.12.2019
PalMod-2-2-TP2	Terrestrischer Kohlenstoffkreislauf: Modellierung des Permafrostkohlenstoffs mithilfe des Modells CLIMBER-2	91111	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.08.2015 – 31.07.2019
PalMod-2-3-TP2	Methankreislauf: Modellierung der Methanemmissionen von Feucht- und Permafrostgebieten mithilfe von LPJmL	91112	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.08.2015 – 31.07.2019
PISM-FESOM	Abschätzung des zukünftigen Antarktischen Eisverlustes mit dem gekoppelten Modell PISM-FESOM	9773	1	Deutsche Forschungsgemeinschaft	01.08.2017 – 31.07.2019
Planetary Boundaries	One Planet Appoaches – Operationalisierung der Planetaren Leitplanken (Planetary Boundaries) für und mit der Wirtschaft und Unternehmen	9473	1	WWF	26.03.2018 – 31.03.2021
SacreX	Stability of atmospheric circulation and its relation to extreme weather	91104	1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.03.2014 – 28.02.2019
SustainCBW	Towards a future sustainable world where climate, biodiversity, natural resources and human well-being are safeguarded	9469	1	Leibniz-Gemeinschaft	01.08.2017 – 31.12.2019
Umweltprogramm 2030	Den ökologischen Wandel gestalten – Umsetzung und Fortschreibung des Integrierten Umweltprogramms 2030	95196	1	Öko-Institut Freiburg	01.11.2018 – 28.02.2021
DOMINOES	Domino effects in the Earth system: can Antartica tip climate policy	9467	1 & 4	Leibniz-Gemeinschaft	01.01.2017 – 31.12.2019
GOTHAM	Global beobachtete Telekonnektionen und ihre Rolle und Darstellung in verschiedenen Atmosphären-Modellen	91122	1 & 4	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.08.2016 – 30.06.2020
ADAPT	Ökonomie des Klimawandels: Unterstützung mongolischer Haushalte bei der Anpassung an den Klimawandel	91162	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.12.2018 – 30.11.2021
AdaptAgrica	Climate risk analysis for identifying and weighting adaption investments in Africa	9481	2	Deutsche Gesellschaft für Internationale Zusammenarbeit	01.09.2018 – 31.12.2019
AgRATI	Agricultural Risk Assessment Tool for Insurances in East Africa	9824	2	EIT – European Institute of Innovation & Technology	01.09.2017 – 28.02.2019
AgRATI India	Agricultural Risk Assessment Tool for Insurances in India	9825	2	EIT – European Institute of Innovation & Technology	01.03.2018 – 31.12.2019
ASCI-Unilver	Adding Simulations of new Crops to the ISIMIP archive	95192	2	Unilever	bis 06/2019
CAREC 2	Climate Adaption and Mitigation Program for the Aral Sea Basin	95191	2	Institution Regional Environmental Centre for Central Asia	02.05.2018 – 30.06.2019
CIREG	Klimainformation zur integrierten Nutzung erneuerbarer Energien in Westafrika	91146	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.02.2018 – 31.01.2021
CLIMASTEPPE	Lösungsansätze für klima-smarte Landnutzung in Russlands Trockensteppen, Teilvorhaben: Dynamik der Treibhausgas-Emissionen und landwirtschaftlichen Erträge sowie deren Austauschbeziehungen	91153	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.11.2018 – 28.02.2021
CLIMOD	Integrating climate impact and spatial microsimulation modelling for improved climate change adaptation decision-making	96121	2	Europäische Union	02.04.2018 – 31.03.2020
ClimSec Sahel	Abschätzung von klimabedingten Auswirkungen auf die Wasserverfügbarkeit, landwirtschaftliche Produktion, Ernährungssicherheit und Migration in Burkina Faso und Mali	9482	2	Auswärtiges Amt	01.11.2018 – 31.12.2020
