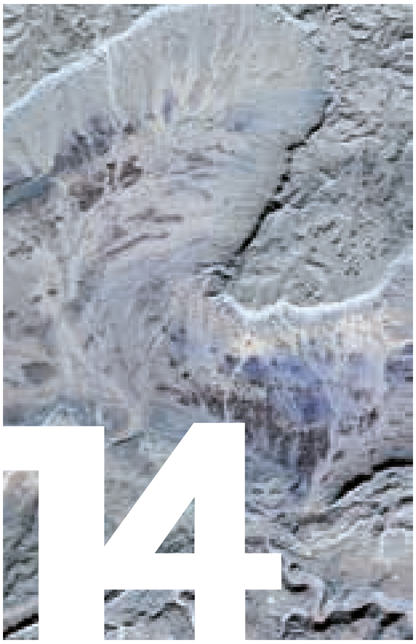
Portal Wissen

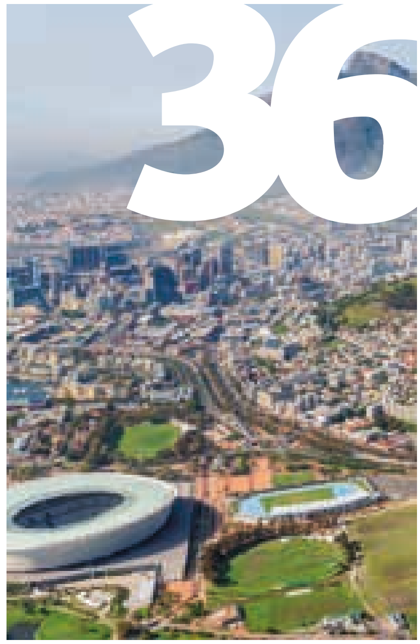
The Research Magazine of the University of Potsdam

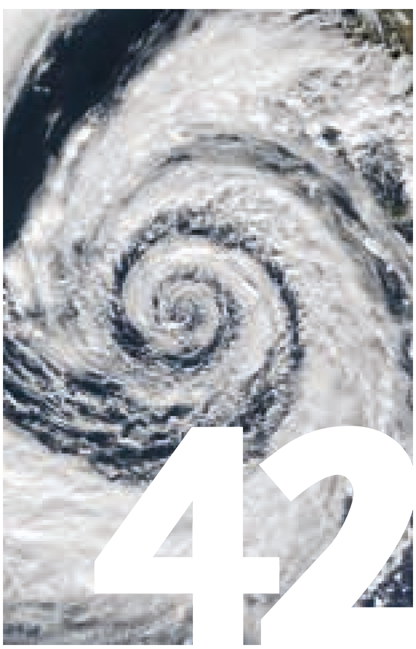
Two 2017

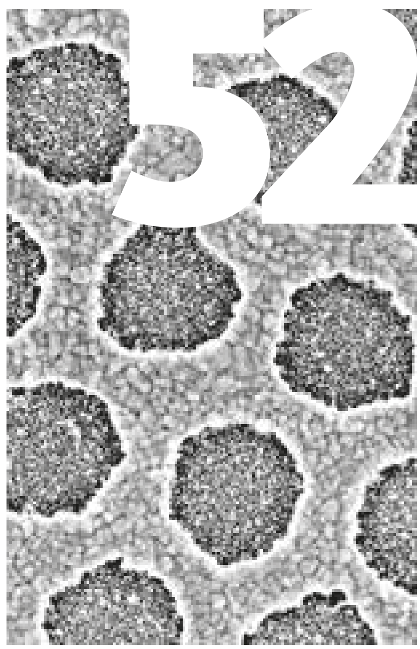
Universität Potsdam

EARTH









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EARTH

Earth's surface is constantly changing. It is the synergetic overlap between the geosphere, biosphere, and climatic sphere and influences the development of our planet. It is our habitat and plays a key role in maintaining the wellbeing of humanity. Many aspects of this system as a whole, however, are not yet understood.

This needs to change immediately because there is not much time left for the Earth – or for us. Photographer and filmmaker Yann Arthus-Bertrand warned in 2009, "In less than 200 years we have disturbed the balance of the Earth that has been created in over four billion years." Potsdam and Berlin geoscientists, biologists, and climatologists have now joined forces*: They are investigating processes of the Earth's surface in order to better understand them on various spatial and time scales and to predict how our living environment will develop.

In this issue of the research magazine "Portal Wissen", we present some of the research projects as well as the researchers who drive them. We followed researchers to Ethiopia – to the "cradle of humankind" – where elaborate drilling is offering a glimpse into climate history. Analyses of the several-hundred-thousand-year old deposits provide insights not only for geological and climate researchers. Biologists were able to reconstruct how entire ecosystems developed over long periods using state-of-the-art genetic analysis. A geomicrobiologist shows us the vast insight you get when you cross disciplinary boundaries. His research is no longer taking place on and in the earth but even in outer space. The young researchers of the research training group StRatGy cut large boulders from the Argentinean Andes into the thinnest of slices in order to understand how the mountains developed. And a data analysis expert explains why it is not enough to collect and feed a lot of data into a computer; they also have to be made readable using the right analytic tools.

"The world is a fine place and worth the fighting for," wrote Ernest Hemingway. This is exactly what researchers are doing when they look for solutions to prevent humanity from irreversibly damaging the Earth. We met a researcher who is working with colleagues throughout Europe to learn more about trace elements and using plants as pollutant "vacuum cleaners". And it was explained to us how satellite images taken from afar are revolutionizing nature conservation.

The diversity of research at the University of Potsdam should not be forgotten. We followed administrative scientists on the trail of successful reforms around the world and we looked at how reading can be more successful. We asked what supplementary extracurricular lessons can offer (or not offer) and looked into the networked classroom of the future. Germanists also revealed their Brandenburg linguistic treasures to us, psychologists showed us their experiments, and a historian explained to us why the MfS – the GDR state security ministry – were active as development workers. Last but not least, we visited a chemist in the lab, were introduced to the language of climate images, and listened to a romance philologist who researches with all her senses.

Enjoy your read!

THE EDITORS
TRANSLATION: SUSANNE VOIGT

*** University of Potsdam (UP), Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ), Alfred Wegener Institute for Polar and Marine Research (AWI), Potsdam Institute for Climate Impact Research (PIK), Museum für Naturkunde Berlin (MfN) and Technische Universität Berlin (TUB).**

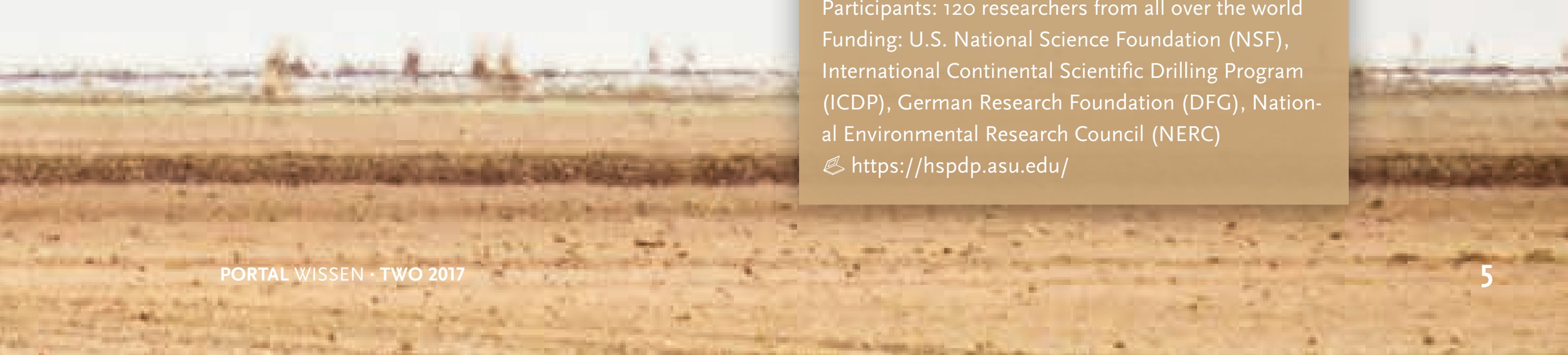
Photo: LacCore National Lacustrine Core Facility/Verena Foerster

THE ARCHIVE OF **HUMANIZATION**

Geoscientists read human evolution from sediment drill cores

Photo: Junginger, Annett

Research in blazing heat –
drilling camp in southern Ethiopia



THE PROJECT

The **“Hominin Sites and Paleolakes Drilling Project”** (HSPDP) is chaired by Prof. Andrew Cohen of the University of Arizona, together with 19 principal investigators including Martin Trauth, and researches human evolution with regard to environmental changes and climatic influences. The **“Chew Bahir Drilling Project”** is a HSPDP sub-project chaired by apl. Prof. Martin H. Trauth (University of Potsdam), Prof. Frank Schäbitz (University of Cologne), Prof. Henry Lamb (Aberystwyth University, UK), and Prof. Asfawossen Asrat (Addis Ababa University, Ethiopia)

Participants: 120 researchers from all over the world
Funding: U.S. National Science Foundation (NSF), International Continental Scientific Drilling Program (ICDP), German Research Foundation (DFG), National Environmental Research Council (NERC)
https://hspdp.asu.edu/

East Africa is the "cradle of humanity", where our ancestors lived some 60,000 years ago and from where they spread throughout the world. In the Great Rift Valley, geoscientists are researching turning points in human evolution and how climatic changes affected them.

It sounds like thrilling adventure set in a romantic landscape: In 2014, researchers set up camp in the wilderness of the East African Rift amidst an arid salt pan – the Chew Bahir basin in southern Ethiopia. Here researchers spend several weeks on a geologic mega-project, drilling 280 meters into the ground and extracting two sediment cores that will provide deep insight into the earth's history. In reality, though, the work is mostly arduous and exhausting. "The weather is blazing hot; there is no shade; you work day and night in shifts, and – despite the heat – you have to wear thick clothing at night to protect yourself from billions of mosquitos." Martin Trauth, apl. Professor of Paleoclimate Dynamics, knows what he is talking about. He has been involved in many projects in East Africa and Southern America. Despite not being personally onsite for this project – he was a young father at the time – he coordinated the project from afar.

But field research in Africa had more surprises and challenges in store – flash floods, all sorts of poisonous animals, and tribal conflict that led to the camp being evacuated. They also faced obstacles at a very different level. "The University's administration is not fully equipped to support international projects of this dimension and complexity," Trauth explains. This is why it took a full year for the administration to release the research funds for drilling in Ethiopia.

Today, the two sediment drill cores extracted by the geoscientists three years ago are being stored in a cool place in a US laboratory. They are now in a collection of cores contributed by 120 researchers throughout the world – paleoanthropologists, geochronologists, geologists, and biologists – for the "Hominin Sites and Paleolakes Drilling Project". The researchers are going back to the "cradle of humanity" to find out how our ancestors adapted to environmental changes. Based on the data obtained from the cores, they can reconstruct climate changes over time. They can spot droughts, humid phases or floods, how the vegetation and, thus, the nutritional basis of prehistoric humans developed – namely, continuously. As a result, the researchers hope to gain new insight into the evolution of humanity.

THE RESEARCHER

Apl. Prof. Dr. Martin Trauth studied geophysics and geology at the University of Karlsruhe. Since 2011, he has been apl. Professor of Paleo-Climate Dynamics at the University of Potsdam and researches climate changes using statistical methods.

