

**Stellungnahme zum
Potsdam-Institut für Klimafolgenforschung e.V., Potsdam (PIK)**

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Vorbemerkung

Die Einrichtungen der Forschung und der wissenschaftlichen Infrastruktur, die sich in der Leibniz-Gemeinschaft zusammengeschlossen haben, werden von Bund und Ländern wegen ihrer überregionalen Bedeutung und eines gesamtstaatlichen wissenschaftspolitischen Interesses gemeinsam gefördert. Turnusmäßig, spätestens alle sieben Jahre, überprüfen Bund und Länder, ob die Voraussetzungen für die gemeinsame Förderung einer Leibniz-Einrichtung noch erfüllt sind.¹

Die wesentliche Grundlage für die Überprüfung in der Gemeinsamen Wissenschaftskonferenz ist regelmäßig eine unabhängige Evaluierung durch den Senat der Leibniz-Gemeinschaft. Die Stellungnahmen des Senats bereitet der Senatsausschuss Evaluierung vor.

Für die Bewertung einer Einrichtung setzt der Ausschuss Bewertungsgruppen mit unabhängigen, fachlich einschlägigen Sachverständigen ein. Der für das PIK zuständigen Gruppe stand eine von der Einrichtung erstellte Evaluierungsunterlage zur Verfügung. Die wesentlichen Aussagen dieser Unterlage sind in der Darstellung (Anlage A dieser Stellungnahme) zusammengefasst.

Wegen der Corona-Pandemie musste der für den 4. und 5. Mai 2021 vorgesehene Evaluierungsbesuch am PIK in Potsdam entfallen. Die Bewertung erfolgte im Rahmen eines Ersatzverfahrens, das der Senatsausschuss Evaluierung (SAE) in Umsetzung eines Grundsatzbeschlusses des Senats vom 31. März 2020 eingerichtet hat. Der Senat hält in diesem Grundsatzbeschluss fest, dass das Ersatzverfahren ein Notbehelf ist und ausschließlich auf Einrichtungen angewendet wird, die im Regeltturnus von sieben Jahren evaluiert werden. Die Bewertungen, auf deren Grundlage der Senat Stellung nimmt, sind auf zentrale Kernfragen der Entwicklung und Perspektive einer Leibniz-Einrichtung fokussiert. Ausführliche Einschätzungen und Schlussvoten zu Teilbereichen und Planungen für „kleine strategische Sondertatbestände“ müssen regelmäßig entfallen.

Die Bewertungsgruppe erstellte den Bewertungsbericht (Anlage B). Das PIK nahm dazu Stellung (Anlage C). Der Senat der Leibniz-Gemeinschaft verabschiedete am 15. März 2022 auf dieser Grundlage die vorliegende Stellungnahme. Der Senat dankt den Mitgliedern der Bewertungsgruppe und des Senatsausschusses Evaluierung für ihre Arbeit.

1. Beurteilung und Empfehlungen

Der Senat schließt sich den Beurteilungen und Empfehlungen der Bewertungsgruppe an. Das PIK erforscht die Ursachen und Folgen des Klimawandels mit dem Ziel, Vermeidungs- und Anpassungsstrategien zu entwickeln, die von Politik, Wirtschaft und Zivilgesellschaft umgesetzt werden können. Leitgedanke ist dabei, ein nachhaltiges Management globaler Gemeinschaftsgüter zu ermöglichen unter Beachtung planetarer Grenzen, z. B. in Bezug auf die Erderwärmung. Dazu arbeiten in vier Forschungsabteilungen Natur-, Wirtschafts- und Sozialwissenschaften zusammen.

¹ Ausführungsvereinbarung zum GWK-Abkommen über die gemeinsame Förderung der Mitgliedseinrichtungen der Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e. V.

Die **Arbeitsergebnisse** des PIK sind hervorragend. Forschungsergebnisse werden regelmäßig in sehr hochrangigen Zeitschriften veröffentlicht und auch die internationale ökonomische Fachgemeinschaft wird mittlerweile sehr gut erreicht. Darüber hinaus erbringt das PIK äußerst wichtige und sehr stark nachgefragte Leistungen in der Politikberatung. Hervorzuheben sind die maßgebliche Mitwirkung im *Intergovernmental Panel on Climate Change* (IPCC) und die wichtigen Beratungsleistungen auf dem Gebiet der CO₂-Besteuerung. Das PIK ist international mit führend bei der Entwicklung aufwändiger numerischer Simulationen zur **Modellierung von Veränderungen des Erdsystems**. Die verschiedenen Modelle wurden seit der letzten Evaluierung ausgezeichnet weiterentwickelt, um insbesondere die Komplexität menschlichen Handelns wie empfohlen besser abzubilden. Die weitere Optimierung dieser Modelle ist sinnvoll. Darüber hinaus sollte die hohe Expertise am PIK genutzt werden, um ganz neuartige Ansätze in der Modellierung zu entwickeln.

Das PIK hat in den letzten Jahren einen umfangreichen personellen und organisatorischen **Veränderungsprozess** sehr gut gestaltet:

- Nachdem 2018 der hochanerkannte Gründungsdirektor in den Ruhestand ging, erhielt das Institut eine wissenschaftliche Doppelspitze. Der neu berufene frühere Direktor des *Stockholm Resilience Centre* vertritt dabei die Natur- und der zuvor stellvertretende Direktor des PIK die Wirtschafts- und Sozialwissenschaften. 2020 wurde das Direktorium um die neu eingestellte Administrative Geschäftsführerin erweitert.
- Auch die vier Abteilungen verfügen über jeweils zwei wissenschaftliche Leitungen. Die Hälfte dieser acht Positionen war in den vergangenen Jahren neu zu besetzen. Drei Stellen wurden mit sehr erfolgreichen, bereits am PIK tätigen Personen besetzt. Für das neue Thema „Klimawandel und Gesundheit“ wurde gemeinsam mit der Charité – Universitätsmedizin Berlin eine Wissenschaftlerin neu an das Institut berufen. Ruhestandsbedingt ist derzeit zudem eine der zwei Leitungsstellen der Abteilung „Komplexitätsforschung“ vakant. Der Senat erwartet, dass die gemeinsam mit der TU Berlin geplante Berufung zügig erfolgt.
- Das PIK hat 2019 das innovative Format der *Future Labs* eingeführt. Die derzeit sieben Einheiten dieser Art dienen dazu, in Zusammenarbeit mit Partnerinstitutionen, insbesondere dem MCC (s. u.), interdisziplinär und explorativ neue Fragestellungen zu verfolgen. Nach fünf Jahren bewertet der Wissenschaftliche Beirat des PIK die Arbeit jedes *Future Lab*, damit das PIK über geeignete Formen der Beendigung oder Verstärkung der Arbeiten entscheiden kann.

Die fachlichen Erweiterungen des PIK in den vergangenen Jahren sind ausgesprochen überzeugend. Die Bewertungsgruppe sieht im Bereich der Sozialwissenschaften sogar noch weiteres Potential für thematische Ausweitungen. Die neue Leitung steht nun vor der äußerst anspruchsvollen Aufgabe, das verbreiterte Spektrum der natur- und sozialwissenschaftlichen Disziplinen noch stärker in einem kohärenten **Forschungsprofil** zusammenzuführen. Grundlage dafür sollte eine übergreifende gemeinsame Zielsetzung für die kommenden zehn Jahre sein.

Der Erweiterung in die Sozialwissenschaften dient seit 2012 die enge Zusammenarbeit mit dem *Mercator Research Institute on Global Commons and Climate Change* (MCC) in Berlin, das

von einem der beiden PIK-Direktoren geleitet wird. Das PIK plant, das MCC im Anschluss an die derzeitige Förderung ab 2025 als **Policy Research Hub on Managing Global Commons and Climate Change** mit 32 VZÄ einschließlich zehn W2-Professuren in das Institut zu integrieren. Die Finanzierung soll über einen Sondertatbestand erfolgen (3,7 Mio. € p.a. zusätzliche Mittel der institutionellen Förderung, 400 T€ p.a. aus dem vorhandenen Budget). Die Pläne werden im Grundsatz unterstützt. Die inhaltliche Integration des *Policy Hub* in das PIK muss jedoch weiterentwickelt und unter Einbeziehung der Hinweise im Bewertungsbericht präzisiert werden. Frühzeitig zu klären ist außerdem, ob ein Umzug der Einheit von Berlin nach Potsdam vorgesehen ist.

Die institutionelle Förderung ist für die derzeitigen Aufgaben des PIK angemessen. Sie betrug 2020 12,4 Mio. €. Das PIK ist nach wie vor äußerst erfolgreich bei der Einwerbung von **Drittmitteln**. Sie stiegen seit der vergangenen Evaluierung noch einmal deutlich von durchschnittlich 10 Mio. € p.a. (2010-2012) auf 16,6 Mio. € p.a. (2018-2020). DFG-Förderungen nahmen zu und einer der PIK-Direktoren warb einen ERC *Advanced Grant* ein.

Der Anteil von **Wissenschaftlerinnen** liegt mit 35 % auf dem gleichen niedrigen Niveau wie bei der letzten Evaluierung. Am 31. Oktober 2020 waren zwei von acht Abteilungsleitungen und sechs von 24 Arbeitsgruppenleitungen mit Wissenschaftlerinnen besetzt. Die beiden Direktoren, der Beirat und das Aufsichtsgremium müssen analysieren, warum es in den vergangenen Jahren nicht gelungen ist, auf allen Ebenen mehr Wissenschaftlerinnen zu gewinnen, damit über zukünftige Stellenbesetzungen eine deutliche Verbesserung erreicht wird. Das jährliche Programmbudget bietet Leitung und Gremien entsprechend den Maßgaben von Bund und Ländern ein geeignetes Instrument, um die Anforderungen und Erfolgskontrolle im Bereich der Gleichstellung der Geschlechter proaktiv zu gestalten.

Das PIK fördert die verschiedenen **Phasen der wissenschaftlichen Qualifikation** sehr erfolgreich. Seit der letzten Evaluierung wechselten neun Wissenschaftlerinnen und Wissenschaftler auf Professuren andernorts und sechs habilitierten sich. Das Institut betreut eine hohe Zahl von Promovierenden, die an Graduiertenschulen der Universität Potsdam und der HU Berlin teilnehmen können. Das PIK sollte prüfen, seine eigenen Veranstaltungen für diesen Adressatenkreis abteilungsübergreifend mit dem Ziel eines eigenen Promotionsprogramms weiterzuentwickeln.

Das PIK unterhält vielfältige und sehr fruchtbare **Kooperationen**, insbesondere mit den benachbarten Hochschulen in Potsdam und Berlin sowie mit außeruniversitären Einrichtungen der Leibniz-Gemeinschaft oder auch der Max-Planck-Gesellschaft. Auch auf internationaler Ebene ist das Institut sehr gut vernetzt und weithin sichtbar. Der Senat erwartet, dass im Namen des Instituts künftig die Mitgliedschaft in der Leibniz-Gemeinschaft zum Ausdruck gebracht wird.

Das PIK erfüllt die Anforderungen, die an eine Einrichtung von überregionaler Bedeutung und gesamtstaatlichem wissenschaftspolitischem Interesse zu stellen sind. Auf der Grundlage rechenintensiver Simulationen erforscht das PIK in interdisziplinären Projekten äußerst relevante Fragestellungen zum Klimawandel und erbringt wichtige, stark wahrgenommene Beratungsleistungen für die nationale und internationale Klimapolitik. Diese Tätigkeiten sind in der am PIK erbrachten Form nicht an einer Hochschule möglich. Eine Eingliederung des PIK in eine Hochschule wird daher nicht empfohlen.

2. Zur Stellungnahme des PIK

Der Senat begrüßt, dass das PIK beabsichtigt, die Empfehlungen und Hinweise aus dem Bewertungsbericht bei seiner weiteren Arbeit zu berücksichtigen.

3. Förderempfehlung

Der Senat der Leibniz-Gemeinschaft empfiehlt Bund und Ländern, das PIK als Einrichtung der Forschung und der wissenschaftlichen Infrastruktur auf der Grundlage der Ausführungsvereinbarung WGL weiter zu fördern.

Annex A: Status report

Potsdam Institute for Climate Impact Research (PIK)

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1. Key data, structure and tasks

Key data

Year established:	1992
Admission to joint funding by Federal and <i>Länder</i> Governments:	1992
Admission to the Leibniz Association:	1997
Last statement by the Leibniz Senate:	2014

Legal form:

Responsible department at <i>Länder</i> level:	Ministry of Science, Research and Culture of the State of Brandenburg (MWFK)
Responsible department at Federal level:	Federal Ministry of Education and Research (BMBF)

Total budget (2020)

- €12.4m institutional funding
- €16.9m revenue from project grants

Number of staff (as of 31.10.2020)

- 245 individuals in research and scientific services
- 59 individuals in service sector
- 26 individuals in administration

Mission and structure

Mission according to statutes

“The purpose of the association is to promote science and research. This purpose is achieved in particular through research projects and the organization of scientific events, the production of publications and the award of research contracts. The association has the task of investigating the immediate and potential effects of global change on the environment and society. The main instruments of investigation are system analysis, modelling and computer simulation. They shall be used in particular to predict or assess regional consequences of global environmental changes. In addition, political and socio-economic management strategies are to be developed that either ensure the avoidance of unacceptable events or optimally combine prevention and adaptation measures.”

PIK has given itself the twofold mission to advance the scientific frontier on interdisciplinary climate impact research for global sustainability and to contribute knowledge and solutions for a safe and just climate future.