CLIM4Vitis	Climate change impact mitigation for European viticulture: knowledge transfer for an integrated approach	96122	2	Europäische Union	01.09.2018 – 31.08.2021
COACCH	CO-designing the Assessment of Climate Change costs	96120	2	Europäische Union	01.12.2017 – 31.05.2021
C2P2	A Symbolic Agent-Based Network Platform Linking Expert Knowledge and Machine Learning for Systemic Risk Mitigation	95199	2	Columbia University	01.12.2018 – 30.06.2020
DENDROKLIMA	Jahrringanalysen auf dem Telegrafenberg (Potsdam) – Nutzung dendrochronologischer Daten Deutschlands zur modellbasierten Analyse der Wirkung von Klimaänderungen auf Waldökosysteme	91124	2	Bundesanstalt für Landwirtschaft und Ernährung	01.09.2016 – 31.08.2019
EUCalc	EU Calculator: pathways and trade-offs towards a sustainable low-carbon Energie Union	96117	2	Europäische Union	01.11.2016 – 28.02.2020
FORMASAM	Forest management scenarios for adaptation and mitigation	9475	2	European Forest Institute	01.04.2018 – 31.03.2020
GeoCare	Geoinformationstechnologie für landwirtschaftlichen Ressourcenschutz und Risikomanagement	95174	2	Universität Kiel	01.01.2017 – 30.09.2019
HyFly	Effektive Stratgien zur Kontrolle und Umgang mit Ausbreitungswegen von Erregern im Luftverkehr	91123	2	Bundesministerium für Bildung und Forschung / Forschungszentrum Jülich	01.07.2016 – 31.08.2019
IKI OASIS	Oasis Platform for Climate and Catastrophe Risk Assessment – Asia	9478	2	OASIS Loss Modelling Framework Limited/BMBUB	01.07.2018 – 30.06.2020
IMpeTUs	Climate Change Impacts on Migration and Urbanization	9472	2	Leibniz-Gemeinschaft	01.03.2018 – 28.02.2021
Insurance	Oasis Innovation Hub for Catastrophe and Climate Risk Assessment	96118	2	Europäische Union	01.05.2017 – 30.04.2020
KNOW	Kohlenstoff- und Holzvorräte des Deutschen Waldes – Verbesserung der Projektionen des aktuellen und künftigen CO_2-Vorrates mittels ökophysiologischer und empirischer Wachstumsmodelle	91187	2	Fachagentur Nachwachsende Rohstoffe e.V.	01.03.2020 – 28.02.2022

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Acronym	Name of project	Ref. Nr.	RD*	Funding agency	Duration
MACMIT	Mitigation von Klimawandel in der Landwirtschaft durch nachhaltiges Ressourcenmanagement	91106	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.08.2014 – 30.11.2019
NICCSA	Unterstützung des National Institute for Climate Change Studies and Actions	9477	2	Deutsche Gesellschaft für Internationale Zusammenarbeit	01.07.2018 – 31.08.2020
OptAKlim	Optimierung von Anbaustrategien und -verfahren zur Klimaanpassung – Analyse und Bewertung auf Landschaftsebene unter besonderer Berücksichtigung von Interaktionen mit dem Pflanzenschutz, der Produktivität, der Fruchtartenverteilungen und den THG-Emissionen	91151	2	Bundesanstalt für Landwirtschaft und Ernährung	21.08.2018 – 20.10.2021
PIKeeBB	Etablierung des Themas Klimawandel und Anpassungsstrategien in die berufliche Bildung auf Basis der Online-Plattform KlimafolgenOnline-Bildung.de	91142	2	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit/FZ Jülich	01.09.2017 – 31.12.2019
ProgRAMM	Anpassung an langfristige Risiken durch klimasensitive Schadorganismen: Proaktive Pflanzengesundheitliche Risikoanalyse durch Modellierung und Monitoring	91150	2	Bundesanstalt für Landwirtschaft und Ernährung	15.08.2018 – 14.10.2021
REFORCE	Resilience mechanisms for risk adapted forest management under climate change	91133	2	Bundesanstalt für Landwirtschaft und Ernährung	01.04.2017 – 31.03.2020
SIM4NEXUS	Sustainable integrated management for the nexus of water-land-food-energy-climate for a resource efficient Europe	96115	2	Europäische Union	01.06.2016 – 31.05.2020