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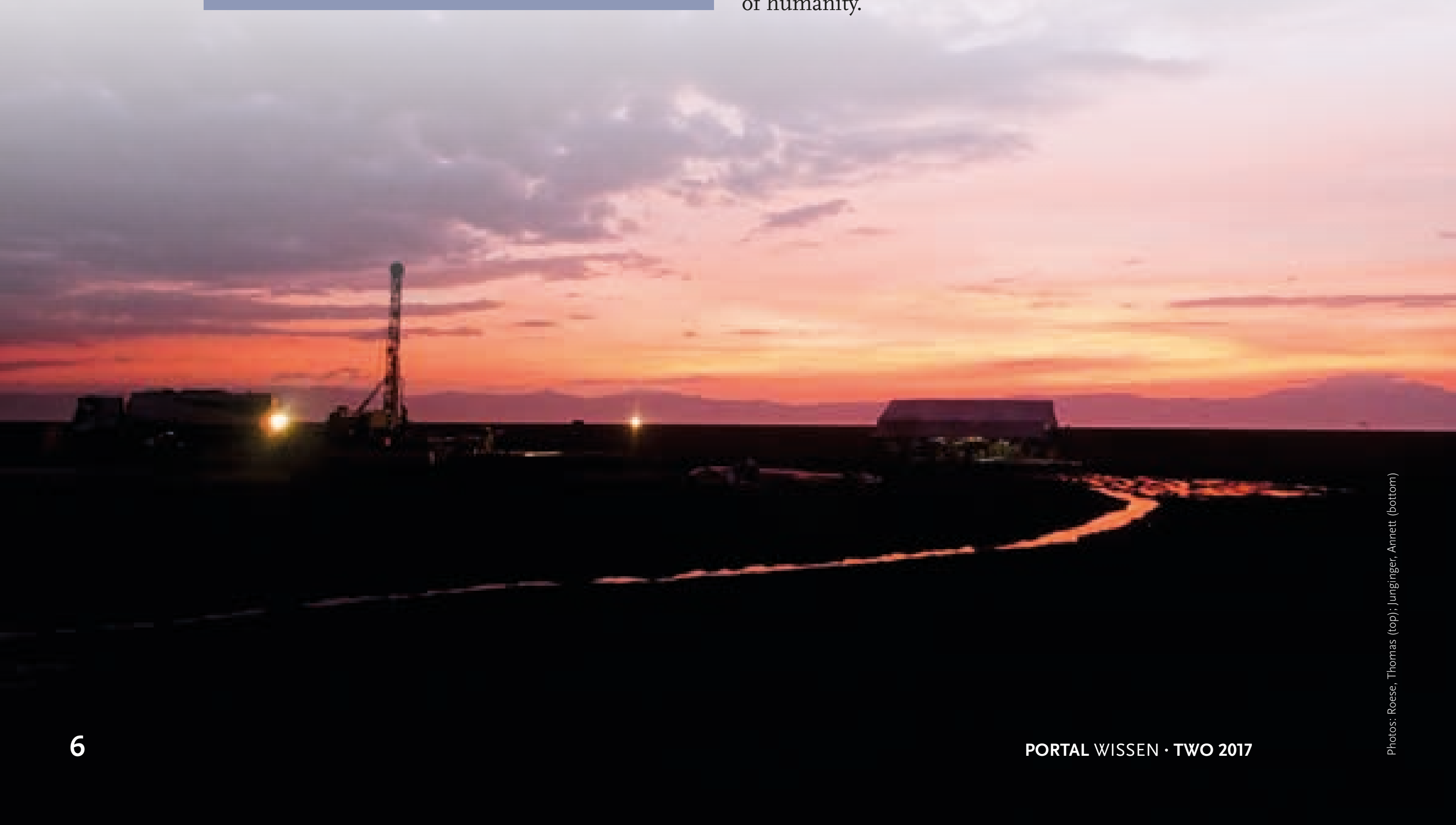
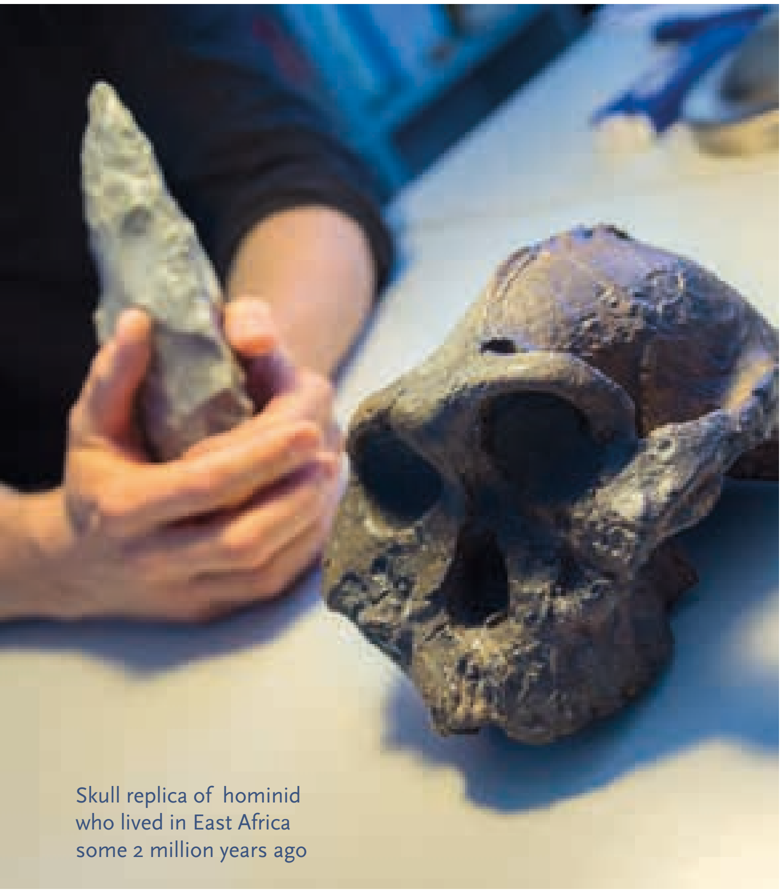


Photos: Roese, Thomas (top); Junginger, Annett (bottom)



Skull replica of hominid who lived in East Africa some 2 million years ago

Prof. Martin Trauth

Homo sapiens is the only extant human species

The history of the early hominid commonly referred to as Nutcracker Man is a good example: A reconstructed replica of the skull of this close relative to our ancestors sits on Martin Trauth's desk. *Paranthropus boisei* is the scientific name of the hominid, who was only 1.30 meters tall and not a representative of our genus *Homo*. It lived in East Africa some 2 million years ago but went extinct about a million years ago. "We are not sure what the reasons were," Martin Trauth says, "but it might well have been a worsening of the climate." The hominid was named for its sturdy jaws and masticatory muscles. "They had their own, inbuilt toolbox with them at all times," Trauth says with a wink. Despite what the name might suggest, *Paranthropus boisei* did not eat nuts but rather grasses and grass seed. The climate changes might have destroyed this species' basic food resource.

Another hominid was living in the same region at the same: *Homo*. And it survived the environmental changes. After all, our immediate ancestors used tools such as the hand axe that seem to have enabled them to rapidly adapt – whereas the Nutcracker Man could not. Have climate changes triggered milestones in human evolution? And why is *Homo sapiens* the only one of 10 known human species to have survived?

Looking 3 million years into the past

Pursuing these questions requires that a lot of time and effort be invested in analyzing the core samples. Researchers in specialized laboratories in the US, France, Great Britain, Ethiopia, Kenya, and Germany are extracting a wide variety of substances – remnants of algae, shells, rotifers, pollen, volcanic ash, or minerals. They establish the thickness of the various sediment layers as well as their physical properties and age, identify key chemical elements, and extract thousands of samples for many more analyses. In a process Martin Trauth calls "sampling party", the core samples are cut lengthwise and samples are then taken for various analyses. Half of the core sample is available for research; the other is archived. In the

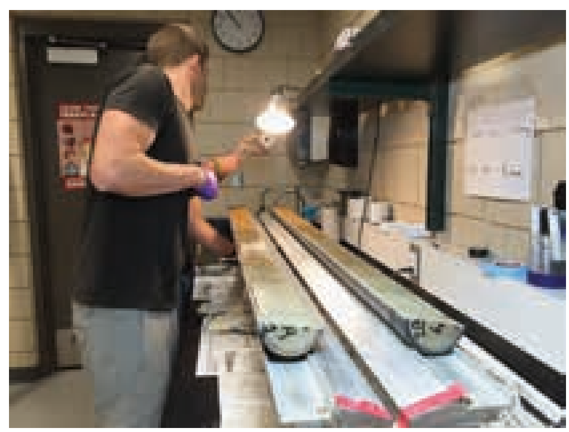
Photos: Roese, Thomas (2)

end, an enormous amount of data arrives at Martin Trauth's desk, and he processes them statistically. The researcher is a specialist in time-series analysis and looks for types of climate transition – some of which affected human evolution, some of which did not.

The oldest layers of the core from the Chew Bahir basin are about 550,000 years old. Core samples from other drillings even originate from 3-million-year-old layers. *Homo sapiens* has been around for about 300,000 years, so the researchers have a comprehensive data basis that covers the environment of modern humanity and spans back to its immediate ancestors – an invaluable archive. The ambitious project hopes to combine the results of many individual analyses into an overall picture. It may well take 10 or even 15 years to analyze all of the samples and interpret the data, Martin Trauth estimates. But they will undoubtedly provide important clues about the link between environmental changes and the development of humanity.

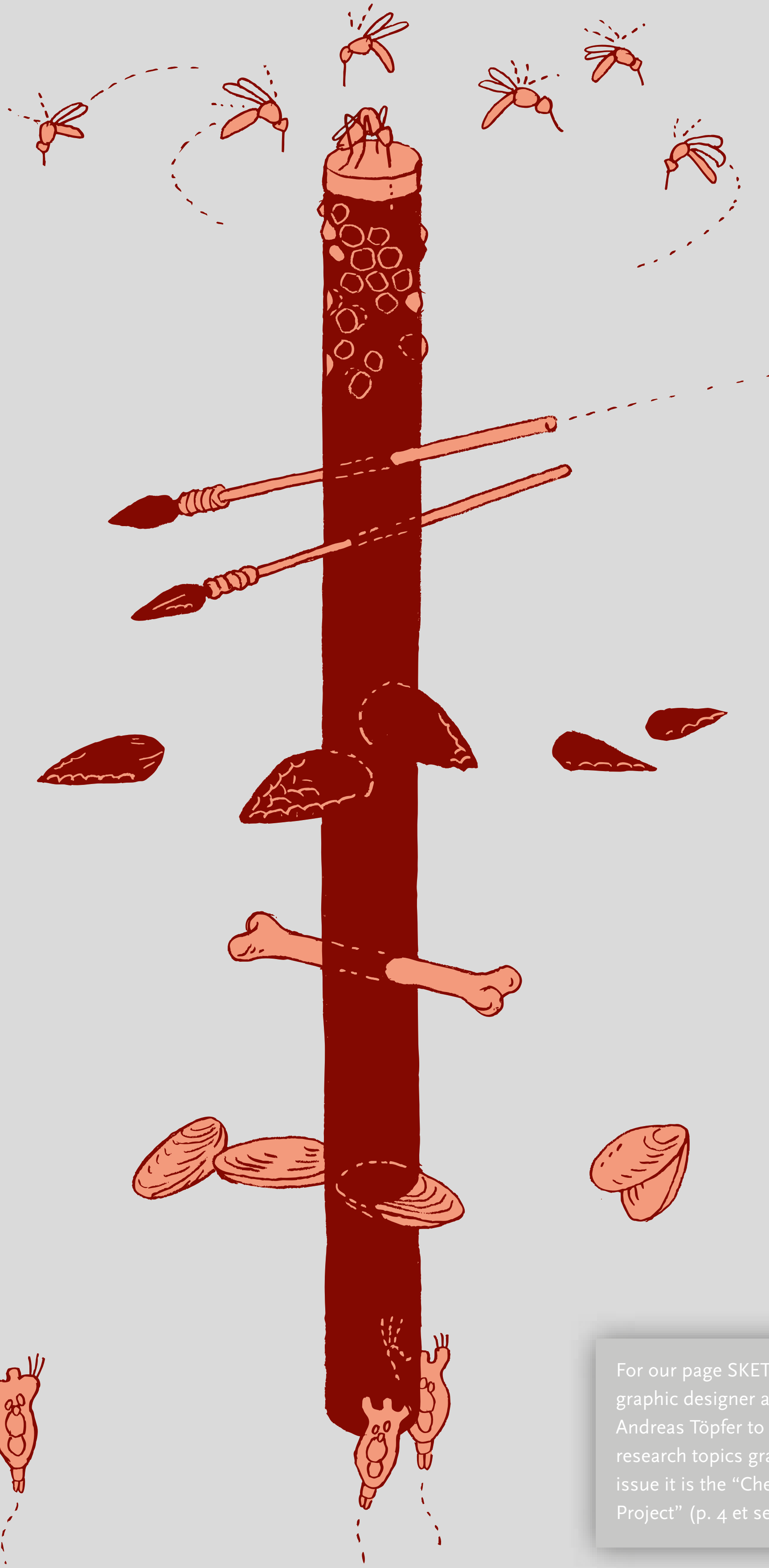
HEIKE KAMPE
TRANSLATION: MONIKA WILKE

Cut lengthwise – the drilling core in the lab



Extracting a drilling core

Photos: Junginger, Annett (3)



For our page SKETCHED, we asked graphic designer and illustrator Andreas Töpfer to interpret one of the research topics graphically. In this issue it is the "Chew Bahir Drilling Project" (p. 4 et seq.).

Illustration: Töpfer, Andreas

Fishing for DNA

A drilling core reveals the history of an entire ecosystem

How wild horses and chickens were bred thousands of years ago, which species were closely related to the long-extinct European straight-tusked elephant, and even whether cave bears used the same winter quarters every year – molecular biologist Michael Hofreiter knows it all. He "hunts" long-extinct animals by analyzing so-called ancient DNA that has, for instance, been extracted from archaeological skeletons. He is currently working with evolutionary biologists and geoscientists on a method for reconstructing the development of an entire ecosystem over thousands of years. To do this, they go "fishing" for DNA in a drilling core – on a very large scale.