Organisation

Research at PIK is organized in **four Research Departments (RDs)**, which study the following questions (for a detailed description see chapter 7):

- Research Department 1 (RD1) – Earth System Analysis: How does the Earth system work and what are the biophysical boundaries that define a safe operating space for human development?
- Research Department 2 (RD2) – Climate Resilience: How can we increase resilience to climate change in different sectors and across scales by managing the global commons within planetary boundaries?
- Research Department 3 (RD3) – Transformation Pathways: What are transformation pathways to a sustainable management of the atmosphere and biosphere as global commons, and what do we gain compared to alternative development pathways transgressing planetary boundaries?
- Research Department 4 (RD4) – Complexity Science: What are the principles that govern the complex natural and societal systems, which enable or hinder that global commons are governed within planetary boundaries?

In addition, seven FutureLabs (FL) were created in 2019/2020 to conduct research at the frontier of global sustainability science. These units are hosted by RDs, one by the Directorate, and function as experimental laboratories for new interdisciplinary research themes applying novel approaches across RDs.

As a share-holder, PIK co-founded the Mercator Research Institute on Global Commons and Climate Change (MCC) jointly with Stiftung Mercator in 2012. This research-based climate economics and policy think tank addresses the question of governing the global commons and contributes to formats at the science-policy interface. The FLs draw on PIK's interdisciplinary competency, and on MCC's socio-economic expertise. The current FutureLabs are:

- Earth Resilience in the Anthropocene
- Inequality, Human Well-Being and Development
- Public Economics and Climate Finance
- Security, Ethnic Conflicts and Migration
- Artificial Intelligence in the Anthropocene
- Game Theory and Networks of Interacting Agents
- Social Metabolism and Impacts

2. Overall concept and core results

Overall concept

Two concepts are pivotal for global sustainability research in the Anthropocene: **planetary boundaries** and **global commons**, together guiding the strategic direction at PIK. The institute's research agenda combines climate impact research and Earth system science, solution-oriented integrated assessment with research on governance of the global commons. In its integrated approach the institute aims at providing:

- (a) an understanding of the Earth system (systems analysis), which ultimately contributes to defining and delineating planetary boundaries
- (b) scenarios of climate impacts and mitigation strategies (scenarios and transformation pathways) in combination with the analysis and modelling of decisions
- (c) knowledge for decision-makers in such a way that it can be relevant for managing the global commons (informing decisions)

Driven by its scientific goals, PIK uses strategically developed numerical models, but also statistical methods of data analysis. PIK provides a dynamically evolving **model ecosystem** to integrate Earth system analysis with the exploration of pathways for sustainable and equitable development to deliver science-based policy advice. Models at PIK serve three primary purposes: (1) Models improving our understanding of natural and socio-economic systems; (2) models providing future scenarios and pathways; (3) and models informing decisions. These purposes are not mutually exclusive, and while most models have a focus in one of the dimensions, they usually integrate parts of all three to different degrees.

One example for a model focusing on the understanding of systems is the Potsdam Earth Model (POEM). POEM a flexible system of models for land biosphere, ocean, ice sheets and atmosphere to simulate the fundamental physical and biogeochemical dynamics of the Earth system. The Potsdam Integrated Assessment Modelling Framework (PIAM) on the other hand explores public policy pathways with a combination of scenario building, energy technology options, economic optimization and multi-criteria policy appraisal. Other models score high in the informing decisions dimension.

The institute coordinates model-related activities that systematically compare models from different institutes worldwide, e.g. the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) and the Shared Socio-economic Pathways process.

Core results

Research

Between 2018 and 2020, work at PIK led to 1051 publications in peer-reviewed journals (see appendix 2). These include 35 articles in *Nature*, *Science* and *PNAS*, and, as recommended after the last evaluation, high-tier economics journals (e.g. *European Economic Review*, *Journal of Environmental Economics and Management* (JEEM), *American Economic Journal: Economic Policy*). Publications also include 19 expert reviews commissioned by public bodies, and 54 data as well as software publications.

PIK (co-)organized 308 scientific conferences, workshops and project meetings (2018-2020). Scientists hold editorial roles in over 50 peer-reviewed journals. From 2018-2020, PIK's scientists received over 20 national and international prizes or awards, from the Environmental Award by the German Federal Environmental Foundation, to the Heinz Maier-Leibnitz Preis awarded jointly by the German Research Association (DFG) and the Federal Ministry for Education and Research (BMBF), to the Dissertation Award of the Leibniz Association.

PIK highlights the following ten overarching achievements, to which multiple publications contributed:

- i) PIK established the discourse on climate-related tipping points in the Earth system, including the understanding of palaeoclimates to better constrain anthropogenic warming risks. The stability properties and time trajectories of the Amazon rainforest were studied. Furthermore, PIK investigated the thresholds and hysteresis of the Greenland and West and East Antarctic ice sheets, and also provided evidence for an ongoing slowdown of the Atlantic overturning circulation. Finally, PIK simulated the Ice Age cycles over the full last three million years to illustrate the exceptionality of modern warming.
- ii) PIK has advanced and applied the planetary boundaries framework with quantitative modelling studies of interactions of multiple planetary boundaries and impacts on societies. Large-scale transformations are required in land-use practices to safeguard food security for 10 billion people while maintaining land-related planetary boundaries, including re-establishing those currently transgressed by agricultural land use. In this context, improved water utilization in agriculture can help achieve important Sustainable Development Goals within planetary boundaries.
- iii) PIK started an international research effort on understanding the role of atmospheric planetary wave resonance and changes in the jet stream for extreme weather events, which have been linked to disproportionate Arctic warming, sea ice loss and changing land-sea contrast, in particular a cooling northern Atlantic surrounded by warming continents. PIK identified a resonance mechanism causing hemisphere-wide extreme events, showed that the summer jet stream has weakened, and how sea ice loss works to disrupt the winter polar vortex. PIK researchers also assessed how recently observed extreme events and regional changes in large-scale precipitation patterns in Europe are affected by atmospheric resonance and more persistent weather patterns.
- iv) PIK investigated global carbon cycle management by integrating modelling of the full global carbon cycle. The institute has led several studies on global land-based carbon dioxide removal, and has combined this with research on renewable electricity systems and the role of synthetic fuels, bioenergy and carbon capture and storage in complementing these systems. PIK also studied the environmental footprint of associated decarbonization strategies. Applying systems analyses, PIK has made progress in deriving energy and land transition pathways that simultaneously achieve carbon neutrality and sustainable management of the biosphere.
- v) PIK has unified the previously fragmented international climate impact modelling community by establishing the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). ISIMIP enables the integrated assessment of climate impacts across sectors and spatial scales through a consistent simulation framework. In sum, more than 170 output datasets were submitted to the last two ISIMIP simulation rounds, contributing to the IPCC 1.5°C Special Report. ISIMIP3 started in 2020 and includes a novel scenario setup for climate impact attribution and incorporates mitigation and adaptation measures in impact projections. PIK organized the ImpactsWorld2017 Conference on the true cost of climate change.
- vi) PIK has advanced the understanding the global economic response to extreme climatic events by generating consistent biophysical projections across event categories within ISIMIP, estimating associated direct economic losses, and simulating their repercussions

along the global supply chain network by the economic-shock model Acclimate, and quantifying short- and long-term macroeconomic responses.

vii) PIK has led the international efforts in integrated assessment analysis of climate change, co-developing the Shared Socio-economic Pathways for climate change research and providing key 1.5°C and 2°C scenarios for assessments by the IPCC. The work is increasingly adopted for the analysis of climate-related financial risks by central banks, financial supervisors and private finance actors. In this context, PIK advises the United Nations Environment Programme Finance Initiative (UNEP FI) and the Network for Greening the Financial System (NGFS) on climate change scenarios.

viii) PIK has demonstrated that carbon pricing can be a central tool for managing the global commons, and provided this knowledge as direct input to national legislation. PIK research showed that carbon pricing can simultaneously achieve emission reductions, inequality reduction and sustainable development goals. PIK built on this knowledge in a joint study with MCC on carbon pricing reform options commissioned for the German Council of Economic Experts. This expertise shaped the Climate Action Program 2030 legislation.

ix) PIK developed the technique of climate networks to analyse large spatio-temporal data, allowing for a new kind of forecasting fundamentally different from the global circulation model-based approach. This revealed a global coupling pattern of extreme rainfall events in high-resolution satellite data, showing for the first time a significant synchronization of extreme-rainfall events in the monsoon systems of south-central Asia, East Asia and Africa and even with the southern hemisphere extra-tropics. PIK has predicted the onset of the Indian Summer monsoon 40 days in advance (two weeks earlier than existing methods), and extreme rainfall in the Eastern Andes. PIK also forecast Pacific Decadal Oscillation phase transitions 6.5 years in advance.

x) PIK contributes to the open science paradigm and to national efforts on scientific software development by making its models available as open-source software packages, leading the Alliance of German Science Organisations' "Recommendations on the Development, Use and Provision of Research Software" and hosting the First Conference for Research Software Engineers in Germany (deRSE19).

Transfer

PIK provides Earth systems-informed policy advice. The institute has participated in the assessment work of the Intergovernmental Panel on Climate Change (IPCC). Under co-chairmanship of one of PIK's Directors the scientific state of climate change mitigation for IPCC's Working Group 3 was successfully completed and published in 2015. PIK researchers also contributed to the Working Group 1 and 2 parts of the Fifth Assessment Report (AR5), which informed the UNFCCC Paris Agreement in 2015. PIK researchers have contributed to special reports and the AR6, currently in preparation. PIK's scenarios and the Shared Socio-economic Pathways (SSP) framework are used for international assessment processes (IPCC SR15, IPCC SRCCL, IPCC AR6, IPBES, TWI2050).

In 2019, PIK advised the German government during the development of its new law on energy transformation. Together with the director of the Leibniz Institute for Economic

Research (RWI), and in close cooperation with the MCC, one of PIK's Directors presented a proposal for a CO₂ price reform. In 2020, the German government adopted a climate package shaped by PIK advice. Several PIK scientists advise the German national government as appointed experts on five advisory boards.

PIK's science-based advice continues to support the European transformation. In this context both Directors advised the European Commission, the Federal Bank, the European Central Bank as well as the "Mission Board for Climate Adaptation and Social Transformation".

PIK's policy advice and industry dialogue has included organizing conferences such as the Berlin Climate and Security Conference with the Federal Foreign Office, From Divestment to Green Investment gathering executive representatives of banks and insurers, or a round-table with the European Automobile Manufacturers Association.

Communicating climate insights to audiences beyond the scientific community is a key part of PIK's outreach and transfer mission. PIK's core objective is to communicate scientific advice to decision-makers in policy and business, and it appears in German lead media daily and weekly in international lead media. In line with its targeted strategy of direct communication, PIK has accumulated over 30.000 Twitter followers.

Technology transfer has led to the PIK spin-off company "elena international – electricity network analysis", which was founded in 2019 and offers consulting services and software solutions for grid operators and energy utilities that are based on analysis methods and modelling approaches developed at PIK. One patent for a method for minimizing instabilities in gas turbines, based on research using the complex networks approach, was granted.

3. Changes and planning

Development since the previous evaluation

Strategic and organizational development

Since the last evaluation, PIK underwent significant change. With the appointment of new Scientific Directors in 2018 (see below), PIK's research agenda has been guided by a framework to integrate research on understanding planetary boundaries and governing global commons. The new strategic direction was discussed institute-wide and was accompanied by organizational changes.

Board of Directors

After the retirement of the Founding Director in 2018 **two Scientific Directors** covering natural and social sciences were appointed. In 2020, an Administrative Director was appointed. Following these changes in the Board of Directors, the four RDs were reorganized to reflect the new strategic direction, and seven FutureLabs were established in 2019/2020 (see chapter 1).

Heads of Research Departments

RD1 – Earth System Analysis

RD1 continues to be led by its two RD Heads. Research of RD1 addresses two main pillars of planetary stability – the climate system and the biosphere.

RD2 - Climate Resilience

In 2019, a new Head was recruited in joint appointment with the Charité – Universitätsmedizin Berlin, leading RD2 jointly with the other RD Head. RD2 advances the understanding of climate resilience, through research on adaptation and mitigation strategies to deal with climate impacts. Thereby, the institute has played an important role in advancing integrated research on mitigation and adaptation processes across scales and sectors. In 2014, the former Assistant Director and Co-Chair of RD2 retired.

RD3 - Transformation Pathways

In 2019 the former Deputy Chair of RD3 became new Head of RD3, in joint appointment with University of Potsdam [since 2020]. He was joined by new (acting) Head. The portfolio of RD3 was changed by bringing together integrated assessment expertise on staying within planetary boundaries with research on the comparative risks of transgressing them.

RD4 - Complexity Science

In 2019, one former Co-Chair of RD3 became new Head of RD4. The second RD Head will retire in 2021. RD4 combines network theory, nonlinear modelling and machine learning for the development of novel models, and has become a synergetic department driving methodological innovation at PIK. In 2019, one former Co-Chair of RD4 became head of FutureLab Social Metabolism and Impacts.

Strategic work planning for the coming years

In the coming years, PIK will further advance integrated Earth System-based climate impact and global sustainability research. It does so by connecting Earth system understanding with solutions and decision support guided by the strategic framework of planetary boundaries and global commons. For this, a better understanding is needed of appropriate governance regimes for common-pool resources and to provide solution-oriented policy pathways for governing global commons to enhance human well-being.

In 2021 one Head of RD4 will change from the administratively active position as Department Head to a purely scientific emeritus status. PIK plans to recruit a successor and to expand research of RD4 towards the areas of Big Data analysis and nonlinear machine learning. The recruitment process has been started with the Technische Universität Berlin.

Planning for additional funds deriving from institutional funding

With its strategy for 2030, PIK seeks to institutionalize a process to provide actionable policy advice integrating science on planetary boundaries and global commons, including analyzing the effect of different normative assumptions on policy options. By establishing strong social sciences that, in synergistic interaction with the natural sciences, create new opportunities at the policy interface, PIK strives to fill a gap experienced by decisionmakers: receiving disciplinary scientific insights, both in the natural and social sciences, in the context of evidence-based policymaking.