SLICE	Short- and Long-Term-Impacts of Climate Extremes – identifying key impact channels and effective strategies for long-term economic development under climate change	91154	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.11.2018 – 31.10.2021
STADTGRÜN	Stadtgrün wertschätzen: Bewertung, Management und Kommunikation als Schlüssel für eine klimaresiliente und naturnahe Grünflächenentwicklung – Modellierung von Klimaeffekten durch Stadtgrün	91127	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.11.2016 – 31.10.2019
Stocktake	Der Global Stocktake unter dem Übereinkommen von Paris: Ausgestaltung, Methodik und Prozess	95187	2	Umweltbundesamt	01.01.2018 – 30.09.2019
SusFood	Nachhaltige Nahrungsmittelproduktion während des Klimawandels in Südasien	91137	2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.07.2017 – 30.06.2019
SUSTAg	Bewertung von Handlungsoptionen für eine nachhaltige Intensivierung der Landwirtschaft und eine integrierte Produktion von Nahrungs- und Nichtnahrungsmitteln auf verschiedenen Skalen	91120	2	Bundesministerium für Bildung und Forschung / Forschungszentrum Jülich	01.04.2016 – 31.08.2019
Tourismus	Folgen des Klimawandels für den Tourismus in den deutschen Alpen- und Mittelgebirgsregionen und Küstenregionen sowie auf Badetourismus und flussbegleitende Tourismusformen (z.B. Radwander- und Wassertourismus)	95185	2	Umweltbundesamt/Fresh-Thougts-Consulting GmbH	17.08.2017 – 31.07.2020
TransformAdapt	Vom Mainstreaming zur transformativen Anpassung an den Klimawandel	95188	2	Umweltbundesamt	15.02.2018 – 15.12.2020
WAPO	Nachhaltige Wasserpolitik	95197	2	adelphi consult GmbH	01.09.2018 – 31.05.2019
Wetlands 3	Adapt to climate change in the Upper Niger Basin and the Inner Niger Delta	95190	2	Wettlands International	bis 02/2019
AHEAD	Unilateral Action to Make a Global Difference: Towards Horizontal Leadership and Vertical Latitude for Germany & California	9219	3	Stiftung Mercator	01.01.2016 – 30.04.2019
BeSmart	Intelligente Strommessung und dynamische Tarife: Konsumentscheidungen, rechtliche Rahmensetzung und Wohlfahrtseffekte	91155	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.11.2018 – 31.10.2021
CD-LINKS	Linking Climate and Development Policies – Leveraging International Networks and Knowledge Sharing	96111	3	Europäische Union	01.09.2015 – 31.08.2019
CDR-MIA	Modellvergleichende Analyse von CDR Methoden	9767	3	Deutsche Forschungsgemeinschaft	01.01.2017 – 31.12.2019
CEMICS 2	Climate Engineering im Kontext von Emissionsminderungsstrategien: Illusion, Komplement oder Substitut (TP Edenhofer)	9769	3	Deutsche Forschungsgemeinschaft	01.03.2017 – 28.02.2020
CEMICS 2	Climate Engineering im Kontext von Emissionsminderungsstrategien: Illusion, Komplement oder Substitut (TP Kriegler)	9768	3	Deutsche Forschungsgemeinschaft	01.04.2017 – 31.03.2020
COMMIT	Modelling of national greenhouse-gas emission mitigation policies and the relationship with global low emission pathways	95193	3	PBL Netherlands Environmental Assessment Agency	22.12.2017 – 21.06.2020
CRESCENDO	Coordinated Research in Earth Systems and Climate: Experiments, Knowledge, Dissemination and Outreach	96112	3	Europäische Union	01.11.2015 – 30.10.2020
DEEDS	Dialogue on European decarbonisation strategies	96119	3	Europäische Union	01.10.2017 – 30.09.2020
DIPOL	Entwicklung von Transformationspfaden zu einer emissionsneutralen Gesellschaft	91149	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.09.2018 – 31.08.2021