Strictly speaking, Michael Hofreiter is a gatherer. The *Schleich* figurines on his office desk give it away. "These are models of some of the animal species I have researched," Hofreiter explains. They include sharks, small horses, mammoths, and *Macrauchenia patachonica*, the "long-necked llama" Charles Darwin referred to as the "strangest animal ever discovered". But Hofreiter did not hunt them: Most of them have been extinct for thousands of years. He finds the few traces that remain of them in well-preserved skeletons, sediment layers, or permafrost soil. As soon as samples are retrieved, Hofreiter and his team begin their molecular biological search. In what are often heavily decayed DNA remains, they look for sections or unique markers that allow individual species to be identified. "Just as a box of cereal is identified at the checkout by a barcode, so too can an organism be identified by a specific DNA sequence," the researcher explains. To do this, the unique DNA section of the respective species is synthesized, its double helix separated by heat, and half of it is applied to slides – in large quantities. With this DNA "fishing pole", the researchers go "fishing" in the sample for the relevant, complementary strand. If it is there, it will "stick". Next, the order of its building blocks – the so-called DNA sequence – is determined and only after this barcoding is complete, the researcher can interpret all genetic information obtained and compare it, for instance, to that of related, modern species. The disadvantage is that you have to know roughly what you are looking for – which organism, or at least which group of organisms.

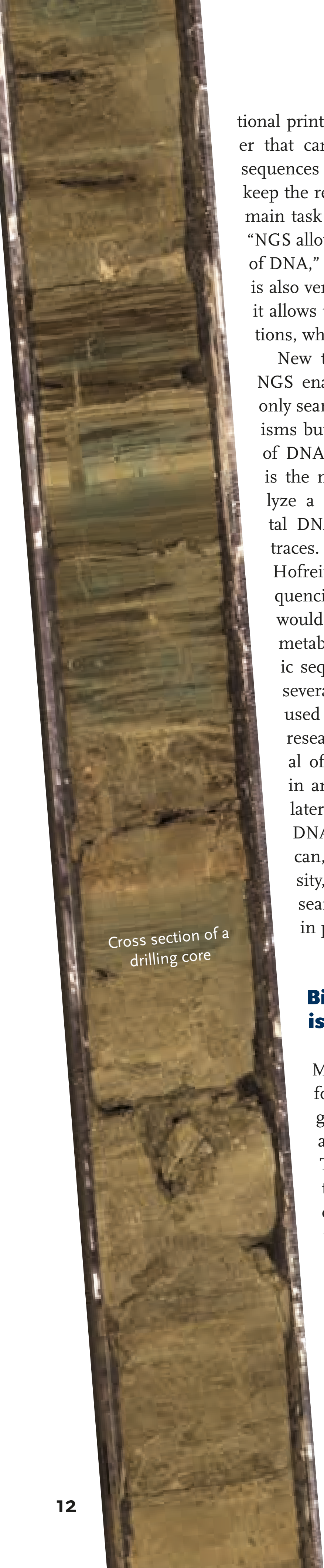
Instead of 96 DNA sequences, 6 billion can be analyzed at once

Standing in the laboratory, analyzing DNA for days on end – this is also how Hofreiter's career as a molecular biologist began. Gene sequencing was still in its infancy not so long ago. "Back then I sequenced radioactively," he says with a laugh. "At first, you could analyze 96 DNA sections at a time." Today, high performance sequencers can do 6 billion sequences per run – in about 24 hours. Next Generation Sequencing (NGS) is the name of the process that revolutionized working with genetic material. In the laboratory of Hofreiter's research team sits a black box that looks like a conven-

In genetics, **barcoding** refers to a method by which a DNA sample is identified as belonging to a particular species. A certain, species-specific sequence of base pairs is used for identification – like a barcode on a product label.

Prof. Michael Hofreiter

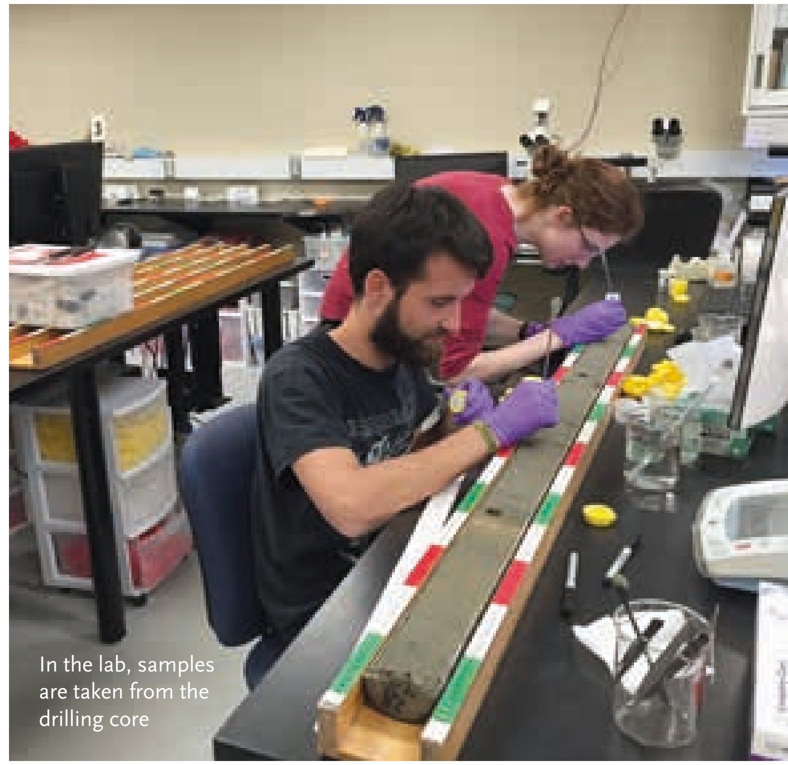
Photo: Fritze, Karla



Cross section of a drilling core

tional printer. In fact, it is a small sequencer that can do "only" some 400 million sequences per run – more than enough to keep the researchers busy for weeks. Their main task is analyzing bioinformatic data. "NGS allows us to sequence vast quantities of DNA," Hofreiter explains. "The method is also very well suited for old DNA, since it allows us to analyze the remaining sections, which are often very short."

New technological developments like NGS enable molecular biologists to not only search samples for individual organisms but also to analyze large quantities of DNA simultaneously. Metabarcoding is the method with which experts analyze a sample's so-called environmental DNA, with many different genetic traces. This, too, requires "fishing", as Hofreiter explains: "The complete sequencing of such a wild mix of DNA would take forever." That is why in metabarcoding short and less specific sequences – that may be typical of several species – are synthesized and used as "fishing poles". This allows researchers to isolate genetic material of the species they are interested in and identify them more precisely later by identifying species-specific DNA sections. An entire ecosystem can, then, be described in its diversity, which could lead to major research advancements in biodiversity in particular.



In the lab, samples are taken from the drilling core

Bit by bit, the drilling core is searched for old DNA

Michael Hofreiter has joined forces with evolutionary biologist Prof. Dr. Ralph Tiedemann and geoscientist Prof. Dr. Martin Trauth from Potsdam in order to reconstruct through metabarcoding the diversity and the development of an ecosystem over a long period – and not just anywhere. In fact, they go where old DNA is very hard to find: in the tropical regions of East Africa. "The hotter the weather, the lower the chances of finding old DNA," the researcher explains. Because the genetic material is better preserved in deeper deposits, the researchers are planning to extract the DNA from a drilling core. This is absolutely a pilot project, so the methods for analyzing the sediments have yet to be found. And while initial random tests using conventional methods were not able to detect old DNA, NGS allowed the researchers to make a discovery: "We produced some million sequences and compared them with databases – and actually detected ancient DNA," the biologist explains. "In low concentrations but enough to work with."

The idea underlying the project is as simple as it is unusual: With the help of metabarcoding the

THE RESEARCHER

Prof. Dr. Michael Hofreiter studied biology in Munich and earned his PhD at Leipzig University in 2002. Until 2010 he worked at the Max Planck Institute for Evolutionary Anthropology in Leipzig. He held a professorship at the University of York from 2009 to 2013, when he was appointed Professor of General Zoology/Evolutionary Adaptive Genomics at the University of Potsdam.

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Photos: LacCore National Lacustrine Core Facility/Verena Foerster (left); Junginger, Annett (right); Fritze, Karla (bottom)

THE PROJECT

DNA Metabarcoding of phyto- and zooplankton in East African lake sediments as proxies for past environmental perturbation

Participants: Professor Dr. Michael Hofreiter, Professor Dr. Ralph Tiedemann, apl. Professor Dr. Martin Trauth
Funding: German Research Foundation (DFG)
Duration: 2016–2018

researchers can "fish" the sediment samples of the drilling core for the DNA of numerous species. As "bait" they synthesize the unique marker gene sections of the species they hope to find and, as Hofreiter explains, not just any species: "On the one hand, we are on the lookout for species we assume lived in East Africa about 100,000 or 200,000 years ago." This could be determined to some extent by looking at the current distribution of species. The researchers, though, are on the lookout for specific organisms whose existence says more about the ecosystem they were living in. "We are looking for organisms that are ecological indicators of, for instance, salt content, oxygen concentration, temperature, and other features." These analyses are then made with samples taken from different sections of the drilling core – and, thus, from different periods.

Data say a lot about the connection between climate change and species development

The project is a good example of how geoscientists and biologists can intensify their collaboration – and practically benefit from each other. After all, it is a novelty that biologists can search drilling cores for ancient DNA and that geoscientists can gain insight into climatic development by identifying genetic material.

For the pilot project, the researchers are now designing marker genes for "only" several dozen species and are analyzing the environmental DNA of only a dozen sediment samples. This should suffice to test their method. "If we are successful, we will apply for a full project," Hofreiter says. If this happens, the researchers would literally take the drilling core apart and "fish" hundreds of samples for several hundred species.

"This would allow us to draw conclusions about the connection between climate change and species development and understand, for instance, which species lived under what climatic conditions and adapted and which ones went extinct," Hofreiter explains. "In fact, we could even make predictions: Some 120,000 years ago it was so warm that hippos swam in the River Thames. If temperatures rise again, we might see them swimming under Tower Bridge one day," he says with a smile.

MATTHIAS ZIMMERMANN
TRANSLATION: MONIKA WILKE

Prof. Michael Hofreiter at the sequencer

Photo: Fritze, Karla

Rapid Eye image of the area around Avdat in the Negev desert, Israel, on 13 March 2016

Nature Conservation from Space

Researchers develop new methods for monitoring protected areas

Earth is being increasingly observed, measured, and photographed. Satellites orbiting our planet at altitudes of hundreds to a thousand kilometers are continuously collecting detailed data on the earth's surface, humidity, temperature, and vegetation density. The EU project ECOPOTENTIAL aims to utilize progressively higher quality remote data to improve monitoring and management of protected areas in Europe – from the Wadden Sea to the Sierra Nevada.

The Negev desert in Israel is an inhospitable place – only specialized plants and animals can survive here – and yet, it is of major ecological importance. Large swaths of it are protected in the Har HaNegev nature reserve, which is the habitat of rare species such as the Arabian leopard, the ibex, the wild donkey, and the edmi gazelle. Researchers at the University of Potsdam examine the desert with satellite imagery and computer models.

THE PROJECT

ECOPOTENTIAL is a Horizon 2020 project that analyzes ecosystems and their functions using remote sensing data.

Funding: European Union, Grant Agreement No. 641762
Duration: 2015–2019
Participants: 47 European scientific institutions
Leadership: National Research Council of Italy (CNR)
www.ecopotential-project.eu

The barren ecosystem is one of 23 mostly European protected areas being studied by hundreds of researchers from 47 institutions in the EU's H2020 project ECOPOTENTIAL. Its central objective is to improve the management of protected areas with the help of remote sensing data. The project comprises marine and alpine habitats, forests, deserts, steppes, and coasts. Areas being researched include ecosystems as diverse as the Wadden Sea, the Bavarian Forest, and the Sierra Nevada.

Remote sensing data provide a host of detailed information

The researchers are interested in the status quo of the protected areas but also want to monitor their development over time. How much damage does a fire cause? How has the stock of trees developed over the past decade? Which coastal stretches are being affected by algal bloom? Can trends be identified? Remote sensing data may provide answers to all of these questions – for large areas and in increasingly higher resolution. Five new European satellites have been launched since 2014 as part of the Sentinel programme. Outfitted with high-resolution spectral sensors and radar, these satellites are monitoring the earth's surface, atmosphere, and oceans. The remote sensing data they generate have become universally accessible over the past years, much available online almost in real time, for instance as part of the Copernicus European earth observation program. Also older data have been freely accessible, such as the archives of the LANDSAT missions' historical satellite imagery since 2008. The sensors capture pictures in a wide range of spectra, partly

Satellite image of the island of Rügen in Winter 2012

far beyond what the human eye can see – for instance in the infrared range. But there's a catch: "They are of no use to most people," explains junior professor Ariane Walz, who chairs the Potsdam research team. Before conclusions can be drawn from them, such as how the vegetation in a protected area is changing, the data need to be converted and interpreted. This requires numerous intermediate steps, adaptations, a great deal of care, and sometimes computer models.

These data have a huge potential for the management of protected areas. "They are very well suited for monitoring. You can see what is changing, how quickly, and whether this is in line with conservation goals," Walz explains. In the Italian Gran Paradiso national park, for instance, remote sensing data may help us to understand an urgent problem: The ibex population there is plagued by high death rates among their young for unknown reasons. Evaluating satellite imagery offered a possible clue: "The images allow for the protein content of the grass to be estimated," Walz explains. The composition of species on the alpine pastures has shifted as a result – to the detriment of those animals no longer able to consume the necessary amount of nutrients.