To achieve the necessary build-up in decision-relevant expertise, PIK plans to establish a Policy Research Hub on Managing Global Commons and Climate Change at PIK by integrating the Mercator Research Institute on Global Commons and Climate Change (MCC) at the level of a Research Department when the funding by Stiftung Mercator expires at the end of 2024.

MCC's core funding amounts to €2.1m per year (from the Foundation Mercator). In addition, MCC's third-party funding was almost at €1.4m in 2020. MCC combines economic and social science analyses with a structured approach at the science-policy interface. Theoretically rooted in its Pragmatic-Enlightened Model (PEM), it builds on laying out options for policy-makers, being explicit about normative assumptions, and in constant exchange with decision-makers. MCC has 55 staff members (35 full-time equivalents [FTE]) and is located in Berlin.

Establishing the Policy Research Hub will be accompanied by a strategic strengthening along the entire knowledge chain. Three strategic areas have been identified as key research gaps, as areas requiring major advancements, and addressing topics of high societal relevance. Three FutureLabs will address these key areas. The FutureLab on Artificial Intelligence in the Anthropocene will combine MCC's strength in machine learning related to research synthesis in the social sciences with PIK's expertise related to the analysis of spatially and temporally highly resolved data. The FutureLab Earth Resilience in the Anthropocene seeks to develop an Earth Resilience Index, making planetary boundaries and Earth system stability accessible for decision-makers. The FutureLab on Inequality, Human Well-Being and Development contributes transparent distributional dimensions to economic responses and decisions.

PIK's SAB highly recommends the application of this *Sondertatbestand*. At its meeting in November 2020, the Board of Trustees (chaired by the State Secretary of the Ministry of Science and Culture of the *Land Brandenburg*) approved the submission of the *Sondertatbestand*. The *Land Brandenburg* and the *Land Berlin* are in close cooperation with regards to funding and location. In order to implement the knowledge chain by developing three FutureLabs and integrating the MCC, PIK intends to apply for additional permanent institutional funding (Extraordinary item of expenditure, *Sondertatbestand*) from 2025 onwards of €3.738m per year supplemented by €400,000 per year of existing own funds. Of the resulting €4.138m per year €715,000 shall be used for operating costs and €3.423m for the following personnel (32 FTE):

- 10 FTE for FL or group leaders with professorships (W2), 4 of which in the FLs and 6 in the Hub
- 10 FTE Senior researchers and senior analysts (E14), 7 of which in the FLs and 3 in the Hub
- 3 FTE Junior analysts and scientific coordination (E13), all of which in the Hub
- 2 FTE Head & Administrative Head of Policy Research Hub
- 7 FTE Science support (incl. IT, administration, communication) for FLs and Hub

4. Controlling and quality management

Facilities, equipment and funding

In 2020, PIK's institutional funding amounted to €12.4m.

Between 2018 and 2020, revenue for project grants totalled approx. €49.7m (Ø €16.6m p.a.), corresponding to 56 % of the overall budget. Thereof, €22.3m (Ø €7.4m p.a.; 45 %) were raised from Federal and *Länder* governments, €16m from the EU (Ø €5.3m p.a.; 32 %), €2.6m (Ø €866,000 p.a.; 5 %) from the Leibniz Association, €2.1m (Ø 700 k€ p.a.; 4 %) from the *Deutsche Forschungsgemeinschaft* (DFG), and €1.8m (Ø €586,000 p.a.; 3.5 %) from foundations.

From services, PIKs generated revenue in the amount of €2m (Ø €666,000 p.a.). For an overview of PIK's revenue and expenses, see appendix 3.

Construction and Facilities

PIK is located on the Albert Einstein science campus on Potsdam's Telegrafenberg. In total, PIK staff are distributed across four main buildings. In 2015 PIK opened a new research building using sustainable methods. The entire building exceeds standards of energy saving regulations, and is heated solely by the high-performance computer. Two further buildings of PIK were refurbished for energy efficiency. In a sustainability initiative, PIK also implemented green practices across its facilities and administrative processes, and with its partners on Telegrafenberg, obtains green electricity for all its buildings.

Information Technology services & infrastructure

The completion of new computer rooms in PIK's new building (above) and the installation of a state-of-the-art high-performance computer (HPC) in 2015 were important milestones since the last evaluation. To meet its long-term requirements and with the approval of Land Brandenburg and its Scientific Advisory Board, PIK is looking forward to replace the current HPC system from 2022 onwards. Like previous installations, this machine will fit into tier III of the HPC pyramid (recommended by the DFG and the German Council of Science and Humanities).

High performance computing at PIK is firmly embedded in IT infrastructure and services. Centralized file storage and computer virtualization facilities are employed utilizing snapshot protection policies together with geo-redundancy concepts. An automated tape library

and specialized software for backup and archiving provide for long-term retention of scientific data and disaster recovery. For several years, archives of scientific data used for publications have been annotated and catalogued by means of an in-house developed meta-database, a process jointly managed by PIK's Science Management, library and IT.

Scientific programming and data management are deliberately organized in a decentralized way coordinated by the Software, Data and Modelling Council (see below) in close collaboration with the IT services team.

The pace of technical innovations and the need for IT security mandates a close collaboration with other institutions in the IT sector. PIK is member of the German Research Network Association (*DFN-Verein*), and cooperates with the IT teams of other Leibniz institutes.

Organisational and operational structure

PIK is headed by the Board of Directors (BoD), which consists of two Scientific Directors and an Administrative Director.

The four Research Departments (RDs) are the major organizational units comprised of Working Groups and cross-cutting FutureLabs. Each department is managed by two Department Heads who are responsible for staff as well as for ensuring research direction, quality and attainment of goals. Together with RD Heads, the BoD implements PIK's strategic direction.

The Board of Scientists consists of all RD Heads, Deputy Heads as well as Working Group and FutureLab leaders. In addition, elected representatives for postdoctoral and doctoral researchers and the ombudspersons are also involved. It meets twice annually and advises the BoD on scientific matters.

The Software, Data and Models Council (SDMC) serves as a place for institute-wide discussion and coordination pertaining to scientific software and model development, data management, and model operation. The best practices agreed on by the SDMC are summarized in a set of guidelines, helping researchers ensure that the software, data and modelling activities are of the highest quality possible. Every Working Group and FutureLab is represented by one designated person in the SDMC, as are the IT team, the ombudspersons, and the Science Management team. The council meets twice a year.

PIK created science management structures to support scientists centrally and in the RDs. The Clearing Group ensures a regular interface between the administration and science management. All communication is led by the press office, who advise on and implement PIK's strategic communication. The Communications and Science Management teams collaborate closely in matters related to transfer.

Elected representatives of the Employees' Council, the Equal Opportunities Officer and BoD meet quarterly to advise in matters affecting workforce.

PIK's staff engage in employee-initiated groups, such as greening@PIK or diversity@PIK.

Quality Management

As a foundation for scientific work, PIK adheres to the Rules for Ensuring Good Scientific Practice at PIK, which are based on the recommendations of the German Research Foundation (DFG). These are complemented by Guidelines for Ensuring Good Scientific Modelling Practice, which include modelling and research data management and were drawn up in 2011 and last updated in 2020. PIK has elected ombudspersons.

Model documentation at PIK is formalized and upheld by institute-wide committees. The best practices agreed by the SDMC (see above) guide the work of every scientist, but are also implemented by the various research software engineer groups, who support PIK researchers by establishing software development standards. PIK carries these commitments outward, as exemplified by the new guided user access to ISIMIP data, its development of quality indicators, and PIK researchers' role in the newly established Open Modeling Foundation.

Ensuring scientific integrity extends to standardized processes for research data management. PIK's guidelines for reporting metadata assign clear responsibility for documentation and archiving of data and publications. PIK hosts its own metadatabase as the backbone for securing its published data for at least ten years.

The institute's publication guidelines are based on DFG recommendations and support the Berlin Declaration on Open Access to Scientific Knowledge in the Sciences and Humanities and Open Access Guidelines of the Leibniz Association. They outline internal assessment and review procedures for manuscripts intended for publication. The guidelines also put in place rules and processes for documentation.

PIK's administration has implemented a strict four-eyes system across all sensitive financial and personnel processes. To further advance and ensure standards in administrative processes, PIK established a position for compliance and quality management.

The research agenda and the allocation of funding are detailed in PIK's programme budget, which monitors and forecasts the scientific and organizational development. It is discussed with the Scientific Advisory Board (see below) and approved by the Board of Trustees. PIK's achievements database and its new publication management database support the monitoring of PIK's output.

Quality management by advisory boards and supervisory board

The Scientific Advisory Board (SAB) supports and advises the Board of Directors in matters relating to scientific, programmatic and significant structural topics at PIK. The SAB meets at least once a year and carries out an audit between two evaluations as it is common for Leibniz institutes. The SAB consists of up to twelve voting members, who reflect the interdisciplinary research fields of the institute. Of PIK's SAB members, 42 % are women and 66 % are international. The appointment period is four years and one consecutive reappointment is possible.

The supervisory board of PIK is the Board of Trustees (*Kuratorium*), which is composed of nine members with voting rights, chaired by a representative of the state of Brandenburg. It decides in all fundamental affairs of the institute, determines the guidelines of the institute's activities and monitors the Board of Directors. The main tasks include the approval of the

programme budget (see above), the institute's activity report for the previous year and the work plan for the following year, as submitted by the Board of Directors. It also appoints members of the Scientific Advisory Board and the Board of Directors. In 2018, it changed the statutes to enable a dual scientific leadership by distinguished scientists of the natural and social sciences as well as an administrative director.

5. Human Resources

As of 31 October 2020, PIK had 330 employees (without assistants, trainees and scholarship recipients, see annex 4). 245 persons worked in research, including the two Directors, 8 Department Heads (and 7 deputies), 24 Working Group or FutureLab leaders, 140 scientists in non-executive positions, and 64 doctoral candidates. Furthermore, 59 persons worked in service positions and 26 had administrative tasks.

Management

PIK generally fills the positions of Scientific Directors and Department Heads by joint professorial appointments through cooperation agreements with universities. In total, PIK successfully established 13 joint appointments with 4 universities in Berlin and Potsdam by the end of 2020. The recruitment procedures follow the „Standards for the appointments of academic management positions within the Leibniz Association“. Scientific leadership positions are discussed with the SAB, and filled through an international recruitment process or via strategic promotion of highly qualified candidates.

Postdoctoral staff

As of 31 October 2020 PIK employed almost 60 postdoctoral researchers, of whom 38 % are international. The FutureLabs create opportunities for qualified postdocs to develop their own research agenda and gain experience in group leadership. PIK offers training in team leadership for all FL leaders and Working Group Leaders.

PIK encourages academic development, but also enables careers outside of academia. Since the last evaluation, at least 9 postdoctoral researchers were offered professorships. In addition, 6 employees successfully completed their habilitation. Postdocs also moved into leading positions in federal or state ministries, other research organizations worldwide, or took roles in the business world.

Postdocs elected their first representatives and held a PostDoc Day offering workshops on pathways to professorships, career opportunities in industry and exchange with PIK alumni. PIK established an alumni programme for former staff and guest researchers aimed particularly at maintaining contact with former Postdocs, PhD students und international researchers now working in different countries and branches.

Doctoral Candidates

As of 31 October 2020 there were 64 PhD candidates employed at PIK, and 11 scholarship recipients (see appendix 4). Between 2018 and 2020, 39 doctoral researchers completed their work at PIK. In addition, scientists of PIK supervised 25 external doctoral candidates

who finished their thesis. On average, it takes 4 years to complete a doctoral degree at PIK. Following DFG and Leibniz recommendations, positions for doctoral researchers are funded for three years.

The institute has had binding guidelines for the structured support of doctoral candidates as well as quality standards for doctoral projects since 2012, based on recommendations of the DFG and the Leibniz Association. The guidelines include a timeline for presenting a first research plan to a colloquium, the responsibilities of a supervisor team (at least two experienced scientists), and a mutual commitment to PIK's rules for ensuring good scientific practice. Doctoral researchers regularly present their research during PhD seminars within every RD, at least once a year. A monthly seminar series is part of PIK's interdisciplinary education programme for doctoral researchers. A member of PIK's central science management team monitors implementation of the guidelines and conducts surveys for quality assurance.

PIK has established cooperation agreements with graduate schools at the University of Potsdam (PoGS) and the Humboldt Universität zu Berlin (HGS), and hosts several doctoral students from the MATH+ Cluster of Excellence in Berlin. PhD researchers can attend courses, for which PIK covers the expenses. Finally, about once a year, the PIK press team offers a media training course for doctoral researchers.

PhD representatives are engaged in the Leibniz PhD-Network, and hosted the annual summit at the institute in 2019. PIK's PhD representatives are active at PIK, established a new mediation team, and organize an annual PhD Day for PIK's doctoral researchers, including in-house training modules. In 2019, the representatives and Board of Directors signed an MoU, which clarifies the role, rights and duties of the representatives as an official part of PIK's organizational make-up.

An analysis (2018) showed that about 29 % of PIK's doctoral researchers remained at the institute right after the completion of their dissertation. A further 33 % went on to other scientific institutions, or to work for public bodies such as ministries (17 %) or think tanks (13 %), as well as NGOs or the private sector.

Non-scientific staff

PIK offers certified traineeships in office management, IT system integration, and public relations. During the evaluation period, three trainees completed their vocational training. Four trainees are currently undergoing their training as IT specialists for system integration (2) and office management assistants (2).

Since the last evaluation, PIK has supported over 60 professional training measures for personnel in science-support positions, including topics ranging from project management to data security, public procurement regulations or gender and diversity in job interviews. In addition, English classes are offered for all staff at PIK.

From 2018-2020, PIK hosted 43 national and international interns. Since 2013, PIK has also hosted one volunteer annually to complete a certified voluntary service year (*Bundesfreiwilligendienst*) [pausing due to the pandemic].