Elektromobilität VW	Transformation Towards Sustainable Transport Systems – The Next Generation Policies	9474	3	Volkswagen AG	01.06.2018 – 31.05.2020
ENavi	Systemintegration und Vernetzung der Energieversorgung	91126	3	Bundesministerium für Bildung und Forschung / Forschungszentrum Jülich	01.10.2016 – 30.09.2019
ENGAGE	Economic-Growth Impacts of Climate Change	9462	3	Leibniz-Gemeinschaft	01.01.2016 – 29.02.2020
FINFAIL	Finanzielle Marktversagen, das Verhalten von Investoren und Implikationen auf den Klimawandel	91135	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.07.2017 – 30.06.2022
IF	Finanzinstrumente für Investitionen in emissionsarme Infrastruktur	91157	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.07.2018 – 30.06.2021
IMPACT	Entwicklungsländer der kleinen Inselstaaten mit Fokus auf die Regionen Karibik und Pazifik und am wenigsten entwickelte Länder mit Fokus auf Subsahara Afrika	9466	3	BMUB/Climate Analytics	01.10.2016 – 30.12.2020
IMPREX	Improving predictions and management of hydrological extremes	96113	3	Europäische Union	01.10.2015 – 30.09.2019
INNOPATH	Innovation pathways, strategies and policies for the Low-Carbon Transition in Europe	96116	3	Europäische Union	01.12.2016 – 30.11.2020
ISIMIP2b	Klimafolgenabschätzung nach Paris	91128	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.11.2016 – 31.03.2019
KLIF	Integrierte Finanz- und Klimapolitik: Handlungsspielräume für Nationalstaaten unter Wettbewerbsdruck	9771	3	Deutsche Forschungsgemeinschaft	01.01.2018 – 31.12.2020
LFV-Krisen	Modellierung internationaler Migration unter Klimawandel und veränderlichen Einwanderungspolitiken – Entwicklung eines Grundmodells	9471	3	Leibniz-Forschungsverbund Krisen	01.11.2017 – 31.03.2019
PEGASOS	Die politische Ökonomie eines globalen Kohleausstiegs – Modellierung und Szenarienanalysen	91158	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.12.2018 – 30.11.2021
PEP1p5	IPCC-Sonderbericht zu 1,5 Grad – Verbundprojekt: Klimapolitische Maßnahmen und Transformationspfade zur Begrenzung der globalen Erwärmung auf 1,5°C – Teilprojekt 1: Koordination und 1,5°C-konsistente Entwicklungspfade	91134	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.05.2017 – 30.10.2019
ROCHADE	Klimapolitik und Vermeidungsstrategien in global vernetzten und in sich entwickelnden Volkswirtschaften: Die Rolle von Strukturwandel und Verteilungseffekten	91160	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2018 – 30.09.2021
START	Strategische Szenarienanalyse	91144	3	Bundesministerium für Bildung und Forschung / Forschungszentrum Jülich	01.10.2017 – 30.04.2020

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Acronym	Name of project	Ref. Nr.	RD*	Funding agency	Duration
Triple F	Die Zukunft fossiler Energieträger im Zuge von Treibhausgas-neutralität	91152	3	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2018 – 30.09.2021
ISIpedia	Die offene Klimafolgen-Enzyklopädie	91140	3 & 2 & 1	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	18.09.2017 – 17.09.2020
SENSES	Angewandte Klimaszenarien: Perspektiven und Handlungsoptionen	91141	3 & 2	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	18.09.2017 – 17.09.2020
Challenge 2018	Restoring land use to support cities	9483	4	ARUP	22.10.2018 – 31.03.2019
CLIC	Klima-Wirkungsketten in einer globalisierten Welt: Eine Herausforderung für Deutschland	91156	4	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.11.2018 – 31.10.2021