THE RESEARCHER

Junior Prof. Dr. Ariane Walz studied geography, geology, physics, and social sciences at the University of Würzburg and the University of Wales (UK). Since 2012, she has been Junior Professor of Landscape Management at the University of Potsdam.

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Potsdam team researches vegetation in the Negev desert

This example shows the kind of detailed analyses that are now possible. The researchers are particularly interested in combining remote sensing data with those that have been collected on the ground over the years and decades: Which species and how many of each live in an area? How much biomass grows on one square meter of alpine grassland? How have ecological communities developed recently? The results from years of fieldwork have turned out to be crucial for satellite data, because they help researchers to interpret them even more precisely. The researchers are also planning to establish the information value of the LANDSAT missions' remote sensing data that have been collected since the 1980s, allowing for meaningful time series to be made.

The Potsdam research focuses on the Negev desert in Israel. Using computer models, the team around Walz simulates how the vegetation there may develop

Photos: JAXA, ESA (top); Fritze, Karla (bottom) over time thanks to remote sensing data that depicts the composition of the vegetation on the earth's surface. Israeli research partners are also analyzing how settlement structures change, since the area is also used by settlers and Bedouins for winegrowing and ranching, which can strain the sensitive dry-zone vegetation.

In their models, the researchers pay particular attention to the effects of extreme events like heavy rainfall or long dry spells on the habitat, since these are expected to occur more often in the future due to climate change. The model, which is validated with current remote sensing data, will enable researchers to estimate plant growth in the Negev desert for the coming decades under various scenarios – and design protective measures.


Prof. Ariane Walz

Researchers and nature conservation authorities cooperate closely

It seems certain that the Negev desert climate will change and its plant community along with it. "We expect longer dry periods and precipitation, often in the form of heavy rainfall that runs off the surface," Walz describes the possible development. Which species will benefit or be displaced as a result of it, though, is not yet clear. Grass is currently the dominant vegetation, interspersed with some adapted shrubs and bushes. The simulations indicate that the area might become overgrown with bushes – a development managers of the protected area want to avoid. When grass disappears, soil erodes faster, which in turn starves pastures and wild animals alike.

In many of the protected areas in this project, researchers are closely cooperating with rangers and nature conservation authorities. In the end, they hope to be able to analyze and use remote sensing data on their own, with the instruments and tools provided to them by the researchers. Looking at the data will be a faster and more convenient way for them to get important information – and insight into areas that are very difficult or impossible to access. Teaching programs, advanced training, and workshops will ensure this knowledge transfer has a long-term impact. If the project reaches its objectives, ECOPOTENTIAL will make a major contribution to opening up the potential of the data for everyday practical use.

For a very long time, high-resolution remote sensing data were just an instrument for scientists. The effort it took to process them was too great for them to offer insight to everyone. This has completely changed. "If there was a forest fire yesterday, I can see today what area has been affected," Walz explains. But the researcher is also aware of the limits of the method: "Whether the vegetation looks especially vital because of the blossoming mistletoes or the sprouting birches is not discernible from space." But even though data from space cannot replace field monitoring, they can strongly support it and fill in large gaps.

HEIKE KAMPE
TRANSLATION: MONIKA WILKE


In the Negev desert

Photos: Fritze, Karla (top); Walz, Prof. Dr. Ariane (bottom)

Quite Warm, Quite Cold

Geomicrobiologist Dirk Wagner researches the smallest lifeforms in extreme environments

The Arctic, deserts, and volcanos: Life exists in very unexpected places – and on a surprising scale. Geomicrobiologist Prof. Dr. Dirk Wagner tracks down these lifeforms. He focuses on tiny organisms that are not only able to withstand such extreme environments, but in fact need them to survive.

Photo: Wagner, Prof. Dr. Dirk

In the Chilean Pan de Azúcar national park

In our series "Pearls of Science", we regularly introduce researchers from institutions connected with the University of Potsdam in the "pearls – Potsdam Research Network". In this issue: Prof. Dr. Dirk Wagner from the Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ).

The Atacama Desert in Chile is one such extreme environment. It stretches some 1200 kilometers along the South American Pacific coast and is considered the driest desert on Earth. Its average precipitation is 0.5 millimeters – per year. Some parts of it have seen no rain for decades. Temperatures are around 30°C during the day and sometimes dip down to -15°C at night. "It's tempting to think: How can any living being survive there," Dirk Wagner says. "Fellow geoscientists – with whom we collaborate closely – are confused when I tell them that many lifeforms exist where nothing grows – albeit at the microbiological level. One gram of soil may well contain a million organisms," explains Wagner, who is Head of the Section Geomicrobiology at the Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ).

Analyzing the environmental DNA helps to understand the diversity of life in soils

It is exactly this extraordinary biological diversity that draws Dirk Wagner to places like the Atacama Desert or the Namib Desert in southwest Africa.

His most recent trip to South America was in March 2016 to collect soil samples. "The climate there is really harsh – you automatically eat less, have to drink a lot, and sense the strong radiation you're being exposed to." The collected samples are frozen and then taken to Potsdam, where they are analyzed in a lab. Wagner and his colleagues are particularly interested in which organisms live in the soil and how they adapt to such extreme environments. The researchers use two methods to determine this: One approach is to carefully isolate individual organisms from the samples, ultimately using DNA analysis. Many of these organisms are being described for the very first time. Classifying organisms is the backbone of microbiological research, as Wagner explains. After all, no more than 1-3% of all microorganisms in soils have been identified. A disadvantage of the method is that it cannot establish in what numbers or proportions certain organisms occur or how they interact with each other and with their geological environment. To learn more, the researchers analyze the environmental DNA, i.e. the entire genome of all organisms in a soil sample. "This enables us to describe the whole community in terms of biodiversity, composition and function," Wagner says. And from here, the researchers dig deeper into what currently interests them most: How do microorganisms interact with their environment? After all, the influence of the tiny organisms on the structure and composition of the soil is crucial for the development of entire habitats. They significantly contribute, for instance, to humus accumulation and aggregate formation – major processes in soil development that stabilize the soil, reduce erosion, and allow higher organisms like plants to move in. "For


Prof. Dirk Wagner


Salt lake in the East Antarctic

Photos: Fritze, Karla (left); Wagner, Prof. Dr. Dirk (right) a long time, geoscientists believed that surface processes are influenced only by tectonics and climate," Wagner explains. "Vegetation hardly played a role. Everyone now knows, though, that this is not the case, yet the many influences of microorganisms on soil development are still not sufficiently factored in."


Dirk Wagner (r) with fellow researchers in Chile

After returning from the Atacama Desert, Wagner and his colleagues designed an experiment to find out how the microorganisms "process" the soil. The researchers prepared two different soil systems – one with microorganisms and one without – and tested them under simulated natural conditions in dry-wet cycles. "I was skeptical whether we would see differences in soil formation processes," the researcher says. "But we were, in fact, able to demonstrate in our first pilot experiment that microorganisms do contribute significantly to aggregate formation and, thus, to soil development and stabilization."

In permafrost, too, there is a lot of life below the surface

As a geomicrobiologist, Wagner is used to moving between sciences. Researching microflora activity in a terrestrial environment requires a combination of biology and geosciences. As a student of biology in Hamburg, Wagner began looking for life in places where others might see only a stone or uninhabited nature. After choosing soil science as his minor, he became interested in interdisciplinary work. In his PhD thesis on the release of methane from rice soils in China, the researcher again combined microbiology and soil science. Since then, his research interests have focused on combining these two disciplines.

In 2000, Wagner joined the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) at Potsdam, and again a fixation of his – this time on polar research – turned out as a stroke of luck. Since then, his research has taken him to permafrost regions in Siberia, Canada, and the Antarctic, for instance, which microbiologists had long ignored. "Permafrost soil was thought to be sterile until 100 years ago. We now know that there is as much life in it as in any other soil." Wagner has long been researching how microorganisms that are also active in frozen soil affect material flows. He and his colleagues are currently determining what will happen if permafrost soils start thawing at greater depths and over longer periods as a result of climate change. "The boundary layer between the active melting zone and the permanently frozen sediments is of particular interest for the development of permafrost landscapes into greenhouse gas sources or sinks. Wells have, there-


In the Siberian permafrost

Environmental DNA is genetic material that organisms leave behind in their habitat. It is detectable practically everywhere – in water, air, and soil. DNA analysis helps researchers identify certain known species in their respective samples. Broad analysis of all DNA traces in a sample can, however, also offer insight into an ecosystem's existing species and biodiversity.

Photos: Wagner, Prof. Dr. Dirk (2)

fore, been dug in the upper sediment layers to help us understand the actual and potential microbiological processes taking place there." After all, large amounts of carbon are stored in permafrost soil sediments. Once they start thawing, microorganisms begin converting the carbon into greenhouse gases. "This is a ticking time bomb; if large areas of permanently frozen ground start to thaw, large quantities of carbon dioxide and methane could be released and further heat up our atmosphere," the researcher explains.

The deep biosphere is a huge ecosystem

In 2012, Wagner switched to the Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ), where he began focusing on another seemingly inhospitable place: the deep biosphere. "Until 30 years ago, it was believed that hardly any life existed meters below the surface." It is now estimated that there is almost as much biomass in the deep biosphere as there is at the surface, and microorganisms live at depths of up to three kilometers with the high temperatures approaching those of the Earth's core being the only limit. This is exciting research for geomicrobiologists: "The deep biosphere is a huge ecosystem. We currently know so little about it and have so many questions." What organisms live there – and what do they live on? What is their role in the cycle of matter at those depths? How are they linked to processes at the surface? And what happens if, for instance, humans want to use their habitat to extract raw materials, produce drinking water and geothermal energy, or store radioactive waste? We can only speculate about what the answers will be. Research on the deep biosphere is still in its infancy, mainly because it is far more difficult to access than deserts or permafrost regions. Unlocking its secrets requires drilling deeply, which is time-consuming and expensive. Researchers from all over the world are, therefore, joining forces to collect sediment and rock samples from suitable places several hundred meters below the surface, for instance in the "International Continental Scientific Drilling Program (ICDP)". Wagner and his team have so far been able to analyze sediments from Lake Towuti in Indonesia and crater lake El'gygytgyn in Siberia. They are

THE RESEARCHER

Prof. Dr. Dirk Wagner studied biology at the University of Hamburg. Since 2012, he has been Head of the Section Geomicrobiology at the GFZ and Professor of Geomicrobiology and Geobiology at the University of Potsdam.

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Atacama Desert in Chile

Frozen Tundra in Siberia

Photos: Fritze, Karla (top); Wagner, Prof. Dr. Dirk (2, bottom) currently involved in a drilling project at the Eger Rift in Bohemia: – "a hotspot for the deep biosphere, since fluids carrying carbon dioxide and mineral nutrients surface there, thus promoting microbiological life," the researcher explains enthusiastically. "We hope to learn a lot about the correlations between biological and geological processes there."

Since interdisciplinary thinking is nothing new to Wagner, it hardly comes as a surprise that his next project will combine geosciences, biology, and climate research as part of a German Research Foundation (DFG) excellence cluster. Only in April 2017 did researchers at the University of Potsdam apply for it, along with partners of the GFZ, the AWI, the Potsdam Institute for Climate Impact Research (PIK), the Museum of Natural History Berlin – Leibniz Institute for Evolution and Biodiversity Science (MfN), and Technische Universität Berlin. For Wagner, this is exactly the kind of exciting project he likes the best: "For the first time, we would set out to research developments on Earth's surface on a large scale – jointly and from various perspectives – to find out how they are interconnected and what we can learn from them in order to better understand how Earth's system develops. I expect this will also bring many fresh ideas into my work."

It doesn't get any more extreme – except in space

Wagner's research interest is almost boundless. Extreme heat, cold, and depth – for him, none of these are limits. He is now looking into space from the Arctic. "It was initially a sort of spin-off from other work, but astrobiology has since become my hobby," the researcher says with a laugh. He is interested in extremophilic microorganisms, i.e. those thriving in extreme conditions. Some, for instance, survive on hydrogen and carbon dioxide alone – which would predestine them for life on Mars. "Over the years, I have gradually become part of the astrobiology community and done some smaller projects in the field." And larger ones as well; most recently, he was involved in an experiment at the German Aerospace Center (DLR) in Berlin-Adlershof that sent microorganisms from Siberian permafrost into space. Using similar minerals to those on Mars, the samples were placed in an exposure module for months outside the International Space Station (ISS) to determine whether they can also thrive in such an environment. "Even if the organisms don't survive, we will probably see what's left of them. These biosignatures would help future Mars rover missions identify possible traces of extraterrestrial life."

Wagner is confident that life will eventually be found on Mars. After all, methane has been detected in its atmosphere. "There are only two possible explanations for this: active geological processes like volcanic activity – for which we have no evidence yet – or biological processes. And there is much to be said for the latter."