Equal opportunities and work-life balance

Equal opportunities

As of 31 October 2020, out of 245 employees in “Research and scientific services” (see appendix 4) 85 were women (35 %). The two Scientific Directors are men, the Administrative Director is a woman. Out of 8 Department Heads 2 were female (25 %; of the deputies, 29 % were women). Out of 24 Working Group and FutureLab Leaders 6 were women (25 %). Among the 140 scientists in non-executive positions were 51 women (36 %). Of the 64 employed doctoral candidates and 11 doctoral scholarship holders 26 were female (35 %).

In 2018, PIK adapted its statutes, which now state that PIK promotes equal opportunity and the compatibility of family and work. PIK implemented Leibniz and state standards for equal opportunities. Target quotas, which indicate the percentage of women in different leadership levels and salary groups, have been integrated in PIK’s equality concept. Compared to the target quota during the last evaluation, PIK has increased the number of women at the level of W2 (0 to 50 %) and W3 (0 to 20 %) professorships, as well as in the PostDoc and PhD groups (both approximately 40 %). PIK has committed itself to an active HR policy in the course of the generational change that is starting to take place.

The equal opportunities officer (EEO) is involved in recruitment and appointment procedures and monitors the promotion of women and young scientists. The EEO was member of the finding commission for the new Board of Directors of PIK. Furthermore, the EEO is active as spokesperson of the Leibniz Working Group on Equal Opportunities and Diversity, and as deputy spokesperson for the Alliance of equal opportunities officers in non-university research organizations.

Since 2010, PIK has been certified by the TOTAL E-QUALITY certificate. In 2019, diversity was included in PIK’s updated Equality Concept and PIK published a diversity mission statement. PIK cooperates with the Potsdam Graduate School (PoGS), offering training specifically geared towards young female scientists. In addition, the institute uses the Leibniz Association’s mentoring programme and Leibniz competition to promote women.

Work life balance

PIK supports work life balance by offering reserved spots for PIK employees’ children in its own joint Telegrafenberg child care centre next to the institute and in another kindergarten in the city of Potsdam. PIK encourages parents to take their parental leave months and implemented measures such as scheduling official work meetings within core hours, or coverage of additional child care costs in case of important PIK events if stretching beyond core working hours.

6. Cooperation and environment

Cooperation with universities

PIK is connected **with universities in Berlin and Brandenburg** on the basis of collaboration agreements. 15 scientists (including two Scientific Directors, seven RD Heads, two deputy heads, two Working Group leaders and two FutureLab leaders) of PIK hold professorships at the following universities:

- Universität Potsdam (4x W3, 1x W2, 1x adjunct professorship, 1x honorary professorship),
- Humboldt-Universität zu Berlin (HU Berlin, 4x W3, 1x W2),
- Technische Universität Berlin (TU Berlin, 2x W3), and
- Charité – Universitätsmedizin Berlin (1x W3).

PIK researchers contribute to university teaching at all levels from undergraduate to PhD students. Scientists were involved in teaching a total of 179 courses, and supported junior scientists by supervising 103 master's and 34 bachelor's theses.

Between 2018 and 2020, PIK researchers have been partners in the following collaborative DFG-funded Priority Programmes (SPPs), Research Units (FORs), and Research Training Groups (GRKs):

- SPP 1158 “Antarctic Research with Comparable Investigations in Arctic Sea Ice Areas” (2013-2020, six subprojects)
- SPP 1689 “Climate Engineering: Risks, Challenges, Opportunities?” (2013-2020, three subprojects)
- SPP 1984 “Hybrid and multimodal energy systems: System theoretical methods for the transformation and operation of complex networks” (since 2017, one subproject)
- SPP 2017 “Glacial and erosional contributions to Late Quaternary uplift of the European Alps” (since 2020, one subproject)
- FOR 2936 “Climate Change and Health in Sub-Saharan Africa” (since 2019, two subprojects)
- GRK 1740 “Dynamical Phenomena in Complex Networks: Fundamentals and Applications” (2011-2020)
- GRK 2043 “Natural Hazards and Risks in a Changing World” (since 2015)

Cooperation within the Leibniz Association

PIK is involved in five Leibniz research alliances: Infections'21, Sustainable Food Production and Healthy Nutrition, Crises in a Globalized World, Energy Transition, and Biodiversity. PIK is also part of the Leibniz research networks Mathematical Modelling and Simulation (MMS) and Integrative Earth Systems Research. In addition, PIK cooperates with Leibniz institutes, such as GESIS, in projects funded through Leibniz' internal competitive procedure.

In collaboration with several Leibniz institutes PIK provides policy advice as well as various transfer activities to increase its interaction with the general public and contribute to evidence-based societal dialogue.

Cooperation through international Joint Projects and Programs

PIK cooperates with 185 partners in 33 countries, and also collaborated with almost 50 business partners (as of 2019). PIK is involved in ca. 130 third party projects and consortia, which often involve extensive partner networks, e. g. (for DFG, see above) PalMod - German Climate Modelling Initiative, the central national research initiative on palaeo climate modelling funded by the Federal Ministry of Education and Research (BMBF), with 18 cooperating institutes; the EU-funded 12-partner consortium CASCADES led by PIK analyses the trade, political and financial channels through which climate change impacts outside of Europe might cascade into Europe; PIK leads the BMBF-funded cooperation of 25 partners in the large-scale energy transformation project Ariadne (part of the BMBF Kopernikus initiative); in the EU-funded TiPES project, a consortium of 18 partners, PIK leads the work package on observation-based analysis of tipping points.

PIK participates in scientific contributions to the IPCC (Intergovernmental Panel on Climate Change), an extensive international collaborative endeavour. These contributions range from model intercomparisons to state-of-the-art scientific assessments of risks of non-linear dynamics in oceans and on land, to climate impacts and mitigation strategies.

The community-driven climate-impacts modelling initiative ISIMIP (The Inter-Sectoral Impact Model Intercomparison project) offers a framework for consistent impact simulations across 14 sectors and different spatial scales. Its data portal currently provides open access to far more than 150 contributions from all around the world.

PIK is also engaged in rapid assessments and scientific syntheses initiatives, such as the Earth Commission and the Food System Economics Commission (FSEC). Both initiatives are co-chaired by one of PIK's directors.

PIK is involved in Integrated Assessment Modelling (IAM) (e.g. IAMC and EMF) and Earth System Modelling (ESM) (e.g. PalMod, EHSMIP) consortia, and contributes to national and international modelling and model comparison initiatives. The institute is also a core contributor to TWI2050, a network of over 70 organizations from universities to think tanks, UN organizations and NGOs worldwide.

PIK has made the acquisition of high-quality data a priority and cooperates with numerous national or local bureaus to gain access. Recent examples include cooperation with the Lake Rukwa Basin Water Board, Tanzania, for assistance in applying GIS tools to obtain data for the SWIM model. In addition, to increase reproducibility and openness, PIK uses multiple high-quality open sources for its data, including the Food and Agricultural Organization of the United Nations (FAO) for agricultural and food data, or the World Development Indicators (Gini coefficient, poverty).

Institution's status in the specialist environment

PIK's competitors range from large multi-disciplinary institutes to specialized chairs at universities, and competitors are often also partners of the institute. PIK's core competitive environment comprises institutes with a similar profile, institutional set up (e.g. related to funding), and size in Germany and internationally, such as the *Helmholtz Centre for Environmental Research* in Leipzig (UFZ), the *International Institute for Applied Systems Analysis* (IIASA) in Laxenburg (Austria), and the *Columbia University's Earth Institute* in New York City (USA).

In addition, institutes with specialized focus are competitors in particular disciplines, such as the *Leibniz Institute for Economic Research* in Essen (RWI) and the *Max Planck Institute for Meteorology* in Hamburg (MPI-M). Finally, due to its science-based policy advice, despite a different mandate, PIK is often compared to think tanks such as the *World Resources Institute* (WRI) in Washington D. C. (USA).

7. Subdivisions of PIK

Research Department 1: Earth System Analysis

[34.1 FTE, thereof 28.6 FTE Research and scientific services, 4.2 FTE Doctoral candidates, and 1.3 FTE Service staff]

Research Department 1 (RD1) consists of seven Working Groups (WG) and hosts one FutureLab (FL):

- WG Long-Term Dynamics of the Earth System,
- WG Ice Dynamics,
- WG Earth System Modes of Operation,
- WG Ecosystems in Transition,
- WG Terrestrial Safe Operating Space,
- WG Whole Earth System Analysis,
- WG Earth System Model Development,
- FL Earth Resilience in the Anthropocene.

RD1 provides the Earth system science foundation of PIK. It focuses on the understanding and modelling of the physical and biogeochemical processes that govern the Earth system and its response to human interference. RD1 research is guided by four major themes:

- **Tipping points.** Non-linear Earth system processes and threshold behaviour.
- **Planetary boundaries.** Definition, quantification and operationalization of planetary boundaries and their interactions.
- **Earth trajectories.** Dynamics and modes of operation of the Earth system (for example circulation changes, feedback systems) under natural and human forcing, and the resulting long-term and short-term trajectories.

- **Extreme events.** Development of an understanding of the dynamical mechanisms and changing statistics of extreme weather events on a warming Earth.

To investigate these topics RD1 develops and applies models of the Earth system and its components, evaluated with historical and palaeoclimate data for different climate states. It analyses observations of current and computes scenarios of future climate and biosphere change to better understand Earth system-wide feedbacks and interactions. RD1 investigates the role of human activities such as greenhouse gas emissions and land use as major drivers of Earth system change and the impacts of these activities on climate, oceans, ecosystems and societies. RD1 thus provides the natural science groundwork for PIK's research on how to govern the global commons and how to maintain a safe and just operating space for humankind in pursuit of sustainable development within planetary boundaries.

Between 2018 and 2020, the department published an average of 83 articles per year in peer-reviewed journals. The department's average yearly revenue from third-party funding was €2.5m, with €962,000 from the EU, €868,000 from Federal and *Länder* governments, €286,000 from the Leibniz-Association and €215,000 from the DFG, and €186,000 from other sponsors. In the same period, 9 department members received their doctoral degree and two department members obtained a habilitation.

Research Department 2: Climate Resilience

[62.9 FTE, thereof 47.2 FTE Research and scientific services, 9.2 FTE Doctoral candidates, and 6.4 FTE Service staff]

RD2 consists of six WG and hosts one FL:

- WG Climate Change and Health,
- WG Land Use and Resilience,
- WG Adaptation in Agricultural Systems,
- WG Forest and Ecosystem Resilience,
- WG Hydroclimatic Risks,
- WG Urban Transformations,
- FL Inequality, Human Well-being and Development.

RD2 strives to improve the understanding of climate resilience, i.e. the resilience of social and ecological systems to climate change, in various sectors and across multiple spatial scales. As a general framing for RD2 research, resilience entails aspects of persistence – the capacity of systems to resist and absorb short-term shocks, yet remain within critical thresholds; adaptability – the capacity to recover, adjust to changing external drivers, and thereby remain on the current trajectory; and transformability – the capacity to cross thresholds, if necessary, into new, robust long-term development trajectories. RD2 research on climate resilience covers three overarching topics:

- **Climate change impacts and their socio-economic consequences** related to land use, agriculture, forests, hydrological systems, human health and well-being, and urban areas;
- **Adaptive capacity of societies and ecosystems** across scales at different levels of global warming;
- **Synergies between climate change adaptation and mitigation** to improve climate resilience and achieve sustainable human development.

RD2 researchers apply empirical and process-based models to quantify climate impacts and improve the understanding of how climate resilience interacts with planetary boundaries at different scales. For example, climate impacts on land productivity and water availability may reduce the tolerable thresholds for human use beyond which key Earth system functions may not be sustained. Managing the global commons needs to take climate impacts and adaptation into account, as potential common goods like land, water, forests, or oceans are increasingly affected by climate change alongside socio-economic pressures. The societal goal of climate-resilient management of the global commons within planetary boundaries is to maintain and improve human health and well-being. To better integrate this dimension, RD2 has established the working group Climate Change and Health and the FutureLab Inequality, Human Well-being and Development.

RD2 has well-established connections within the international climate impact modelling community, as it employs a range of biophysical and socio-economic models from global to local scales. Moreover, RD2 researchers coordinate and co-lead a number of systematic model inter-comparison activities, like ISIMIP and AgMIP. ISIMIP was initiated and coordinated in RD2 until 2018, before the core team moved to RD3. In close cooperation with RD1 and RD3, the global land biosphere model LPJmL and the global land-use model MAGPIE have been made available as open-source software packages, which are important pillars for the Potsdam Integrated Assessment Modelling Framework (PIAM). The LPJmL development also supports the Potsdam Earth Model (POEM). Process-based regional impact models are applied to translate global climate change into regional impacts on land, water and vegetation and to explore adaptation strategies. RD2 researchers use econometric and epidemiological methods at the regional to local scale to analyse data from household panel surveys, field experiments, and randomized controlled trials. Within RD2, simulation modellers directly interact with empirical researchers for conducting comprehensive climate impact assessments.

Between 2018 and 2020, the department published an average of 105 articles per year in peer-reviewed journals. The department's average yearly revenue from third-party funding was €5.6m, with €2.2m from the EU, €2.1m from Federal and *Länder* governments, €303,000 from the Leibniz-Association and €888,000 from other sponsors. In the same period, 12 department members received their doctoral degree and one department member obtained a habilitation.

Research Department 3: Transformation Pathways

[83.8 FTE, thereof 51.4 FTE Research and scientific services, 24.8 FTE Doctoral candidates, and 7.6 FTE Service staff]

RD3 consists of seven Working Groups (WG) and hosts two FLs:

- WG Impacts of Climate Change on Human Population Dynamics,
- WG Data-centric Modeling of Cross-sectoral Impacts,
- WG Economic Modeling of Climate Change,
- WG Land-use Management,
- WG Energy Systems,
- WG Climate & Energy Policy,
- WG Research Software Engineering for Transformation Pathways,
- FL Public Economics and Climate Finance,
- FL Security, Ethnic Conflicts and Migration.