CoSy-CC2	Complex Systems Approach to Understanding Causes and Consequences of Past, Present and Future Climate Change	91103	4	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.03.2014 – 30.09.2019
Health Footprint	Carbon footprint of the Austrian health sector	9468	4	Universität Klagenfurt	01.04.2017 – 31.03.2019
Hybride Energiesysteme	Konsistente Modellierung, Auslegung und Analyse von mehr-schichtigen hybriden Energiesystemen mit verteilter Regelung	9774	4	Deutsche Forschungsgemeinschaft	01.10.2017 – 30.09.2020
ImpactEE	Impact of intensified weather extremes on Europe's economy	9223	4	VW-Stiftung	01.10.2018 – 31.10.2022
IUCliD	Einfluss von Unsicherheiten auf die Analyse von Klimadaten (IUCLiD): Ansätze zur Analyse von Messergebnissen, die als zeitabhängige Wahrscheinlichkeitsverteilungen vorliegen	9770	4	Deutsche Forschungsgemeinschaft	01.09.2017 – 31.08.2020
KLiB	NKI: Klimaneutral Leben in Berlin	91129	4	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.01.2017 – 31.08.2019
Networked Images	Neue Potentiale zur Analyse vernetzter Bilder: Ähnlichkeit als Kriterium von Bildvergleichen in den Bildwissenschaften, in der Visualisierung und in der Informatik am Beispiel von Klimabildern im Internet	9221	4	VW-Stiftung	01.10.2017 – 31.03.2020
QUEST	Quantitative paleoenvironments from speleo thems	96114	4	Europäische Union	01.01.2016 – 31.12.2019
Wiederkehranalyse	Wiederkehranalyse von Regimeänderungen in dynamischen Systemen	9772	4	Deutsche Forschungsgemeinschaft	01.12.2017 – 30.11.2020
zeean	[zi:n] – ein algorithmen-gestütztes Modell zur Analyse und Modellierung von Warennetzwerken und Lieferketten	91139	4	Bundesministerium für Bildung und Forschung / Forschungszentrum Jülich/VDI-VDE	01.09.2017 – 31.08.2020
BePerfekt	Entwicklung eines Instrumentes zur Befähigung von Personen und Teams in Transferstrukturen	91138	VB	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.08.2017 – 31.07.2020
EPICC	East Africa Peru India Climate Capacities	91147	VB	Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit	01.11.2017 – 31.12.2020
GIZ-HMCCC	Nachhaltiger Umgang mit menschlicher Mobilität im Kontext des Klimawandels	95195	VB	Deutsche Gesellschaft für Internationale Zusammenarbeit	31.10.2018 – 30.06.2019
KK Sahel	Klimafolgen als Konfliktursachen? Qualitative Länderstudie in der Sahelregion ausgehend von einer klimamodellbasierten Fallauswahl	9476	VB	HSFK/Leibniz-Gemeinschaft	23.05.2018 – 22.05.2019
Sektorale Verwertung II	Professionalisierung und Verstetigung des Verwertungskonzeptes für das Potsdam-Institut für Klimafolgenforschung	91125	VB	Bundesministerium für Bildung und Forschung / Deutsches Luft- und Raumfahrtszentrum	01.10.2016 – 30.09.2019
WBGU	Wissenschaftlicher Beirat Globale Umweltveränderungen	9336	VB	Alfred-Wegener-Stiftung	aktuell bis 31.10.20

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[6.6] Publications 2019

Web of Science indexed articles / Articles in ISI journals 2019

Agarwal, A., Caesar, L., Marwan, N., Maheswaran, R., Merz, B., **Kurths, J.** (2019): Network-based identification and characterization of teleconnections on different scales. – Nature Scientific Reports, 9, Art. 8808. – DOI: 10.1038/s41598-019-45423-5

Aghdassi, S. J. S., Schwab, F., **Hoffmann, P.,** Gastmeier, P. (2019): Assoziation von Klimafaktoren mit Wundinfektionsraten. Daten aus 17 Jahren Krankenhaus-Infektions-Surveillance. – Deutsches Ärzteblatt, 116, 31-32, 529-536. – DOI: 10.3238/arztebl.2019.0529

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