MATTHIAS ZIMMERMANN
TRANSLATION: MONIKA WILKE

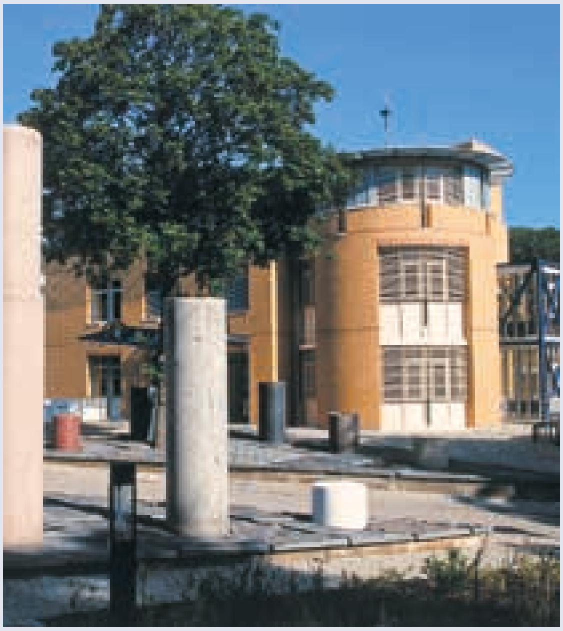

Photo: GFZ

THE GFZ

The **Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ)** researches Earth's system. Its over 450 researchers and almost 200 PhD students research the history of our planet, processes at and below its surface, and the many interactions between geo-, cryo-, hydro-, atmo- and biospheres.

www.gfz-potsdam.de

GFZ
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The **pearls – Potsdam Research Network** connects the University of Potsdam and 21 non-university research institutions in the science region of Potsdam/Berlin. The network focuses on joint research projects, developing young researchers, and joint research marketing of the science region Potsdam.

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LAYER BY LAYER

Geologists research sedimentary basin formation in the Andes

Photo: Fritze, Karla

Cretaceous stromatolithe from the Yacoraite Formation in northwestern Argentina

THE PROJECT

StRATEGy (SuRfAce processes, Tectonics and Georesources: The Andean foreland basin of Argentina) is a German-Argentinian PhD program researching the formation processes of sediments in Argentina.

Participants: University of Potsdam, Helmholtz Centre Potsdam – German Research Centre for Geosciences (GFZ), University consortium of Buenos Aires, University consortium of Salta – Jujuy – Tucumán
Funding: German Research Foundation (DFG), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET)
Duration: 2015–2018
http://www.irtg-strategy.de/index/

Millions of years ago, rivers and seas helped shape the sediment layers of geological basins. Some of these layers were then covered by further deposits, while others were pushed up by mountain rock folding. Research on a sedimentary basin in the Andes is expected to offer new insight into which geological processes were involved.

When setting off for work, Wera Schmidt must make sure she has three things: sunscreen, a compass, and a hammer. As a geologist, her fieldwork periodically takes her to the Jujuy region in the Andes Mountains in northwestern Argentina, where she spent five weeks in March and April 2017. In the field, at an altitude of over 4000 meters, her trained eye easily spots what she is looking for: seemingly inconspicuous brownish rocks with rounded moldings. With her hammer she takes samples, and with her magnifying glass she studies their macroscopic properties. These rocks, though, are anything but inconspicuous: They are stromatolithes, i.e. fossils of ancient colonies of microorganisms. Stromatolithes have existed for 3.7 billion years, making them the oldest oxygen-producing organisms on Earth. The ones that Schmidt finds in Argentina are 65 million years old.

Thin section of the stromatolithe

Rock structures provide insight into geological processes

The area where the geologist works contains rocks formed millions of years ago. It is part of the Salta basin, which covers several hundred square kilometers of northwestern Argentina. Tres Cruces – Three Crosses – is the name of this sub-basin. The oldest deposits here date back to when dinosaurs roamed the earth. Where the Andes now stand, there used to be a water-covered plateau. "Whether this was an ocean of seawater or a large freshwater lake, we don't know yet," says Maria Mutti, Professor of Sedimentology and head of the project.

Answering this question is a main objective for Schmidt, who is doing her doctorate in the "StRATEGy" PhD program. Where are the rock formations that interest her? What are their dimensions? What types of rock do they comprise, and what factors contributed to them being deposited where they are now? It requires a bit of Sherlock Holmes work, Schmidt says.

The young scientist analyzes some of the rock samples in a Brazilian laboratory and others in Potsdam. Last year, she brought a total of 60 kilograms to Pots-

Prof. Maria Mutti (left) and Wera Schmidt

Photos: Fritze, Karla (2)

dam. "Each type of rock needs a particular sedimentation environment," the doctoral student explains. In the laboratory, the samples undergo various chemical analyses, are sliced ultra-thin, and analyzed under a microscope down to the micrometer. The geoscientists determine the age of the various rock formations, which structures they contain, and what conclusions can be drawn with regard to environmental and climatic parameters. They also create a 3D model of the sediment layers in the basin, which they had previously measured with a GPS locator. The model will ultimately even show the progression of sediment formation over time.

Working in the high mountains requires physical fitness – and good preparation

The team around Schmidt and Mutti includes two researchers from Argentina, Prof. Dr. Claudia Galli and Prof. Dr. Beatriz Coira. The four drove an off-road vehicle through the mountains, inspected the area, and discussed the work ahead. An all-female team – a rarity in science.

For their own safety, the researchers have to always keep an eye on the high-mountain weather. "This year, the coastal El Niño on the Pacific side of South America brought one storm front after another," Schmidt describes the danger. There were cherry-sized hail, material damages, landslides, and debris avalanches. "Nobody wants to be in the field then." Physical fitness is also required: the researchers have to climb steep slopes and cope with the thin mountain air that causes headaches, nightmares, and shortness of breath.

Schmidt spends weeks and months in the field for her studies. "Forget all you think you know about Argentina," she says with a laugh. She lives in the simplest of conditions, alternating between a small, old, countryside hotel and a cabin in a mining village. "There is no red wine, tango, or steak." Instead, you get insight into the indigenous people's lives, which are determined by spirituality and the rhythm of the seasons. Enviable scenic views of nature make up for the lack of comfort.

THE RESEARCHERS

Prof. Dr. Maria Mutti studied earth sciences at the University of Bologna and the University of Milan (Italy) as well as geology at the University of Wisconsin (USA). Since 2002, she has been a professor at the University of Potsdam. Her research focuses on limestone.

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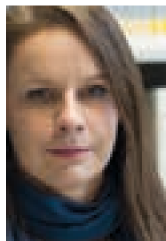

Wera Schmidt, M.Sc., studied geosciences at the University of Bochum. Since 2015, she has been participating in the "StRATEGy" PhD program at the University of Potsdam.

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When the researchers looked at their rock samples under a microscope, they were thrilled to discover ooids – small grains of calcite. It is very rare to find them along with stromatolithes. "An unusual, surprising constellation," which makes the geologists wonder what they will find next, Mutti explains. Their findings might also be of commercial interest: In Brazil, large oil deposits were found below sediments similar to those of the basin in Argentina – by chance.

HEIKE KAMPE
TRANSLATION: MONIKA WILKE

Yacoraite Formation at the northern edge of the Tres Cruces basin

Illustration: Fotolia/amiak

The Human Factor

Professor Emmanuel Müller is working on new data analysis methods

Photo: HPI/Kay Herschelmann

For most people, “big data” is just an abstract term, an obscure mass of numbers, data, and formulas. Emmanuel Müller, however, is at home in this world. He is able to make connections visible, identify patterns in a vast array of highly complex data, and gain new insight for science and industry. Müller is a data mining expert. He uses statistical methods to extract information from large data resources and focuses on humans, who ought to understand hidden patterns and unknown relationships in these data.

“I’m sorry; I'm a bit tired. It was a short night.” Emmanuel Müller became a father only a few days ago. His second son just spent his first night at home – apparently quite a restless one. Müller nevertheless receives us in his office at 10pm; the 35 year old shows no signs of tiredness. Of course, he would also like to be with his family now but “as a researcher, you live for your profession.”

THE RESEARCHER

Prof. Dr. Emmanuel Müller studied computer science at RWTH Aachen University. Since 2015, he has been Professor for Knowledge Discovery and Data Mining at GFZ and HPI, which formed the joint Digital Engineering Faculty with the University of Potsdam in April 2017.

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Satellite image of Amsterdam

“Our hypotheses come from the machine”

Two years ago, Müller came to Potsdam from Karlsruhe – and became a professor at the Hasso Plattner Institute of the University of Potsdam (HPI) – only 33 years old. He heads the Knowledge Discovery and Data Mining Chair, a joint research group of HPI and the German Research Centre for Geosciences (GFZ). A computer scientist working as a geoscientist? Is that possible? “We are researching and developing data mining methods,” Müller explains. He and his team extract new patterns from big data and make visible unexpected connections in the data. There is a high demand for this in almost every research field. Whether these are data from gene sequencing or research on climate or energy is initially secondary. “Data researchers do not research for a specific domain; they work across disciplines.” For Müller, this is precisely the appeal of his field of research. In geosciences, he is particularly interested in remote sensing data, which monitor and detect various phenomena on Earth, measuring, for example, vegetation or greenhouse

Photos: HPI/Kay Herschelmann (top); contains modified Copernicus Sentinel data (2017), processed by ESA (CC BY-SA 3.0 IGO) (middle); ESA/ATG medialab (bottom) gases. His task is to develop methods to analyze them, bridging computer science and geosciences.

The amount of available data is more extensive and complex than ever before. It is now even possible to examine not only existing working hypotheses with data but also to deduce new ones. Data analysis makes hidden structures and contexts visible – and opens up new perspectives. "Our hypotheses come from the machine," Müller puts it in a nutshell. Humans are nevertheless the focus of his work. "The goal is to make these patterns comprehensible for individuals and to have humans verify them. Data science does not mean replacing humans."

The idea for this approach came, however, from industry rather than science. In 2008, Müller – a research assistant at RWTH Aachen University at the time – was analyzing data that a car company had provided for a Bachelor thesis as part of a joint project with the university. What followed surprised the researcher. "The anomalies in the data were not simple measurement errors but had to be manually examined and verified by the company." Unfortunately, the company was initially unable to draw conclusions from the data mining results, because the existing methods were incapable of describing the anomalies to the user. The statistical method lacked the intuitive aspect and, thus, the factor human.

Change points indicate when something is changing in the system

This industrial project made the researcher aware of a new, widespread problem. Discussions with other industry partners and experts showed that the known data analysis and data mining methods often fail to meet their needs – a problem that the Helmholtz Association recognized. Müller mentions the GFZ as a good example. "Scholars have to understand and question causal connections." In the age of big data, correlations and predictions – such as potential buying behavior in advertising – are no longer enough to provide a deep understanding of the connections. Researchers need to know exactly what is actually in the data, which are divided into cohorts by algorithms and are completed with information on statistical probabilities. Müller wants to strengthen the role of the human in big data science – using methods that more readily detect anomalies in data and enable a more sensitive evaluation. "This is when it started getting exciting for us! We addressed this subject in three doctoral theses and in several research projects, and we continue to research it," Müller says.

Methods capable of identifying changes – so-called change points – are at the center of Müller's field of research. They indicate that something in the system is changing – be it data on vegetation recorded by satellite or a hospital patient's vital signs recorded by measuring devices. The procedures Müller is developing are intended to describe not only what is changing but also to answer why. "There are still too few procedures for this, and that motivates us." Data science is a rapidly growing field. There are still only a few courses of study that train the experts so sought after by industry and academia. "We will be only able to meet this demand if we train at all levels – our students as well as company employees," Müller asserts. The number of places at universities, however, is increasing. "We will close the gap in the coming years."

Big data, data mining, and deep learning – there is an increasing number of technical terms in the world of data. Few people, however, actually know what they mean. Data will also become increasingly significant in the coming years. Their analysis facilitates many things, generates new knowledge, and reveals previously unknown connections. The researcher emphasizes that there is one thing that they are still unable to do: "Algorithms can support decision-making of, for example, corporate executives, politicians, or scholars, but humans still have to make the decision."

HEIKE KAMPE
TRANSLATION: SUSANNE VOIGT

Photo: Fotolia/Elnur

Photo: Fotolia/Tatyana Gladskih

Learning to Read

How to do it better

Since before the PISA tests, we have known that children's educational success depends – among others – on their social and cultural background. But how does this correlation come about? Potsdam educational researchers Nadine Spörer and Guido Nottbusch want to investigate this more closely. They explore how children's reading skills develop and the roles that family and institutional learning environments play.

Kids love stories. "When you read something exciting aloud, they forget everything around them," says Jenny Ziemann. She is a teacher at a nursery school in Potsdam and has even more tricks up her sleeve to interest children in books – especially those who receive little encouragement at home. The trick is to arouse their curiosity. "If they see a beetle in the garden, we look up its name in a nature book. And when we bake a cake, we look at the cookbook together."

There are many different ways to prime children to learn to read: "Letters, syllables, and words are practically everywhere. You just have to draw attention to them," says Ziemann and points to an "H" on a nearby bus stop sign. Many educators like her succeed in creating an environment in which children acquire language in a playful manner, expand their vocabulary, listen attentively, and learn to understand. Researchers call this a "positive learning environment" – which can stand in stark contrast to a child's domestic environment. Not every family talks, tells stories, and reads aloud to their children enough. But can nursery school really make up for such deficits? And do disadvantaged children benefit from teachers' stimuli as much as those who receive more attention and education at home? "Traditionally, the effects of institutional and domestic learning environments have been studied in isolation. We are interested in their interaction," says Nadine Spörer, Professor of Educational Psychology with a focus on primary education at the University of Potsdam. Together with Professor of Pedagogy Guido Nottbusch, she is the first to look at differential effects: Do both environments shape children from different backgrounds in the same way and to the same extent? How do experiences at nursery school, school, and at home complement each other?