Both the impacts of climate change and climate protection measures affect societies and natural systems. For example, climate change as well as the decarbonization of the energy system can impact economic development; biodiversity is lost due to climate change but is also threatened by land transformations in response to increasing bioenergy demand; and climate change but also carbon pricing could increase inequality. Thus, the assessment of the impacts of climate change and climate protection measures need to be integrated. RD3 particularly addresses the following topics:

- **Development of integrated climate protection and climate impact pathways.** Evaluation of mitigation strategies and remaining impacts with regard to socio-economic development, distributional effects and planetary integrity.
- **Societal impacts of climate change.** Assessment of climate change as a potential driver of migration, displacement, and conflict, particularly taking into account impacts of weather extremes.
- **Sustainable land use.** Evaluation of land-use transformation pathways exploiting mitigation potentials while ensuring biosphere integrity.
- **Sustainable energy use.** Exploration of transformation pathways towards sustainable and carbon-neutral energy use taking into account their resource use and environmental footprint.
- **Policy strategies for climate protection pathways.** Analysis of regulatory and economic climate policy instruments with regard to their efficiency and distributional implications.

To address these topics, RD3 builds on the energy-economy model REMIND and the land-use model MAgPIE driven by inputs from PIK's land biosphere model LPJmL. These models are combined with the reduced-complexity climate model MAGICC to form the integrated assessment modelling framework PIAM. The modelling chain allows for the assess-

ment of mitigation strategies based on a detailed representation of energy and land systems, and will be extended to also account for socio-economic impacts of climate change. The integration builds on biophysical impact projections from the Inter-Sectoral Impact Model Intercomparison Project ISIMIP and the derivation of socio-economic impacts developed in RD3. Conversely, the research on mitigation pathways will inform the generation of forcing data (e.g. land-use patterns) for ISIMIP to allow for a consistent multi-model assessment of the impacts of climate protection measures and remaining climate change.

Between 2018 and 2020, the department published on average 68 articles per year in peer-reviewed journals. The department's average yearly revenue from third-party funding was €5.1m, with €2.6m from Federal and *Länder* governments, €1.7m from the EU, €177,000 from the DFG, €155,000 from the Leibniz-Association, €229,000 from foundations, and €231,000 from other sponsors. In the same period, 5 department members received their doctoral degree.

Research Department 4: Complexity Science

[39 FTE, thereof 21 FTE Research and scientific services, 14,7 FTE Doctoral candidates, and 3.3 FTE Service staff]

RD4 consists of five working groups (WG) and one service unit and hosts two FLs:

- WG Dynamics, Stability and Resilience of Complex Hybrid Infrastructure Networks,
- WG Numerical Analysis of Global Economic Impacts,
- WG Development of Advanced Time Series Analysis Techniques,
- WG Data-based Analysis of Climate Decisions,
- WG Network- and Machine-learning-based Prediction of Extreme Events,
- Service unit Computational Methods and Visualisation,
- FL Artificial Intelligence in the Anthropocene,
- FL Game Theory and Networks of Interacting Agents.

From the physical climate via ecosystems all the way to the societal aspects of climate-change mitigation, impacts and adaptation, all of these systems can be considered and treated as complex systems. The dynamics emerging from their nonlinear interactions at the macroscopic level require the development of novel and advanced methods. Researchers in RD4 aim to find principles, analysis methods, and modelling techniques with a focus on four main research areas:

- **Climate phenomena and extremes:** Prediction and modelling with complex networks, statistical physics, and machine learning.
- **Abrupt climate transitions:** Detection and prediction with advanced time series analysis, numerical modelling, and analytical concepts.
- **Socio-economic and infrastructure networks:** Understanding dynamics through new modelling and stability concepts.

- **Climate decisions:** Uncovering principles and modelling interactions using econometrics, game theory and machine learning.

The global commons are governed by complex dynamics and need to be managed within planetary boundaries, which provides RD4 with an exciting and highly relevant research agenda. RD4 investigates the properties of the natural and societal complex systems in the realm of climate change and its impacts.

Thus, RD4 aims at pioneering, developing, and evaluating new methods beyond existing classical theories, with a focus on data-driven modelling and inference of the governing principles. In particular, research in RD4 intends to advance the understanding of the complex nature of these systems in order to find new principles that can improve and complement existing modelling and empirical approaches. RD4 also engages in knowledge transfer and policy advice by providing policy briefings and media contributions, as well as developing start-up companies, software libraries, and patents. RD4 was speaker of one DFG international research training group (GRK 1740) and actively involved in a cluster of excellence (Math+) as well as in an additional training group (GRK 2043).

Between 2018 and 2020, the department published on average 114 articles per year in peer-reviewed journals. During the same period, the department's average yearly revenue from third-party funding was €2.1m, with €1.1m from Federal and *Länder* governments, €448,000 from the EU, €269,000 from the DFG, €119,000 from the Leibniz-Association, €125,000 from foundations and €28,000 from other sponsors. Between 2018 and 2020, 13 department members received their doctoral degree, and one department member obtained a habilitation.

8. Handling of recommendations from the previous evaluation

PIK responded as follows to the 12 recommendations of the last external evaluation (highlighted in italics, see also statement of the Senate of the Leibniz Association issued on 23 March 2015, pages B-3/B-4):

- 1) *“Recently, PIK has established a new line of research on adaptation to global change. The first projects are highly innovative and have yielded very promising results. PIK must intensify its efforts in this area well beyond the steps taken so far and turn **adaptation research** into a major pillar of its research portfolio. The respective recommendation issued in the last evaluation report is thus emphatically reiterated.”*

PIK has integrated adaptation and mitigation research into research on climate resilience and on transformation pathways to engage with adaptation research as a cross-cutting issue [see ch. 3].

- 2) *“Within the research domains, the future strategies are well-elaborated and both ambitious and realistic. However, the multi-dimensional task space envisaged for the institute as a whole is not fully convincing, as it does not provide sufficiently concrete strategic guidance. It would be very helpful for PIK's further development if **specific and practical***

strategic objectives were articulated clearly, and explicit steps on how to reach them were elucidated.”

With the appointment of the new Scientific Directors, the institute implemented a new strategic direction [ch. 3]. Strategic objectives on institutional and RD-level are discussed with the SAB [ch. 4].

- 3) *“The well-established work on Integrated Assessment Models (IAM) is a pivotal pillar of PIK’s recognition. PIK quite rightly plans to develop these models further. In order to maintain its top position in this important area in the long run, however, PIK is recommended to initiate a **new generation of agent-based models** in addition to the existing ones. Currently, as the Potsdam Institute has recognised itself, the aspects of actors and agency are becoming ever more important. However, they are not modelled appropriately and are indeed difficult to implement in the existing models. In order to expand the range of possible scenarios, it would be highly useful to enhance the consideration of factors with non-linear effects.”*

PIK points to its modelling ecosystem and the development of agent-based models [ch. 3], as well as the work of Research Department 4: Complexity Science and the FutureLab Game Theory and Networks of Interacting Agents [ch. 7].

- 4) *“Systematically calibrating and validating the models is notoriously difficult, yet indispensable. In order to continue making progress in this area, PIK should explore ways of acquiring better **access to high-quality observational data**, especially via strategic collaborations.”*

PIK points to cooperations set up to gain access to high quality data, ranging from Lake Rukwa Basin Water Board, Tanzania, to the National Renewable Energy Laboratory (NREL, USA). In addition, to increase reproducibility and openness, PIK uses multiple high-quality open sources (including Food and Agricultural Organization of the United Nations) [ch. 6].

- 5) *“Since much of PIK’s research is highly relevant to the economics community, there is substantial potential to increase the **number of publications in economics journals** that should be fully tapped by the institute.”*

According to PIK, the publishing portfolio has been expanded to economics journals. PIK collaborates with the socio-economic sciences at MCC and from 2018 to mid-2020, PIK and MCC co-authored 55 peer-reviewed publications [ch. 2].

- 6) *“PIK has stated that **additional personnel for supporting tasks** would be helpful. The institute will have to prioritise these needs and use the increased financial flexibility to allocate the available resources to administrative and other urgent tasks. After the recent years of marked growth, PIK will have to adapt to the changed circumstances, according to which a further exceptional increase of institutional funding cannot necessarily be expected.”*

Following the last evaluation, PIK successively transferred funds that were freed up to prioritized areas. For example, model operations were strengthened by converting

temporary contracts into permanent ones, the administration was reinforced and re-organized, and IT was supported by trainees and further positions have been reserved. Since 2018, PIK has prioritized its research agenda. [ch. 3].

- 7) *“PIK has been very successful in procuring third-party funding for research projects. Whilst the overall level should be maintained, acquisition of **funding from the German Research Foundation (DFG)** should be increased, as already recommended in the last evaluation.”*

Between 2018 and 2020 PIK acquired on average €714,000 (4,3 % of total third-party funding) from the German Research Foundation (DFG). Between 2011 and 2013 the acquisition amounted to €241,000 (2,3 % of total third-party funding).

- 8) *“Whilst PIK’s numerous activities in **public outreach and policy advice** are highly regarded, it is suggested that these activities should be more systematically coordinated by formulating clear goals and then devising an overarching strategy on how to reach them.”*

PIK points to its central communications team as well as its science management and transfer team [ch. 4, results ch. 2] As part of the *Sondertatbestand* [ch. 3], PIK plans to establish a policy research hub including a policy unit, to facilitate an iterative process between science, decisionmakers and society.

- 9) *“In order to strengthen the ties to universities further, PIK should make significant efforts to initiate and participate in larger **DFG-funded joint research projects** such as Collaborative Research Centres or Research Units.”*

Since the last evaluation, PIK has been part of several Priority Programmes (SPPs), Research Units (FORs) and International Research Training Groups (IGRKs). It was speaker of the first International Research Training Group with Brazil (IRTG/GRK 1740) [ch. 6].

- 10) *“Women are clearly underrepresented in the scientific sector, especially at leadership level. PIK must further intensify its efforts to increase the **proportion of women in scientific leadership positions.**”*

Compared to the target quota during the last evaluation, PIK has increased the representation of women on the level of W2 (0 to 50 %) and W3 (0 to 20 %) professorships, as well as in the PostDoc and PhD groups (both approximately 40 %). Representation at the scientific leadership level, however, has remained almost the same (at about 23 %; not taking into account the Administrative Director). PIK also points to the development of equal opportunity measures across the institute [ch. 5].

- 11) *“PIK harbours great expertise within its pool of **junior scientists**, many of whom are able to generate creative ideas and valuable strategic input. It is recommended to encourage more bottom-up contributions from these junior researchers and to introduce procedures to systematically utilise this potential input in order to promote PIK’s further development.”*

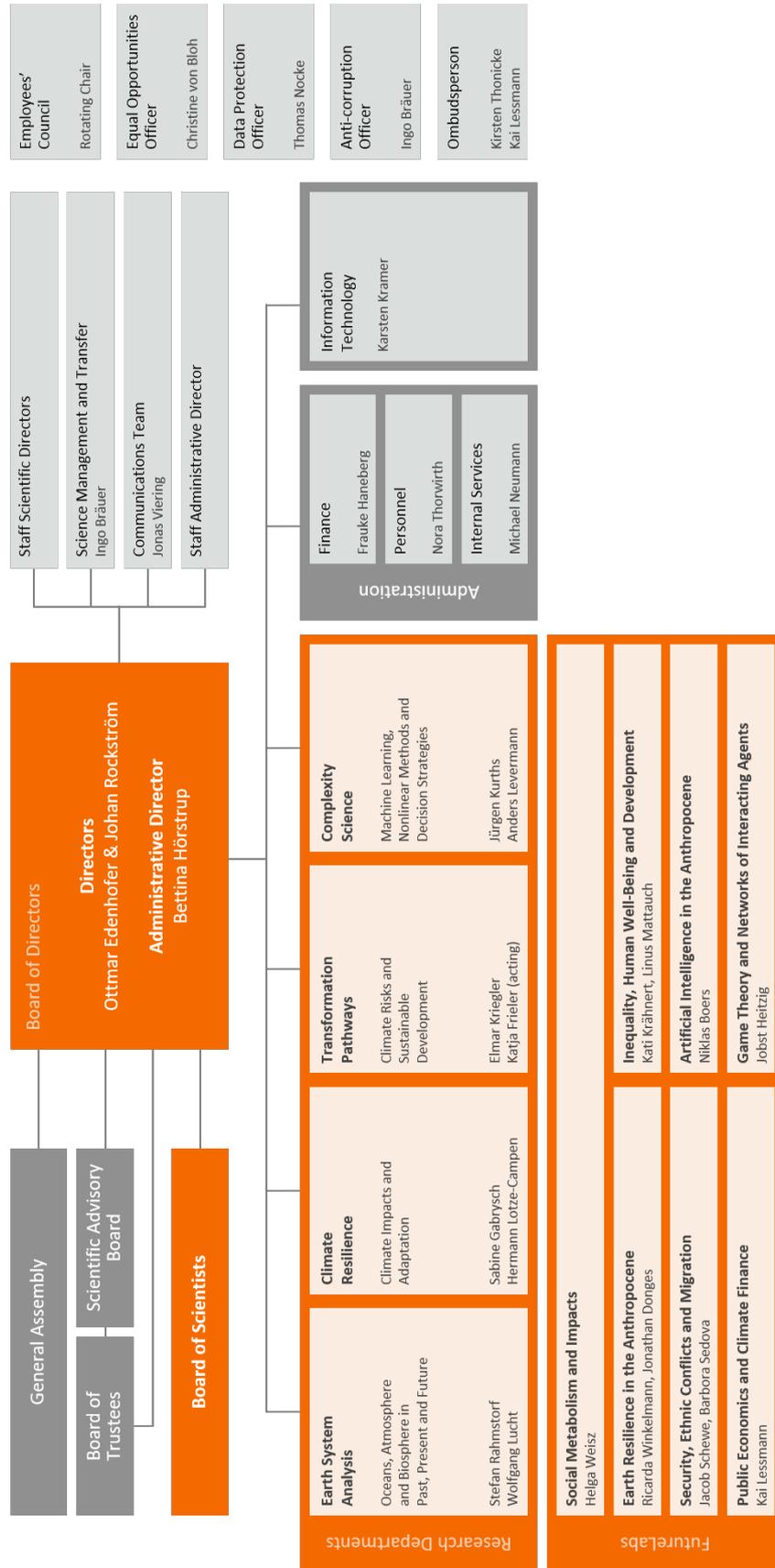
PIK’s junior scientists’ actively participate in PIK-wide processes and are represented in committees [ch. 5].