More than 3000 children interviewed

For their work, the two researchers used data from the National Educational Panel Study, which documents the development of more than 3000 children from nursery school to school – a wealth of information from and about adolescents, their parents, educators, and teachers. This allows researchers to analyze interconnections and interdependencies. Spörer and Nottbusch are particularly interested in the period from nursery school through 2^{nd} grade. "In primary school pedagogy, we focus mainly on classroom con-

Nursery school teacher Jenny Ziemann is reading a story

Photos: pixabay/dassel (top); Pannhausen, Franziska (bottom) ditions to develop more effective learning methods," Spörer explains. "But we know that learning success also depends on previous experience in nursery school and at home, so we have to begin at a much younger age." In their current longitudinal study, the researchers are, therefore, also looking at the effect of particular learning environments in preschool and how they influenced each other. They are searching for the levers that will enable them to better support children's development at school.

For Spörer, working with data collected by someone else is a new experience. While the educational researcher had to accept that she had no influence on the interviews, the Educational Panel Study does provide prepared data of a large sample collected over a long duration. "That's the advantage. The study is so extensive that it provides a lot of information that interests us," she explains.

The 3000 children included in the Panel were tested at various points in their development: How large is their vocabulary? How fluent are they? How much do they understand of what they take in? At the same time, their parents, educators and teachers answered questions about the concrete learning environments parallel. How many books and which toys are available to them at nursery school and at home? How do children and adults treat one another? What is the parents' level of education? Is German spoken at home?

Compensating for what is lacking

Spörer especially has in mind the needs of children with a migration background, whose first language is not German. However, socioeconomic hardship or having parents with lower educational qualifications may also negatively affect adolescents' educational pathways. The researcher asks whether and how nursery schools and schools can compensate for what is lacking. Do disadvantaged children succeed in taking advantage of institutional education, or do their problems actually worsen over time? For Spörer, the diagnostic competencies of teachers and educators are key. They have to understand the specific situation of a child, recognize his or her capabilities, and provide targeted support.

Creating learning environments in which children from different backgrounds can develop equally well is also one of the goals of the Potsdam research group "Heterogeneity and Inclusion", another participant in the project. The researchers will be able to unearth the huge data mine until 2018. Their newly gained knowledge will be shared in the German Research Foundation's (DFG) priority program 1646, which evaluates datasets from the National Educational Panel, a nationwide network of 25 individual projects that the DFG hopes will boost empirical educational sciences. Never before have longitudinal studies in this form on individual educational pathways been done in Germany. The results are eagerly awaited and are to help document development patterns in children, youths, and young adults, design courses of action for educational policy, and – last but not least – better prepare prospective teachers for working with adolescents.

ANTJE HORN-CONRAD
TRANSLATION: MONIKA WILKE

THE PROJECT

The project **"Heterogeneity and Reading Competency: The Role of Institutional and Domestic Learning Environments"** is part of the DFG priority program 1646 "Education as a Lifelong Process" and is being done in cooperation with the research group "Heterogeneity and Inclusion" at the University of Potsdam.

https://www.uni-potsdam.de/psych-grundschulpaed/forschung/heterogenitaet.html

THE RESEARCHERS

Prof. Dr. Nadine Spörer is Professor of Educational Psychology with a focus on primary education at the University of Potsdam. In her research she investigates the development of reading competency, the promotion of self-regulated learning, and the conditions under which inclusive education at primary school can succeed.

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Prof. Dr. Guido Nottbusch is Professor of Primary School Pedagogy in German at the University of Potsdam. His research focuses on acquisition of written language, reading competency, digital learning at primary school, the influence of capital and lowercase letters on reading processes, and the production of written texts.

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THE PROJECT

Carbon Governance Arrangements and the Nation-State: The Reconfiguration of Public Authority in Developing Countries

Participants: Prof. Harald Fuhr, Dr. Thomas Hickmann, Fee Stehle M.A. (University of Potsdam); Prof. Markus Lederer, Chris Höhne M.A. (TU Darmstadt)
Funding: German Research Association (DFG)
Duration: 2015–2018

Photo: Fotolia/HandmadePictures

Cape Town, South Africa

City Country Climate

Why global climate policy is also a matter of administration

Climate change affects us all. It confronts humanity with problems that we can only overcome together – if at all. Year after year, representatives from hundreds of countries have, therefore, been struggling to adopt uniform directives and globally effective measures at international climate conferences. Their implementation poses major challenges for developing countries in particular. At the same time, other actors – like cities – are taking the initiative and making their own climate policy. Political scientist Prof. Harald Fuhr and his team investigate how administrations in nation-states deal with this climate policy pressure – both top-down and bottom-up.

US President Donald Trump had been in office for four months when he decreed a return to the age of coal. At the same time, he announced he would be reversing the Clean Power Plan of his predecessor Barack Obama, which was to be the US' contribution to achieving the goals of the Paris 2015 Climate Agreement. Trump's actions triggered a storm of indignation worldwide. Many Americans also rejected Trump's renunciation of international climate protection agreements, and some are even fighting back. California, for example, has long pursued its own climate policy and is willing to push back against Trump's – in court, if necessary. With Los Angeles and San Francisco, two major cities are active in the renowned C40 (Cities Climate Leadership Group), which aims to jointly promote climate protection independent of national government and administrations. Others are following suit: After Trump's withdrawal from the climate agreement, over 300 US cities totaling 65 million citizens committed to the Paris agreements.

"Climate protection is no longer the task of individual countries but the result of international agreements, which, in turn, have to be implemented at the national level," says Harald Fuhr, Professor of International Politics at the University of Potsdam. "For some time, however, we have been able to observe new actors at the sub-national level." Regions – such as states like California – and especially cities are getting involved in finding specific solutions to climate issues. "This exerts pressure on national administrations from two sides – top-down and bottom-up."

The city network **C40 Cities Climate Leadership Group** – established in 2005 – started as a group of 40 cities with more than 3 million inhabitants each, whose goal is to reduce their greenhouse gas emissions. By early 2017, the network had grown to 90 cities on six continents, comprising one twelfth of the world's population and 25% of global GDP.

http://www.c40.org/

Top-down and bottom-up pressures are changing national administrations

In the DFG project "Carbon Governance Arrangements and the Nation-State: The Reconfiguration of Public Authority in Developing Countries", Fuhr, his team, and colleagues from the Technische Universität Darmstadt are investigating how administrations deal with this pressure. Do new national administrative structures emerge when global climate agreements are to be implemented at the national level? Will local administrations be strengthened if regions or cities create their own climate policy? And how do you bridge the two levels? "We are ultimately interested in how the coexistence of global, national, and local actors affects authority and administrative structures and what concrete political action results from them," says Fuhr.

The researchers are working on two climate policy initiatives: They are investigating the implementation of the global forest protection initiative Reducing


Prof. Harald Fuhr


Dr. Thomas Hickmann

Photos: Roese, Thomas (2)

Rainforest in India

REDD+ (Reducing Emissions from Deforestation and Forest Degradation) is a program that supports developing countries in sustainably conserving their forests as carbon stocks. A key element of the program are performance-based payments for measurable and verifiable emission reduction based on forest protection measures. This is to give forests a greater financial importance when economic decisions are being made and to make forests a more financially attractive carbon stock.

http://www.un-redd.org/

Emissions from Deforestation and Forest Degradation REDD+, which offers developing countries financial incentives to avoid deforestation. This is a challenge for national administrations, as Fuhr explains: "It must be ensured that the forests in such regions are preserved, yet the process has to be monitored and coordinated at the national level." The researchers are, therefore, interested in how national administrations are able to implement the global guidelines – and whether they are changing, for example, by establishing new structures.

Fuhr and his team are also looking at large cities that engage in the C40 city network. They are pioneers and their experiments – if successful – will set a precedent. There are three main reasons for cities to become activists in the fight against climate change, all of them related to population development, explains Dr. Thomas Hickmann, who supervises the project together with Prof. Harald Fuhr and Prof. Markus Lederer from the Technische Universität Darmstadt. First, cities are making their own climate policy simply because they can. "The importance of cities is increasing, primarily because they are growing." In 2008, the world's urban population exceeded 50% for the first time, and in 2050 it will be two thirds. Cairo already has as many inhabitants as Scandinavia. "Cities are developing into global players," says the political scientist. "As a consequence, what they do – also as political actors – is becoming increasingly important." Second, the increasing number of inhabitants also increases environmental impact, such as smog, and waste, and ineffective infrastructures. Because residents and political stakeholders of cities are feeling the problems in their own backyards, the pressure to solve them is growing. And third, cities – almost traditionally – are not only the cause of environmental problems but also as the place where solutions for them are created and tested. "Both technological and political innovations are being developed in cities in particular." The researchers are interested in the influence of this innovative potential on administrative structures. Will the cities be able to forge their own path on climate protection, even if there is headwind from the national level? Will such local initiatives also strengthen local administrations? And can they actually go beyond their urban boundaries and set a precedent?

Jakarta at night

The path of developing countries is crucial for global climate policy

The researchers are looking at these two developments in four countries: Brazil, India, Indonesia, and South Africa – all of which are emerging countries.

PhD student Fee Stehle in the Brazilian environmental ministry

The municipal administration of São Paulo sets a good example of "Urban Greening" with its rooftop garden.

For good reason: Currently, most of the world's population is living in so-called developing and emerging countries. Their paths will have a lasting impact on the world community. This is also true of climate change, as Hickmann explains. "Some calculations show that developing countries will soon produce more pollution than industrialized ones. It would be fatal if emerging countries like these four we are investigating develop as industrialized ones have done." Most developing countries and emerging economies, however, face other problems, such as food shortages, political instability, or poor economic development. Whether reversing climate change is possible at all will depend on whether global climate policy generally initiated by industrialized countries can also be implemented in developing ones. This is a good reason for Fuhr and his colleagues to dedicate special attention to them. "We have been studying policies 'crossing' borders, especially from north to south, from industrialized countries to developing ones."

Despite all four are emerging countries, each was chosen because its differences from the others: While some are increasingly involved in the REDD + program because of their large forested areas, others have large cities that are active in international networks. The "top-down and bottom-up pressure" on national administrations, which the researchers are interested in, is, therefore, different in each case. "It suggests that local administrations are strengthened in states with active cities and that those participating in the international forest protection program develop new central administrative bodies," says Hickmann. In addition, two are federal states, and two are centralized states with strong decentralized elements. "This way we hope to determine in which political constellations stakeholder interaction works well and in which it doesn't."

Months of research are necessary to track the processes, structures, and the ongoing political actions. "You cannot just march into a ministry and ask, 'What are you doing here?'," says Fuhr. During an exploratory research trip, the researchers establish contacts and seek out contact partners as well as access to the appropriate documents. "We do not always start from scratch. We have longstanding partners and research contacts in most of the countries. We also receive support from the German Association for International Cooperation (GIZ) and the local German embassies."

During a second stay of three to four months, the researchers conduct dozens of interviews and look at administrative processes and structures by talking to employees of ministries, regional authorities, and city administrations. "It is tedious, but once you've managed to make it into their office, most interview partners are interested in an exchange," Hickmann says.

South Africa has strong cities with innovative approaches

"Fieldwork" in one of the four countries – South Africa – is now complete. PhD student Fee Stehle spent

Photos: Fuhr, Prof. Dr. Harald (2)

THE RESEARCHERS

Prof. Dr. Harald Fuhr studied political sciences, sociology, economics, and social history at Goethe University Frankfurt am Main and Philipps Universität Marburg/Lahn from 1972-1979; PhD (1985) and habilitation (1993) in Constance. Since 1997, he has been Professor of International Politics at the University of Potsdam.

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Dr. Thomas Hickmann has been a researcher at the chair International Politics since October 2009. He studied political and administrative sciences at the universities of Potsdam and Copenhagen and completed his doctoral studies in 2014.

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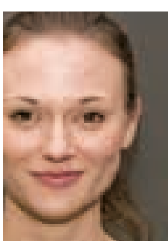

Fee Stehle studied political sciences, French philology, and administrative science at the University of Potsdam. Since 2015, she has been a research associate in the project "Carbon Governance Arrangements and the Nation-State".

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10 months preparing for the research trip – studying literature and evaluating government documents and laws, media coverage, and online information . She also established contacts with relevant stakeholders and experts, had initial talks with scholars and staff at international and non-governmental organizations as well as German institutions abroad. "This ultimately led to a kind of map of important players in South Africa's administration," she says. "In the end, I was able to talk to many South African government representatives." With quite surprising results. While the country is hardly involved in the REDD + program, three cities – Cape Town, Johannesburg, and Durban – are involved in transnational city networks. Not least because of their impulses, a number of successful programs have been initiatived. Durban, for example, has taken measures to preserve important coastal areas. "Johannesburg is implementing the sustainable city program 'Corridors of Freedom'. Expanding the public transport system and a higher residential density will reduce emissions," explains Stehle. "In addition, the city has created the stock exchange-listed equity fund Green Bond to finance urban climate measures." In Cape Town, numerous public buildings and even traffic lights were switched to solar power. The city also funds the installation of solar-powered water boilers.