12) *“It is necessary that PIK develop and implement a clear overarching **data management strategy** with standard procedures for data acquisition, processing and management, access and dissemination, exploration and analysis, data storage, archiving, retrieval, safety (including disaster recovery), and security.”*

According to PIK, it has established information technology standards and processes, as well as quality management measures for data and modelling, which are closely coordinated, not least through the institute-wide Software, Data and Modelling Council [ch. 4].

Appendix 1

Organisational Chart



Appendix 2

Publications, patents, and expert reviews

	Period		
	2018	2019	2020
Monographs	3	5	2
Individual contributions to edited volumes	26	23	20
Articles in peer-reviewed journals	346	309	396
Articles in other journals	9	12	9
Expert reviews (<i>Gutachten</i> ; commissioned by public entities)	6	6	7
Working and discussion papers	15	14	28
Editorship of edited volumes	2	0	1
Data publications	9	13	8
Software publications	10	8	6

Appendix 3 Revenue and Expenditure

Erträge		2018			2019			2020		
		k€	%	%	k€	%	%	k€	%	%
Total revenue (Sum of I, II. und III.; excluding DFG-fees)		29.173,0			36.243,9			33.481,2		
I.	Erträge (Summe I.1.; I.2. und I.3.)	25.815,9	100 %		32.475,1	100 %		29.964,9	100 %	
1.	INSTITUTIONAL FUNDING	12.034,0	47 %		12.156,0	37 %		12.398,0	41 %	
1.1	Institutional funding by federal and state governments (AV-WGL)	12.034,0			12.156,0			12.398,0		
2.	REVENUE FROM PROJECT GRANTS	13.276,1	51 %	100 %	19.509,6	60 %	100 %	16.916,9	56 %	100 %
2.1	DFG	647,7		5 %	813,9		4 %	680,6		4 %
2.2	Leibniz Association (competitive procedure)	1.006,4		8 %	724,3		4 %	872,9		5 %
2.3	Federal, state governments	6.187,0		47 %	7.716,1		40 %	8.391,7		50 %
2.4	EU	4.167,6		31 %	8.315,1		43 %	3.544,1		21 %
2.5	Stiftungen	250,8		2 %	264,1		1 %	1.242,2		7 %
2.6	Other sponsors	1.016,7		8 %	1.676,0		9 %	2.185,4		13 %
3.	REVENUE FROM SERVICES	505,8	2 %		809,5	2 %		650,0	2 %	
3.1	Revenue from commissioned work	505,8			809,5			650,0		
II.	Miscellaneous revenue (e.g. donations, reserves)	3.357,1			3.768,8			3.516,3		
III.	Revenue for construction projects	0,0			0,0			0,0		

Expenditures		k€	k€	k€
Expenditures (excluding DFG fees)		28.881,0	35.948,9	33.135,7
1.	Personnel	16.169,3	18.822,8	21.177,9
2.	Material expenses	3.610,6	7.328,4	2.925,5
3.	Equipment investements	913,9	464,5	331,3
4.	Construction projects, acquisition of property	12,1	8,4	507,6
5.	Other operating expenses	4.440,4	5.488,2	6492,7
6.	Drawing reserves	3.734,7	3.836,6	1.700,7

DFG-fees (2.5 % of revenue from institutional funding)	292,0	295,0	301,3
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Appendix 4

Staff

(Basic financing and third-party funding / proportion of women (as of: 31 October 2020))

	Full time equivalents		Employees		Female employees		Inter-national
	Total	on third-party funding	Total	on temporary contracts	Total	on temporary contracts	Total
	Number	Percent	Number	Percent	Number	Percent	Number
Research and scientific services	215,7	77,9	245	82,9	85	90,6	77
1 st level (Scientific Directors)	2,0	0,0	2	50,0	0	0,0	1
2 nd level (Department Heads or equi.)	15,0	0,0	15	6,7	4	25,0	0
3 rd level (Working Group Leaders or equi.)	22,5	26,7	24	37,5	6	50,0	2
Scientists in non-executive positions (E13 and above)	119,3	88,9	140	91,4	51	96,1	48
Doctoral researchers (E 13)	56,9	98,2	64	100,0	24	100,0	26
Science support	48,7	22,4	59				
Scientific coordinators (E 13)	5,8	-	6				
Project coordinators (E 11 to E 13)	7,9	87,3	10				
Scientific advisors & managers (from E 13)	8,6	9,3	11				
PR and communications (from E 13)	5,0	16	6				
Team & project assistants (E 9 to E 11)	4,5	-	6				
Team & project assistants (E 5 to E 8)	7,4	21,6	10				
IT team (from E 10)	9,6	8,3	10				
Administration	24,7	-	26				
Administrative Director	1,0	-	1				
Heads of admin. departments (from E 13)	3,0	-	3				
Advisors (from E 13)	2,0	-	2				
Internal administration (E 9 to E 12)	13,5	-	14				
Internal services (E 4 to E 8)	5,3	-	6				
Student assistants	12,2	60,8	37				
Trainees (vocational training)	4	-	4				
Scholarship recipients at the institution	14,0	-	14		3		8
Doctoral candidates	11,0	-	11		2		5
Post-doctoral researchers	3,0	-	3		1		3

Annex B: Evaluation Report

Potsdam Institute for Climate Impact Research (PIK)

Contents

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Appendix:

Members of review board

1. Summary and main recommendations

The Potsdam Institute for Climate Impact Research (PIK) studies the causes and consequences of climate change, with the aim of developing mitigation and adaptation strategies. The guiding principle of PIK's work is to facilitate a sustainable management of global commons while taking account of planetary boundaries. Scientists from the fields of natural, economic and social sciences work together in four research departments (RDs), conducting research to obtain interdisciplinary findings that are used as the basis for decision-making in politics, the economy and civil society.

A key part of PIK's work involves developing and using a large number of computer simulations to model the Earth system in the past and future. Models of central importance are the Potsdam Earth Model (POEM) and the Potsdam Integrated Assessment Modelling Framework (PIAM). POEM is a flexible system of models for land biosphere, ocean, ice sheets and atmosphere to simulate the fundamental physical and biogeochemical dynamics of the Earth system. PIAM explores public policy pathways with a combination of scenario building, energy technology options, economic optimisation and multi-criteria policy assessment.

PIK's research results are of an outstanding quality. Examples are given by work on climate-related tipping points in the Earth system (e.g. the ongoing slowdown of the Atlantic Overturning Circulation), the role of atmospheric planetary wave resonance and changes in the jet stream for extreme weather events, and the management of the global carbon cycle as well as carbon pricing. The institute's excellent research results are regularly published in top-tier journals, including *Nature*, *Science* and *PNAS*. As recommended during the last evaluation, PIK now also publishes more frequently in high-ranking economics journals. In addition, the institute provides very important and highly demanded policy advice. Worth highlighting here is PIK's significant involvement in the assessment work of the Intergovernmental Panel on Climate Change (IPCC) and the policy advice to the EU and Germany regarding carbon taxation. In addition to the core funding from federal *and Länder* governments the institute's work is strongly supported by third-party funds, which have increased significantly in the last seven years.

Since the last evaluation, PIK has very successfully completed a comprehensive change process in terms of staff and organisation. Following the retirement of the renowned founding director in 2018, two new joint directors were appointed. The former Executive Director of the Stockholm Resilience Centre represents PIK's work in the natural sciences, while the former Deputy Director of PIK and former Head of RD3 now additionally represents the institute's economic focus at the highest leadership level. In addition, four of the eight department heads (two per department) have been newly appointed since the last evaluation. Three of the positions were filled with very successful scientists who were already employees at PIK, leading to only minor changes of the topics covered. The fourth position was filled with an external candidate in a joint appointment with Charité – Universitätsmedizin Berlin. The addition of the topic of public health to the research spectrum of RD2 is welcomed.

Meaningful changes have also been made at the organisational level. In particular, seven FutureLabs (FLs) were introduced as new structural units in 2019 that are each associated

with an RD. These FLs are interdisciplinary units, which investigate innovative new topics. Within the FLs, PIK works very closely with the Mercator Research Institute on Global Commons and Climate Change (MCC) in Berlin. MCC combines economic and social science analyses with a structured approach at the science-policy interface. It has been funded by Stiftung Mercator since 2012 and is led by one of the PIK directors, who represents the economic focus of PIK.

Special consideration should be given to the following main recommendations in the evaluation report (highlighted in **bold face** in the text):

Overall concept, activities and results (chapter 2)

1. The **system of models** has been expanded significantly in the last years. As recommended during the last evaluation, agent-based models have been developed to better depict the complexity of human behaviour. However, there is a need for further research here and PIK should increase its involvement in this complex and very important field. In addition, PIK should take greater account of the different types of uncertainties in its models and forecasts.

Regarding the simulation of transformative scenarios PIK should strengthen work on non-linearities and surprises caused by e.g. natural disasters or crises like the COVID-19 pandemic. In addition, PIK should investigate how observational data, which is obtained from partners for the validation of models, can be integrated in the models themselves. In parallel to optimising the existing models, PIK should draw up a long-term strategy with the aim of developing the next generation of models to better address the complexity of behaviour of individual agents.

Changes and planning (chapter 3)

2. By appointing two directors, one of them being an economist, PIK has taken an important step towards a further strengthening of the social sciences within the institute's work. The inclusion of the topic of public health is also welcomed. The new directors should now develop an **overarching vision** with aims for the next ten years. In the process, they should check to what extent they can integrate other important social science disciplines, besides economics, that are important for the work of the institute, such as political sciences, sociology or behavioural psychology. By doing so, the new leadership team has to balance options for widening interdisciplinary work with the challenging task of bringing together the already now broad spectrum of disciplines in a coherent research profile that integrates PIK's work in natural and in social sciences in a well-adjusted way.
3. By **integrating the Mercator Research Institute on Global Commons and Climate Change (MCC)** PIK plans to establish a Policy Research Hub on Managing Global Commons and Climate Change at PIK, as well as further strengthening three of the seven FutureLabs. At the moment, MCC has 55 staff members (35 full-time equivalents [FTE]) and is located in Berlin. Its core funding from Stiftung Mercator amounts to €2.1m per year and expires at the end of 2024. In addition, MCC secured third-party funding of nearly €1.4m in 2020. To integrate the MCC, PIK intends to apply for additional permanent institutional funding (extraordinary item of expenditure, *Sondertatbestand*)

from 2025 onwards of €3.738m per year, supplemented by €400,000 per year of existing own funds.

The submitted plans are supported in principle, but should be developed further and fleshed out before an application for additional funding is made. The plan to substantially expand the work in the field of social sciences through the integration of the MCC is a very welcome one. However, PIK should strengthen other disciplines here too, in addition to the focus on economics (see recommendation 2), and should develop a coherent plan which themes should strategically be addressed.

Regarding the organisational structure PIK should check whether the planned integration as a fifth RD is the best solution. An alternative might be a cross-cutting unit as an interface between the existing four RDs and policy. This decision may also be related to the as yet unresolved question of whether the MCC should stay at its current location in Berlin or move to Potsdam.

Human resources (chapter 5)

4. The **training formats for doctoral candidates** at PIK are still largely organised within the four departments. PIK should assess whether it could offer more interdepartmental formats, which could serve as a basis for an own doctoral programme.
5. With regard to gender equality the situation at PIK is still very unsatisfactory. The **proportion of women** in research and scientific services is low at around 35%, and unfortunately no higher than it was at the last evaluation. As of 31 October 2020, of the 17 leading scientists (2 scientific directors, 8 department heads and 7 deputy department heads) only 4 (24%) were women. Among the 24 heads of Working Groups and Future Labs there were 6 women (25%). Together with its supervisory board PIK must implement a clearly defined strategy to increase the proportion of women, especially at leadership level. This strategy should be supplemented with measures to promote an inclusive and diverse working environment.

Subdivisions of PIK (chapter 7)

6. After the welcomed inclusion of public health topics, it is now the task to sharpen **RD2's scientific profile**. The high number of different projects currently being pursued leads to the risk of fragmentation, as PIK's Scientific Advisory Board has already flagged up. The focus of the research work should be less on the *impact* of climate change and more on *resilience* to climate change, as seen for instance in the very interesting work on the resilience of global trade networks, including food systems. In terms of adaptation to climate change, local strategies and practices should be developed as well.
7. The very successful, long-standing **head of RD4 will retire in 2021**. It is good to see that PIK and Technische Universität Berlin plan to conduct a joint appointment procedure for the new head of department. However, this procedure will have to be tackled very fast to minimise the length of time the position is vacant.

2. Overall concept, activities and results

Overall concept

The Potsdam Institute for Climate Impact Research (PIK) studies the causes and consequences of climate change, with the aim of developing mitigation and adaptation strategies. The guiding principle of PIK's work is to facilitate a sustainable management of global commons while taking account of planetary boundaries. Scientists from the fields of natural, economic and social sciences work together in four research departments (RDs), conducting research to obtain interdisciplinary findings that are used as the basis for decision-making in politics, the economy and civil society. A key part of PIK's work involves developing and using a large number of computer simulations to model the Earth system in the past and future (see below).

Activities and results

Research

PIK's research results are of an outstanding quality. Research worth highlighting has included climate-related tipping points in the Earth system (e.g. the ongoing slowdown of the Atlantic Overturning Circulation), the role of atmospheric planetary wave resonance and changes in the jet stream for extreme weather events, and the management of the global carbon cycle as well as carbon pricing. The institute's excellent research results are regularly published in top-tier journals, including *Nature*, *Science* and *PNAS*. As recommended during the last evaluation, the institute now also publishes more frequently in high-ranking economics journals, e.g. *Energy Economics* and *Journal of Environmental Economics and Management (JEEM)*.

Modelling Strategy

PIK has developed a large number of excellent models and enjoys an outstanding reputation for the software engineering that goes into them. PIK's publications include data as well as software publications. Two integrated model systems are of central importance: the Potsdam Earth Model (POEM) and the Potsdam Integrated Assessment Modelling Framework (PIAM), which integrate various sub-models. POEM is a flexible system of models for land biosphere, ocean, ice sheets and atmosphere to simulate the fundamental physical and biogeochemical dynamics of the Earth system. PIAM explores public policy pathways with a combination of scenario building, energy technology options, economic optimization and multi-criteria policy assessment. Furthermore, PIK coordinates model-related activities that systematically compare models from different institutes worldwide, e.g. the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) and the Shared Socio-economic Pathways process.

The system of models has been expanded significantly in the last years. For instance, it now also includes models for climate change, human migration and urbanisation patterns, the impact of weather extremes on economic development, the coupling of social world dynamics and biophysical-ecological Earth dynamics. **As recommended during the last evaluation, agent-based models have been developed to better depict the complexity of human behaviour. However, there is a need for further research here and PIK**

should increase its involvement in this complex and very important field. In addition, PIK should take greater account of the different types of uncertainties in its models and forecasts.

Regarding the simulation of transformative scenarios PIK should strengthen work on non-linearities and surprises caused by e.g. natural disasters or crises like the COVID-19 pandemic. In addition, PIK should investigate how observational data, which is obtained from partners for the validation of models, can be integrated in the models themselves. In parallel to optimising the existing models, PIK should draw up a long-term strategy with the aim of developing the next generation of models to better address the complexity of behaviour of individual agents.

Knowledge Exchange and Transfer

PIK provides very important and highly demanded policy advice. Worth highlighting here is PIK's significant involvement in the assessment work of the Intergovernmental Panel on Climate Change (IPCC) and the policy advice to the EU and Germany regarding carbon taxation. Under the co-chairmanship of one of PIK's directors, the scientific state of climate change mitigation was described and published in 2015 for IPCC's Working Group 3. PIK researchers also contributed to the Working Groups 1 and 2 parts of the Fifth Assessment Report, which informed the UNFCCC Paris Agreement in 2015. PIK scientists also advise the European Commission, the Federal Bank, the European Central Bank and the Mission Board for Climate Adaptation and Social Transformation.

In 2019, PIK advised the German government during the development of its new law on energy transformation. Together with the Leibniz Institute for Economic Research (RWI), and in close cooperation with the MCC, it developed a proposal for a CO₂ price reform.

PIK's transfer activities also include organizing conferences such as the Berlin Climate and Security Conference with the German Federal Foreign Office, bringing together executive representatives of banks and insurers, and a round table with the European Automobile Manufacturers Association. PIK also very successfully communicates insights on climate change to the general public, e.g. via appearances in the media and on Twitter (30.000 followers).

Technology transfer has also led to two spin-off companies: *elena international*, which was founded in 2019, offers consulting services and software solutions for grid operators and energy utilities that are based on analysis methods and modelling approaches developed at PIK; *Climate Risk Solutions* offers economic climate risk consulting and is based on Acclimate, a PIK-developed open-source economic shock model. Even though patents are not the focus of PIK's research, one patent has been granted: for a method for minimizing instabilities in gas turbines, based on research using the complex networks approach.

3. Changes and planning

Development since the previous evaluation

Since the last evaluation, PIK has very successfully completed a comprehensive change process in terms of staff and organisation. Following the retirement of the renowned

founding director in 2018, two new joint directors were appointed. The former Executive Director of the Stockholm Resilience Centre represents PIK's work in the natural sciences, while the former Deputy Director of PIK and former Head of RD3 now additionally represents the institute's economic focus at the highest leadership level.

Within the four RDs, four of the eight heads of department have been newly appointed, and another one is due to retire in 2021. Three of the four positions were filled with very successful candidates who were already working at PIK, leading to only minor changes of the topics covered. The fourth position was filled with an external candidate in a joint appointment with Charité – Universitätsmedizin Berlin. The addition of the topic of public health to the research spectrum of RD2 is welcomed.

Meaningful changes have also been made at the organisational level. Within the four departments, the former 'flagship projects' have been turned into working groups. In addition, seven FutureLabs (FLs) were introduced as a new instrument in 2019 that are each associated with an RD. These FLs are interdisciplinary units, which investigate innovative new topics (see chapter 4). The FLs will be evaluated by the Scientific Advisory Board after five years. Within the FLs, PIK works very closely with the Mercator Research Institute on Global Commons and Climate Change (MCC) in Berlin. MCC combines economic and social science analyses with a structured approach at the science-policy interface. It has been funded by Stiftung Mercator since 2012 and is led by one of the PIK directors, who represents the economic focus of PIK.

Strategic work planning for the coming years

By appointing two directors, one of them being an economist, PIK has taken an important step towards a further strengthening of the social sciences within the institute's work. The inclusion of the topic of public health is also welcomed. The new directors should now develop an overarching vision with aims for the next ten years. In the process, they should check to what extent they can integrate other important social science disciplines, besides economics, that are important for the work of the institute, such as political sciences, sociology or behavioural psychology. By doing so, the new leadership team has to balance options for widening interdisciplinary work with the challenging task of bringing together the already now broad spectrum of disciplines in a coherent research profile that integrates PIK's work in natural and in social sciences in a well-adjusted way.

Planning for additional institutional funding

By integrating the Mercator Research Institute on Global Commons and Climate Change (MCC) PIK plans to establish a Policy Research Hub on Managing Global Commons and Climate Change at PIK as well as further strengthening three of the seven FutureLabs. At the moment, MCC has 55 staff members (35 full-time equivalents [FTE]) and is located in Berlin. Its core funding from Stiftung Mercator amounts to €2.1m per year and expires at the end of 2024. In addition, MCC secured third-party funding of nearly €1.4m in 2020. To integrate the MCC, PIK intends to apply for additional permanent institutional funding (extraordinary item of expenditure,

Sondertatbestand) from 2025 onwards of €3.738m per year, supplemented by €400,000 per year of existing own funds. Of the resulting €4.138m per year, €715,000 will be used for operating costs and €3.423m for personnel (32 FTE, including 10 W2 professorships).

The submitted plans are supported in principle, but should be developed further and fleshed out before an application for additional funding is made. The plan to substantially expand the work in the field of social sciences through the integration of the MCC is a very welcome one. However, PIK should strengthen other disciplines here too, in addition to the focus on economics (see recommendation 2), and should develop a coherent plan which themes should strategically be addressed.

Regarding the organisational structure PIK should check whether the planned integration as a fifth RD is the best solution. An alternative might be a cross-cutting unit as an interface between the existing four RDs and policy. This decision may also be related to the as yet unresolved question of whether the MCC should stay at its current location in Berlin or move to Potsdam.

4. Controlling and quality management

Facilities, equipment and funding

Funding

The institutional funding provision is sufficient to cover PIK's current portfolio of activities. Since the last evaluation, the institute's core budget has increased from €10.5m in 2013 to €12.4m in 2020.

PIK continues to be extremely successful in securing revenue from project grants, which have increased significantly since the last evaluation. Between 2011 and 2013, average revenue from project grants was €10m p.a. (47% of the overall budget), and it increased to €16.6m p.a. on average (56%) between 2018 and 2020. In the process, PIK also increased its revenues from the German Research Foundation (DFG), as recommended, from €240,000 to €700,000 on average p.a. An ERC Advanced Grant for one of the two directors also deserves a mention. It is good to see that PIK has set itself the aim of securing further ERC grants because it is ideally positioned to do so.

Furthermore, between 2018 and 2020, PIK generated €2m from services (average of €666,000 p.a.).

Facilities and equipment

Following the erection of a new building in 2015 and the refurbishment of two further buildings to improve energy efficiency, the institute now has very good facilities and equipment. It is good to see that PIK attaches great importance to sustainability in the operation of its facilities.

High-performance computer infrastructure

Since computer-intensive modelling forms the basis of PIK's work, it is essential that the institute is equipped with modern, regularly updated in-house supercomputing facilities. PIK last updated its high-performance computer (HPC) facilities in 2015. As recommended, it also developed a sound data security strategy and implemented a data mirroring system. It is good to see that the institute has plans to replace the current system from 2022 onwards with a new state-of-the-art HPC. For its HPC activities, PIK additionally uses the infrastructure offered by national facilities, such as the North German Supercomputing Alliance and the German Climate Computing Centre. PIK is participating in the National Research Data Infrastructure (NFDI) consortium NFDI4Earth, which aims to consolidate and harmonise research-data-related services in Earth System Sciences. The federal and *Länder* governments approved a proposal in 2021 to fund the consortium.

Organisational and operational structure

The organisational and operational structures are appropriate and effective. Since the last evaluation, PIK has undertaken some comprehensive and logical organisational restructuring.

The Board of Directors (BoD) has been expanded from one director to three. PIK now has two scientific directors instead of one. As recommended during the last evaluation, the administrative director is now also a member of the BoD. The statutes have been revised in line with the usual standards for Leibniz institutions to take account of these and other points recommended during the last evaluation.

Within the four departments, the former 'flagship projects' have been turned into working groups. In addition, FutureLabs (FLs) were introduced as new structural units in 2019, in collaboration with the MCC. This is welcomed, however in some cases the connection to the RDs should be intensified.

A number of different formats provide adequate support for internal communications. The key one is the Board of Scientists. It consists of all eight RD heads and deputy heads, as well as Working Group and FutureLab leaders. In addition, elected representatives of postdoctoral and doctoral researchers and the ombudspersons are also involved. It meets twice annually and advises the BoD on scientific matters.

Quality management

The institute's quality management is aligned with the established standards. Rules are in place to ensure good scientific practice, which are based on the recommendations of the German Research Foundation as well as good scientific modelling. PIK has elected ombudspersons and has established a position for compliance and quality management. Its efforts to ensure scientific integrity extend to standardised processes for research data management.

The research agenda and the allocation of funding are detailed in PIK's programme budget, which monitors and forecasts the scientific and organizational development. PIK's

achievements database and its new publication management database support the monitoring of PIK's output.

Quality management by the advisory board and supervisory board

The Board of Trustees (*Kuratorium*) and the Scientific Advisory Board (SAB) fulfil their role in an adequate manner. In between evaluation periods, the SAB conducts an audit of the institute as a whole and of its individual units, as is usual for Leibniz institutes.

5. Human Resources

Leading scientific and administrative positions

PIK generally fills the positions of scientific directors and department heads through joint professorial appointments based on cooperation agreements with universities. The recruitment procedures follow the Standards for Appointments to Academic Management Positions within the Leibniz Association.

Scientific leadership positions are discussed with the SAB, and filled through an international recruitment process or via strategic promotion of highly qualified internal candidates. Since the last evaluation, six new appointments have been made to leadership positions (2 scientific directors and 4 department heads). Four positions were filled internally and two with external candidates.

Staff with a doctoral degree and doctoral candidates

PIK provides a stimulating environment for young researchers and follows the Career Guidelines of the Leibniz Association.

The success of PIK's support can be seen in the fact that, since the last evaluation, 9 postdoctoral researchers have been offered professorships. In addition, 6 employees successfully completed their habilitation. Postdocs also moved into leading positions in federal or *Land* ministries, in other research organisations around the world, and in the business world. The newly established FutureLabs create opportunities for qualified postdocs to develop their own research agenda and gain experience in group leadership.

At 31 October 2020, there were 64 PhD candidates employed at PIK, and 11 scholarship recipients. Between 2018 and 2020, 39 doctoral researchers employed at PIK completed their doctorates. In addition, 25 doctoral researchers employed externally but supervised by PIK researchers also completed doctorates. On average, it takes 4 years to complete a doctoral degree at PIK. Many doctoral candidates are employed within third-party projects for three years. It is good to see that PIK always manages to finance a fourth year if necessary. However, the institute should define a transparent standard procedure on how to get funding for this fourth year. The institute has binding guidelines for the structured support of doctoral candidates as well as quality standards for doctoral projects. It is good to see that doctoral candidates have access to external graduate schools e.g. at the University of Potsdam (PoGS) and Humboldt Universität zu Berlin (HGS). **The training formats for doctoral candidates at PIK are still largely organised within the four departments. PIK**

should assess whether it could offer more interdepartmental formats, which could serve as a basis for an own doctoral programme.

Equal opportunities and work-life balance

With regard to gender equality the situation at PIK is still very unsatisfactory. The proportion of women in research and scientific services is low at around 35%, and unfortunately no higher than it was at the last evaluation. As of 31 October 2020, of the 17 leading scientists (2 scientific directors, 8 department heads and 7 deputy department heads) only 4 (24%) were women. Among the 24 heads of Working Groups and Future Labs there were 6 women (25%). Together with its supervisory board PIK must implement a clearly defined strategy to increase the proportion of women, especially at leadership level. This strategy should be supplemented with measures to promote an inclusive and diverse working environment.