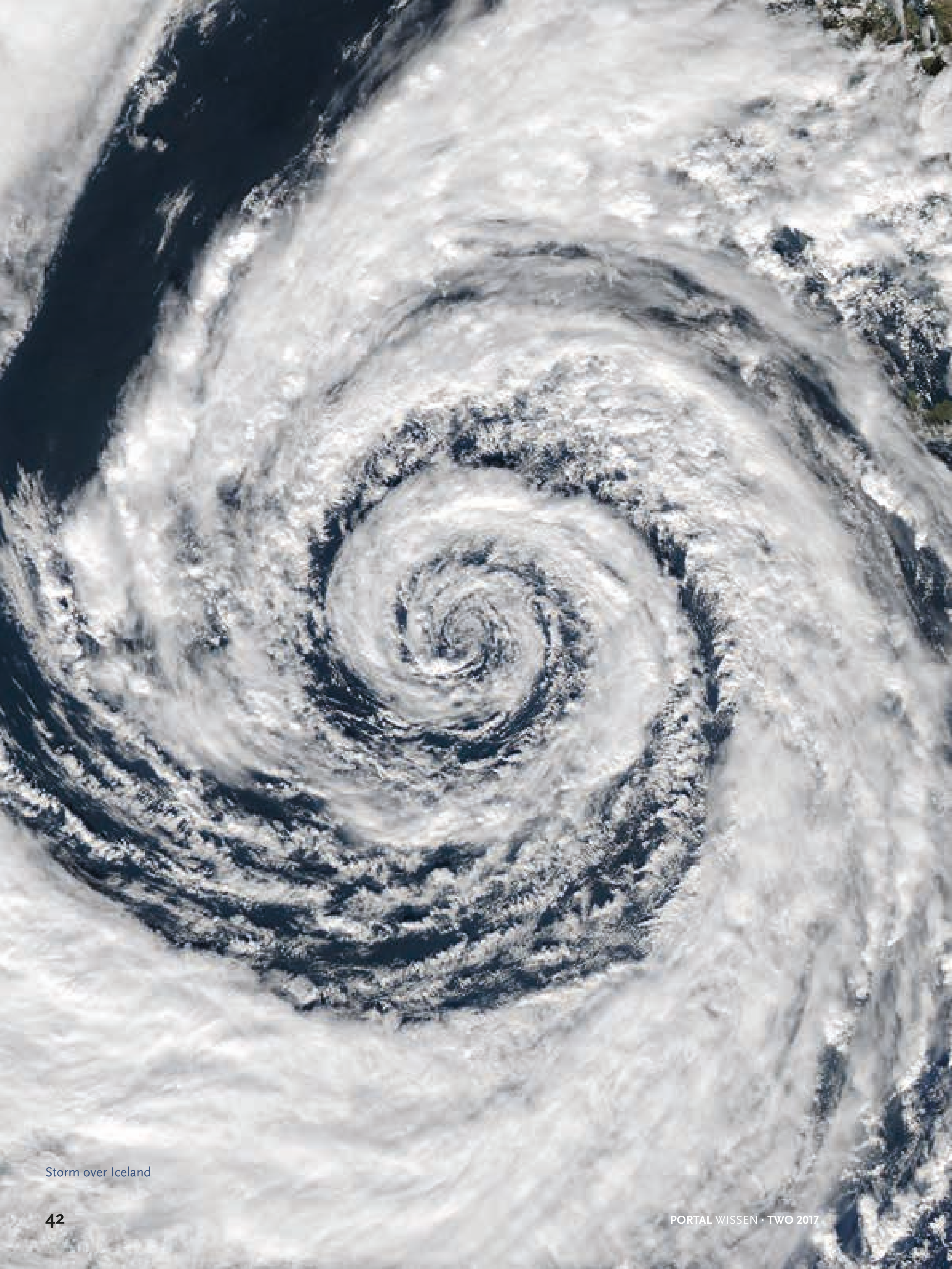
These are promising initiatives, Stehle says. "Urban players in South Africa are sometimes more advanced than those at the national level when it comes to renewable energies and implementing flagship projects." This is particularly evident in cities that depend on the national administration's cooperation. Because the South African energy sector is centrally governed, cities have little leeway in changing their energy mix and switching to renewable energies. "In the context of such massive national conditions, urban measures have only a limited impact," she says. This will not change without a mental paradigm shift in the national administration.

Changes are only possible together

The researchers' conclusion has, thus, become something of an appeal: This will only work if everyone works together. Cities can establish themselves as pioneers of successful climate policy. Without a functioning cooperation with national administrations, though, they remain beacons with no signaling effect, but these are what matters. After all, the innovative approaches of individual large cities have to be implemented in small- and medium-sized municipalities in order to achieve the climate goals. "This is only possible with the help of the national administrations," says Hickmann. "That's why we find the 'cities, cities, cities!' hype a bit exaggerated. Cities are integrated into a political and administrative system upon which they depend and within which they operate, but they can and will change it in the long term."

Harald Fuhr sees administrations worldwide in a process of change, and climate policy is a striking example of it. "Our project comes at the right time. We are witnessing new actors are taking their first steps, negotiating their interests with the established powers and resolving conflicts." In many countries, national administrations are starting to notice regional and urban actors – and to take them seriously. "The coming years will show how they adapt to it. And we will be there."

MATTHIAS ZIMMERMANN
TRANSLATION: SUSANNE VOIGT



Storm over Iceland

POTSDAM RESEARCHERS ANALYZE CLIMATE IMAGES ON THE INTERNET

Photo: pixabay/WikiImages

2013 was a record year in Australia: The average temperature reached an all-time high. To even be able to depict it, meteorologists had to introduce a new color. Since then, magenta has come to visually represent temperatures over 50°C. A new research project uses both digital and art history methods to look into the history and variety of these and many other climate images on the internet. Who creates climate images on the web? Who uses them, and for what purpose? Which images gain currency and how? These questions are explored by researchers at the University of Potsdam, the Potsdam University of Applied Sciences (FH), and the Potsdam Institute for Climate Impact Research (PIK).

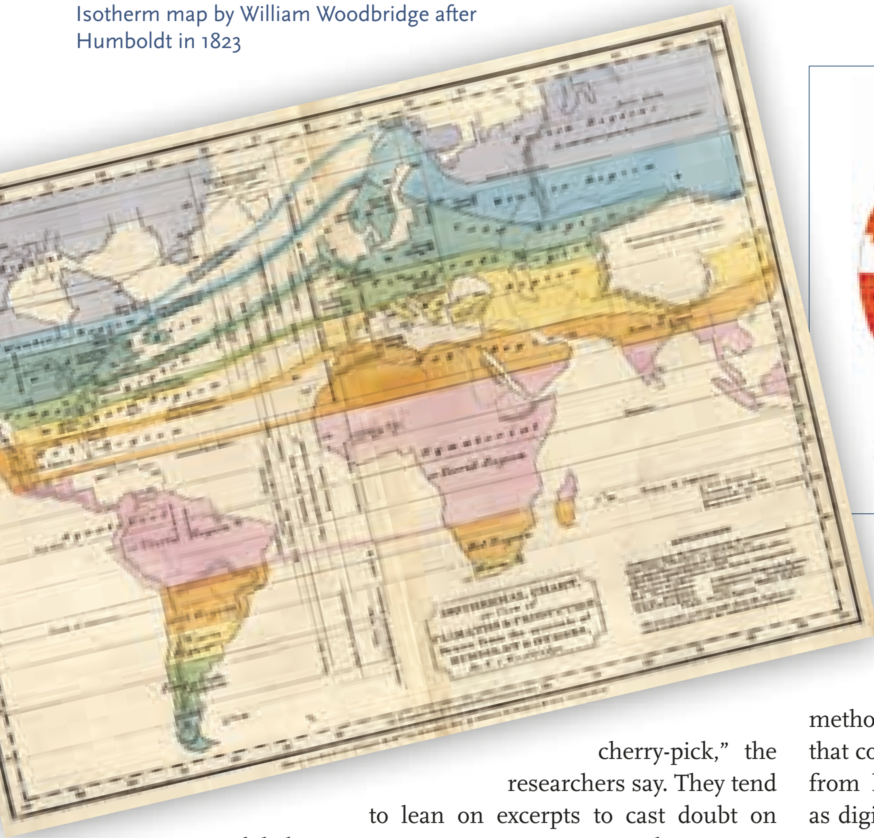
A polar bear stranded on a melting ice floe, flooded cities, dried up riverbeds, or overturned wind turbines – pictures are used to tell us something about the climate. To this end, they use a certain visual language. A Potsdam research team is analyzing the rhetoric of climate images and the strategies of various stakeholders. “We use image recognition software that works like a search engine,” explains Sebastian Meier of the Interaction Design Lab at FH Potsdam. “It automatically crawls the internet and collects information on images and their contexts.”

How many illustrations does an environmental organization like Greenpeace, for instance, use on its website? Are climate charts and diagrams or photos and comics being used? What colors, shapes, and contents are depicted? What year are the images from? “We are looking for commonalities among climate images on the internet,” summarizes media ecologist Prof. Dr. Birgit Schneider of the University of Potsdam.

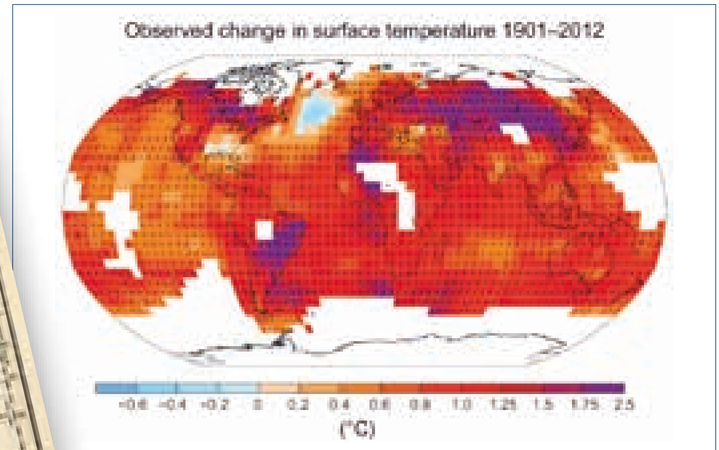
The color ranges chosen is also a part of visual language. Global warming depicted in a bright red may look very threatening, whereas cool blue tones might convey something less dramatic. “Behind every visual statement, there is a desire to convince,” Schneider explains. When visualizations distort scientific findings and manipulate the public, however, that becomes a problem, since a lay audience might not notice it. “Scientific images of climate change are often very complex,” says Dr. Thomas Nocke of the PIK. The Intergovernmental Panel on Climate Change, national environmental agencies, and research institutions are among those creating such complex visualizations. But if politicians, journalists, or bloggers modify and simplify them, scientific correctness may fall by the wayside. And climate change deniers use other means than climate change activists. “A typical strategy of deniers is to

A polar bear stranded on a melting ice floe – one of the striking images of climate change

Photo: pixabay/docoparisienne



Isotherm map by William Woodbridge after Humboldt in 1823



Global development of average temperatures between 1901 and 2012

cherry-pick," the researchers say. They tend to lean on excerpts to cast doubt on global warming. "Sometimes certain datasets are simply omitted, or certain regions or periods are selected to support an argument," Nocke says. Obsolete scientific theses are often used to depict climate change as a lie.

Climate images are used to negotiate trust in science

Uncertainty is a challenge for climate images. It poses a risk, particularly to the credibility of the presented information, since leeway in forecasts can be difficult for lay audiences to understand. "Probability plays into the hand of deniers," Nocke explains. "The ethos of research, however, is supposed to be objective," Schneider adds. "Yet researchers admitting what they are not sure about comes across as a sign of weakness to climate change skeptics." For Schneider, climate images, therefore, reflect a society's trust in science.

The researcher has dealt with climate images for a long time. For about eight years, she has been compiling relevant representations in science, art, entertainment, and advertising in a database, where they – 3000 images in total – are searchable by keyword: futures, curves, anomalies, apocalypse, world on fire, or skeptics. "As an art historian and media ecologist, I asked myself whether processing the images digitally would make sense." A major advantage would be that with quantitative methods researchers would be able to quickly analyze millions of pictures, whereas the qualitative analysis of just a few pictures by art historians takes considerably longer.

Furthermore, the researchers are explicitly interested in a critical review of digital methods. "We want to test the suitability of algorithms that computer scientists use every day using methods from humanities," Meier explains. For as objective as digital methods may seem, their results cannot be trusted without examination. Faulty, insufficient data or wrong search parameters can distort results. A poorly chosen training dataset – with which software "learns" – may bias the results. This became obvious with the image recognition algorithms of Google and flickr: People with dark skin were not detected properly, since the training dataset was calibrated mainly on people with fair skin. So how can digital methods be more than just supporting tools? This is another question the team will be addressing in the coming years.