6. Cooperation and environment

Cooperation with universities in Potsdam and Berlin

PIK is closely connected with universities in Brandenburg and Berlin. One of the two new directors and four other scientists were jointly appointed to professorships with the University of Potsdam. The other director and another scientist were jointly appointed to professorships with Technische Universität Berlin (TU Berlin). Five joint appointments to professorships were carried out with Humboldt Universität zu Berlin (HU Berlin) and another one with Charité – Universitätsmedizin Berlin. Between 2018 and 2020, PIK researchers were involved as partners of the universities in four DFG-funded Priority Programmes (SPPs), one Research Unit (FOR) and two Research Training Groups (GRKs). Some of these collaborative projects are still ongoing. PIK researchers contribute to university teaching at all levels from undergraduate to PhD students.

Other national collaborations

PIK's main forms of collaboration within the Leibniz Association are through the five Leibniz Research Alliances in which it is involved. The institute is also part of two Leibniz Research Networks: Mathematical Modelling and Simulation, and Integrated Earth System Research. In addition, PIK cooperates with Leibniz Institutes in projects funded through the Leibniz internal competitive procedure. Other important national collaborations are with the Max Planck Institute (MPI) for Meteorology in Hamburg, the MPI for Biogeochemistry in Jena and the Helmholtz Centre for Environmental Research in Leipzig – UFZ.

International cooperation and visibility

PIK is highly visible at the international level and collaborates in various projects with many different partners from all over the world. The reports of the IPCC (Intergovernmental Panel on Climate Change) enjoy particularly high visibility and are a major international collaborative endeavour. PIK's contributions range from model intercomparison projects and state-of-the-art scientific assessments of risks of non-linear dynamics in oceans and on land to climate impacts and mitigation strategies.

Another major joint project involving PIK is the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP), which offers a framework for consistent impact simulations across 14 sectors and different spatial scales. Furthermore, PIK is involved in consortia dealing with Integrated Assessment Modelling (e.g. IAMC and EMF) and Earth System Modelling (e.g. PalMod and EHSMIP).

Following a recommendation from the last evaluation, PIK has prioritised the acquisition of high-quality data and cooperates with numerous partners to gain access to such data. Recent examples include cooperation with the Lake Rukwa Basin Water Board in Tanzania for assistance in applying geographic information system tools to obtain data for the SWIM model. In addition, to increase reproducibility and openness, PIK uses multiple high-quality open sources for its data, including the Food and Agricultural Organization of the United Nations (FAO) for agricultural and food data, and the World Development Indicators.

7. Subdivisions of PIK

Research Department 1: Earth System Analysis

[34.1 FTE, of whom 28.6 FTE research and scientific services staff, 4.2 FTE doctoral candidates, and 1.3 FTE service staff]

The Research Department 1 (RD1) is one of the leading international groups in the field of Earth system analysis. Its excellent work provides the natural sciences background for PIK's research. The aim of the RD is to understand and model physical and biogeochemical processes of the Earth system and its response to human interference with a clear focus on tipping points, planetary boundaries, earth trajectories and extreme events. For the simulation of the extremely complex processes that occur in this context, the RD develops and uses an impressive array of models to investigate e.g. the atmosphere (Aeolus), the ocean (MOM), ice sheets (PISM) and global land biosphere (LPJmL). The various models demonstrate very good adaptability and are brought together in the overarching Potsdam Earth Model (POEM). The LPJmL model also creates a link to the second central PIK model: the Potsdam Integrated Assessment Modelling Framework (PIAM), which is used primarily in RD2 and RD3.

RD1 has made very good progress since the last evaluation and has developed a new Earth system model of intermediate complexity for timescales up to hundreds of millennia (CLIMBER-X). Moreover, pioneering plant-economic concepts have been introduced into vegetation models to study biodiversity interactions with the Earth system. Other very notable contributions have been made in the fields of Pleistocene ice ages, sea level rise and planetary wave resonance. The excellent research results are reflected in an impressive publication record, with numerous articles in high-ranking journals. The RD secures a very high level of third-party funding, which has almost doubled since the last evaluation. The majority comes from the EU. The RD is also very successful when it comes to training doctoral candidates.

The main focus of the future plans is on the important and necessary further development of the existing models. As well as global processes, there should be a greater focus on local phenomena at scales relevant for human decision-making and the uncertainty of

forecasts. In addition, PIK should investigate how observational data, which is provided by partners for the validation of models, can be integrated in the models themselves (see recommendation in chapter 2).

Research Department 2: Climate Resilience

[62.9 FTE, of whom 47.2 FTE research and scientific services staff, 9.2 FTE doctoral candidates, and 6.4 FTE service staff]

RD2 successfully conducts research on the resilience of social and ecological systems to climate change, in various sectors and across multiple spatial scales. The research programme is very impressive in its breadth, covering aspects of persistence, the capacity to recover and the transformability of systems, reflecting the full diversity of impacts of climate change. The work is based on a range of innovative biophysical and socio-economic models, e.g. the global land biosphere model LPJmL and the global land use model MAgPIE. These models are important pillars of the Potsdam Integrated Assessment Modelling Framework (PIAM) and are an important contribution to the global scientific community. The LPJmL also supports the Potsdam Earth Model (POEM, see RD1). It is welcomed that the models have been made available as open source software. Furthermore, until 2018, RD2 coordinated the important activities of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP), which were moved to RD3 when the responsible member of staff took over as head of that department.

Shortly after the last evaluation, one of the two long-serving department heads retired. His position was filled in 2019 in a joint appointment procedure conducted with Charité – Universitätsmedizin Berlin. The associated broadening of the department's research to include public health is a welcome development. Among other things, it allows the department to investigate the effects that future pandemics might have on global commons. RD2's outstanding research results are widely recognised internationally and are published in leading journals. Third-party funding is also very high and has increased significantly since the last evaluation. Funding from the EU in particular has almost tripled and now represents the largest share. The number of doctorates completed is also high.

After the welcomed inclusion of public health topics, it is now the task to sharpen RD2's scientific profile. The high number of different projects currently being pursued leads to the risk of fragmentation, as PIK's Scientific Advisory Board has already flagged up. The focus of the research work should be less on the *impact* of climate change and more on *resilience* to climate change, as seen for instance in the very interesting work on the resilience of global trade networks, including food systems. In terms of adaptation to climate change, local strategies and practices should be developed as well.

Research Department 3: Transformation Pathways

[83.8 FTE, of whom 51.4 FTE research and scientific services staff, 24.8 FTE doctoral candidates, and 7.6 FTE service staff]

RD3 conducts very successful research on impacts of climate change and on transformation pathways leading to a sustainable management of the atmosphere and biosphere as global

commons. The topics dealt with are of high relevance and include e.g. distributional impacts of climate policy, climate-induced migration and the role of the financial sector in mitigating climate change. The work is based on the Potsdam Integrated Assessment Modelling Framework (PIAM), which integrates a number of innovative sub-models like MagPIE, LPJmL (see RD2), the energy-economy model REMIND and the reduced-complexity climate model MAGICC. Furthermore, since 2018, RD3 has been responsible for the ISIMIP project (see RD2), which has been expanded to add an impact attribution framework designed to quantify the contribution of climate change to observed changes in natural and human systems.

The scientific output is excellent in terms of quality, with a substantial share of publications appearing in top-tier journals of different disciplines. As recommended during the last evaluation, RD3 now also publishes much more frequently in high-ranking economic journals. Overall, however, the number of publications in relation to the number of staff is considerably lower than in the other RDs. This might be due to different publication cultures in different disciplines but the RD should reflect critically on this point. Third-party funding revenues are very high and have more than tripled since the last evaluation. As well as significant funding from the federal and *Länder* governments and the EU, RD3 now also receives funding from the DFG. The number of completed doctorates is low compared with the other RDs and should be increased.

During the last years RD3 was in a period of transition because of personnel changes in both RD leadership positions. One of the two former department heads took on the role of a scientific director of PIK in 2018, and the other switched departments to become head of RD4 in 2019 (see below). Both positions have been filled with deputy heads of RD2 and RD3. In the future the RD aims to advance economic modelling of climate change mitigation and impacts, including the analysis of distributional effects. However, within the investigated topics (e.g. economic structural changes, migration and ethnic conflicts) more consideration should be given to the fact that they also have strong links to scientific fields like political sciences, sociology and behavioural psychology and might therefore profit from a broader socio-economic perspective (see recommendation in chapter 3).

In relation to the further development of the Integrated Assessment Modelling (IAM) and as recommended, the RD has developed agent-based models to better depict the complexity of human behaviour. However, there is a need for further research in this challenging field. In addition, the research on transformative scenarios should also pay more attention to non-linearities and surprises caused by e.g. natural disasters and crises. This could also consider scenarios of economic “degrowth” (or qualitative growth), instead of the (quantitative) economic growth paradigm. Another aspect that should receive greater attention in future concerns different types of uncertainties of forecasts (see recommendation in chapter 2).

Research Department 4: Complexity Science

[39 FTE, of whom 21 FTE research and scientific services staff, 14.7 FTE doctoral candidates, and 3.3 FTE service staff]

This Research Department (RD4) conducts cutting-edge transdisciplinary research and development on methodologies, including e.g. complex networks, nonlinear modelling and

machine learning, with an emphasis on their application to the Earth system. RD4 is known internationally for its pioneering contributions to the development of climate networks, including their application to medium and long-term prediction of the Indian summer monsoon, El Niño events, extreme rainfall and droughts in the Amazon. RD4 has developed novel schemes that enable successful predictions well beyond classical lag times, as well as methods to identify complex teleconnections in the climate system and to enhance the understanding of abrupt climate transitions. It has also very successfully started to generalise machine-learning methods to develop paradigmatic model systems that have demonstrated great potential for application to observed climate data. RD4 also develops advanced innovative methods to improve estimates of the socio-economic impacts of climate change.

The RD has made very good progress since the last evaluation. The outstanding research results are regularly published in high-ranking journals. Third-party funding is very high and has more than doubled since the last evaluation. It is pleasing to see that the RD now secures funding from the DFG, as well as from the federal and *Länder* governments and the EU. Worth highlighting is RD4's involvement in the Cluster of Excellence MATH+. The number of doctorates completed is very high. It is also very pleasing to see that two spin-off companies have been established successfully.

RD4 is currently in a period of transition. One of the two heads of department left the department in 2019 to run the FutureLab on *Social Metabolism and Adaptation*. The vacancy was filled seamlessly with the former head of RD3. **The second very successful, long-standing head of RD4 will retire in 2021. It is good to see that PIK and Technische Universität Berlin plan to conduct a joint appointment procedure for the new head of department. However, this procedure will have to be tackled very fast to minimise the length of time the position is vacant.**

Against the background of the change of personnel at the top of the department, it makes sense that the plans for the future have not yet been fleshed out in detail. The idea of expanding the research in the field of big data analytics and non-linear machine learning is a good and timely one. However, the plans must be made considerably more precise by the new department heads, especially in terms of the work that will have to be reduced in exchange. In addition, the department should check to what extent the range of investigated scales can be expanded, particularly in relation to the enduring topic of weather-climate interactions. Another aim of the new heads of department should be to intensify collaboration with the other RDs and to, thus, increase RD4's impact on the other RDs' work.

8. Handling of recommendations of the last external evaluation

PIK has successfully addressed most of the recommendations made by the Leibniz Association Senate in 2015 (see status report, p. A-23ff.). The recommendation on the proportion of women, especially in scientific leadership positions still applies. The new directors have to achieve improvements (see chapter 5).

Appendix

1. Review Board

Chair (Member of the Leibniz Senate Evaluation Committee)

Nicola **Fohrer** Institute for Natural Resource Conservation,
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Management, Kiel University

Deputy Chair (Member of the Leibniz Senate Evaluation Committee)

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Representative of the Federal Government

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Representative of the Länder Governments (Member of the Leibniz Senate Evaluation Committee)

Babett **Gläser** Saxon State Ministry for Science, Culture and
Tourism

29 October 2021

Annex C: Statement of the Institution on the Evaluation Report

Potsdam Institute for Climate Impact Research (PIK)

The Board of Directors, on behalf of the Potsdam Institute for Climate Impact Research, would like to thank the review board for conducting this comprehensive evaluation. The review board's acknowledgement of our achievements not only affirms PIK's development, but also serves as an important motivation to continue with our strategic direction.

The evaluation commission acknowledges the outstanding quality of PIK's excellent research results. We are particularly grateful for and proud of the praise for our four research departments. This is a well-deserved recognition of their remarkable work, which is highly relevant both academically and for scientific policy advice.

We are thankful for the review board's recognition of PIK's very successful transformation since the appointment of the new Directors. We appreciate the recommendations by the evaluation committee and, in dialogue with our Scientific Advisory Board, will take them into account as we implement the next phase in PIK's strategic development. It is PIK's vision to advance the scientific frontier on interdisciplinary climate impact research for global sustainability and to contribute knowledge and solutions for a safe and just climate future. A guiding framework for our work is the integration of research on understanding planetary boundaries and governing global commons.

With that in mind, we particularly welcome the support for our planned Sondertatbestand, which is a significant step in advancing our strategy. Echoing the recommendation by the review board, PIK's strategy for 2030 seeks to strengthen our interdisciplinary research capabilities by raising further our social sciences, as we continue advancing our natural sciences and interdisciplinary research integration across disciplines. It is our aim to continue positioning PIK at the international frontier of climate impact research and global sustainability science, and thereby provide an even stronger science-based policy interface. For this, a better understanding is needed of appropriate governance regimes for common-pool resources and interactions, and of impacts from human pressures on the coupled Earth system, in order to provide solution-oriented policy pathways for governing global commons to enhance human well-being. As recognized by the review board, we significantly enhanced our research in climate economics, and as recommended, we strive to expand into broader social sciences. The Sondertatbestand seeks to raise to the same level of excellence and relevance the social sciences at PIK while at the same time strengthening the natural sciences.

We are rightfully held to high standards related to gender equality. With the generational change taking place over the coming years as well as other measures stemming from our Equality Concept, we are committed to an equal representation in general and especially at the leadership levels.

We would like to also thank the Ministry of Science, Research and Culture of the State of Brandenburg for the trustful cooperation and its continued and substantial support of PIK.