Researchers analyze communication on climate change

"Even now, computer science is everywhere in our lives," Thomas Nocke finds. Algorithms are making major decisions: They are indispensable in training

Between April 2017 and March 2020, Volkswagen Foundation will be funding the collaborative project **"New potentials for analyzing network images – Similarity as a criterion for comparing images in image studies, computer and visualization science using the example of climate images on the web"**. Two doctoral theses will be written on the subject, and a colloquium, workshops, publications, and a website are planned.

✎ http://www.uni-potsdam.de/medienoekologie/index/digitale-analyse-vernetzterklima-bilder.html

Photos: Woodbridge, William (top left); IPCC (top right); pixabay/Engin_Akyurt (bottom)

THE RESEARCHERS

Prof. Dr. Birgit Schneider studied art theory and media theory. Since 2015, she has been Professor of Media Ecology at the University of Potsdam.

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Sebastian Meier studied communication design and interface design. Since 2012, he has been a member of the Interaction Design Lab.

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Photos: pixabay/skeeze (background); Fritze, Karla (3)

The research team

driverless cars, investigative authorities use image analysis methods for crime detection, and dating sites match couples using algorithms – with far-reaching ethical consequences. "We believe that computer science can benefit from including humanities perspectives." Climate images are, thus, well suited for testing the common application of humanities and digital methods as such. And in times of digital humanities and big data, critical views are all the more important.

Climate change is a global challenge – that is why the Potsdam researchers are focusing on how it is communicated. Climate images need to convey scientific findings in a way everyone can understand and as neutrally as possible. So there will be not only publications, workshops, and meetings at the end of the project but also interactive online exploration tools. "We are not talking about an Excel sheet listing all characteristics of climate images," says Meier. The tools will be descriptive and reveal new correlations. Last but not least, the researchers hope their work improves communication on climate change. "If all goes well, we will be able to provide political decisionmakers, the scientific community, and the arts scene with new ideas on how to better understand the global challenge of climate change," Schneider says.

JANA SCHOLZ
TRANSLATION: MONIKA WILKE

Photos: Fritze, Karla (top); Fotolia/cartoonresource (bottom)

OBSERVATION CAMERAS FOR MOZAMBIQUE

The Ministry of State Security as a "development worker"

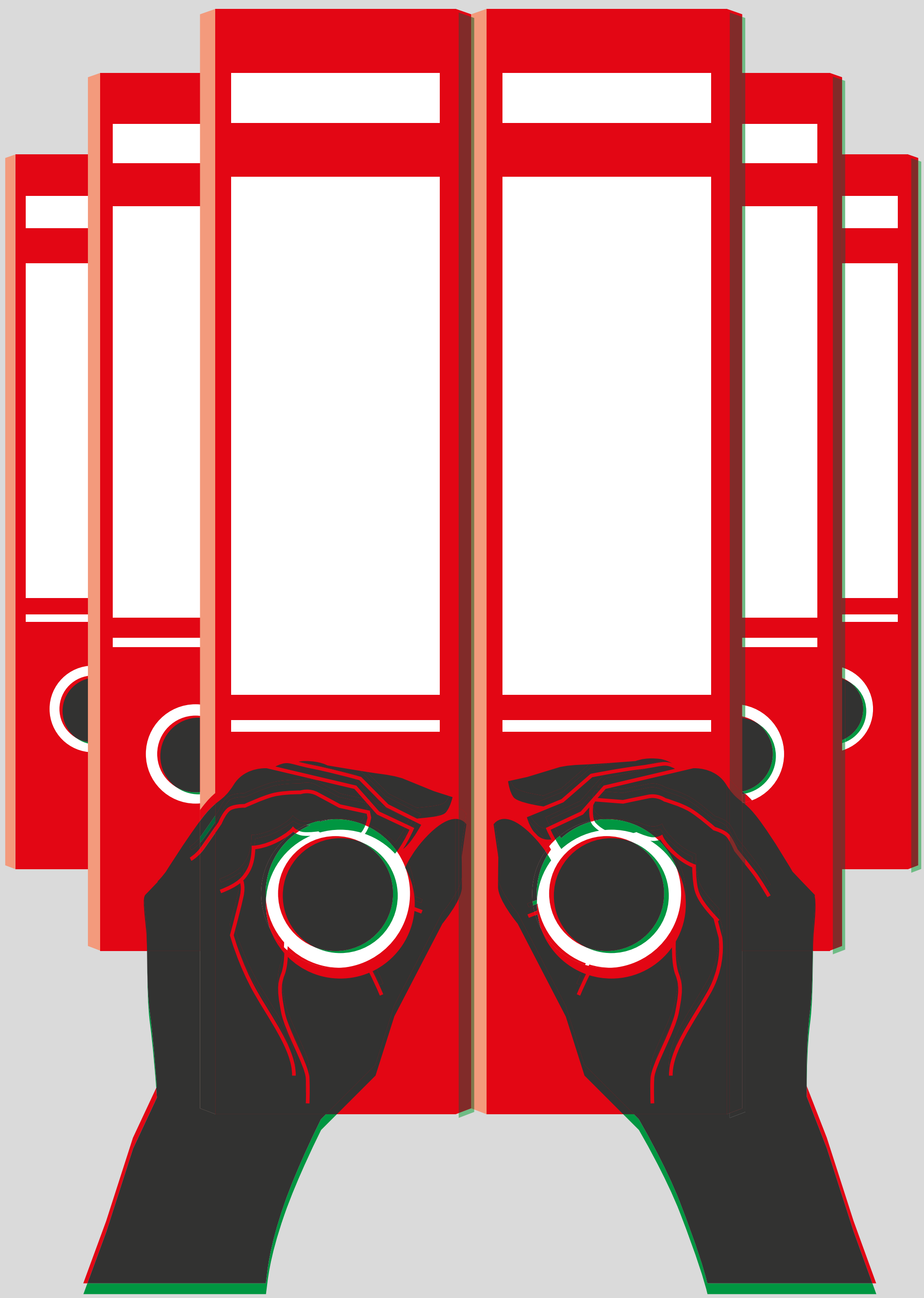
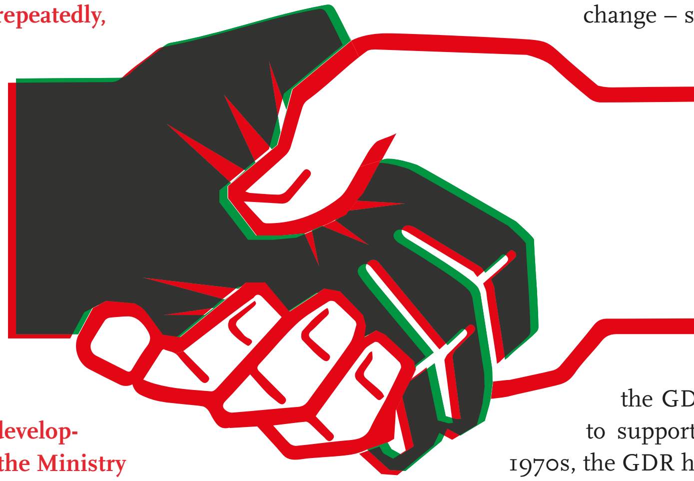


Illustration: Töpfer, Andreas

At the Centre for Contemporary History (ZZF) in Potsdam, 39 folders with copies of documents from archives from around the world are piled up on the desk of doctoral candidate Anna Warda. She has read them repeatedly, translated some of them, and also learned to interpret the cryptic abbreviations in the documents written in Portuguese, Spanish, English, Kiswahili, and German. They are testimonials of the so-called development assistance by the Ministry of State Security (MfS) in the Global South. Warda is focusing on the activities of the MfS in Zanzibar, Mozambique, and Nicaragua from the 1960s to German reunification.



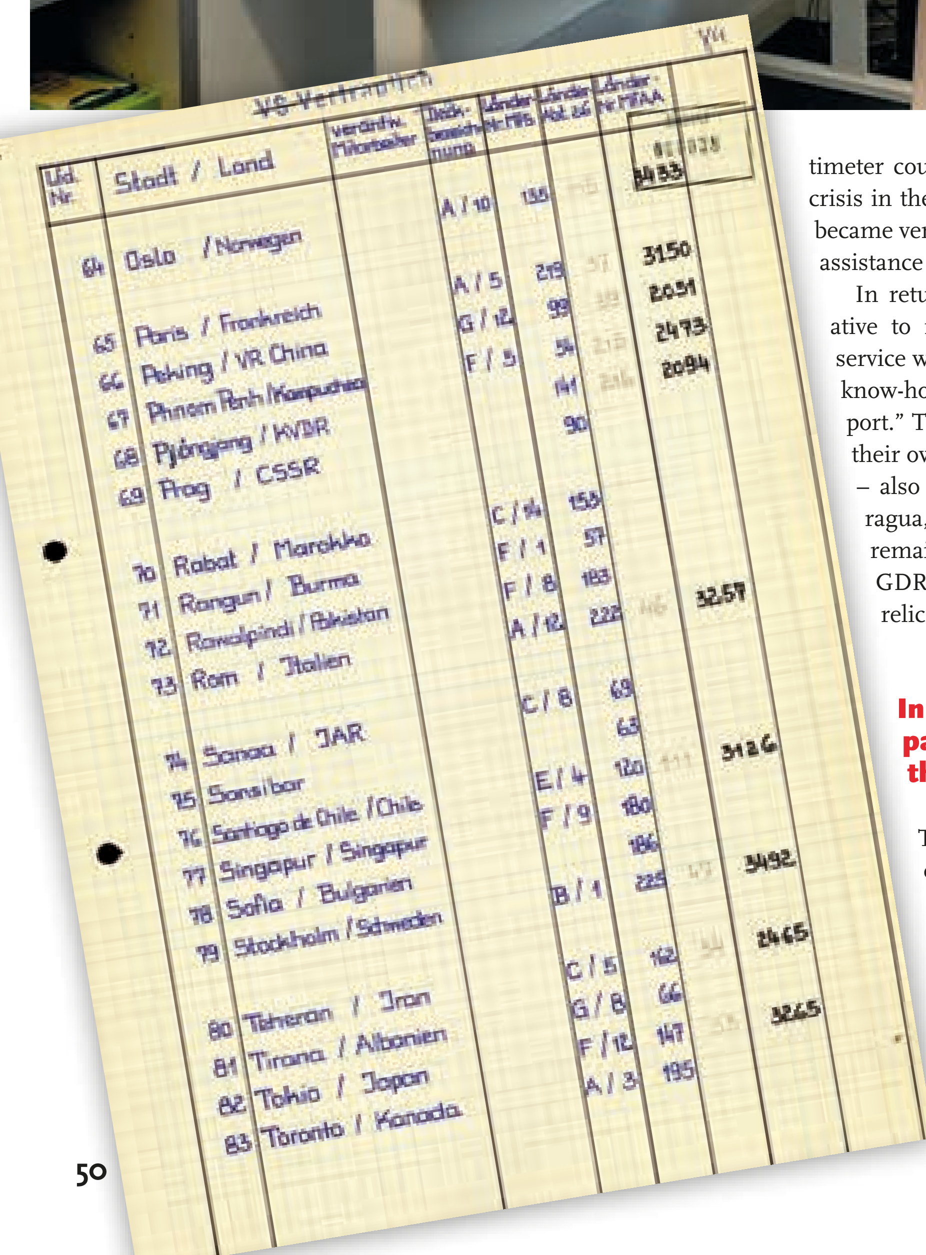
The state security service of the German Democratic Republic (GDR) was active in more than 25 countries in the Global South – spanning from Asia to Africa to South America. "In most of these countries, radical change – such as the end of colonial rule – had created a political vacuum," the historian explains. "And so these countries' elite decided to set up a socialist state and turned to the GDR for support."

Over its almost 40-year existence, the GDR had various motives to support them: Right into the 1970s, the GDR had yet to be recognized by Federal Germany under international law. Diplomatic relations with other countries were welcome, allowing the GDR to assert itself as one of two German states. "During the Cold War, every cen-

GDR exports: housing construction and surveillance technology

Photo: Wikipedia.de/Sigrun Ingel; Illustration: Töpfer, Andreas

Anna Warda



VS-Vertraulich

Lfd. Nr.	Stadt / Land	verantw. Mitarbeiter	Dok.-Bezeichnung	Länder Nr MfS	Länder Abt 26	Länder Nr MfAA
						3433
64	Oslo / Norwegen		A / 10	155		
65	Paris / Frankreich		A / 5	219	37	3150
66	Peking / VR China		G / 12	99	39	2031
67	Phnom Penh / Kampuchea		F / 5	56	215	2473
68	Pjöngjang / KVDR			141	216	2094
69	Prag / CSSR			90		
70	Rabat / Marokko		C / 14	153		
71	Rangun / Burma		F / 1	57		
72	Rawalpindi / Pakistan		F / 8	183		
73	Rom / Italien		A / 12	222	116	3257
74	Sanaa / JAR		C / 8	69		
75	Sansibar			63		
76	Santiago de Chile / Chile		E / 4	120	111	3126
77	Singapur / Singapur		F / 9	180		
78	Sofia / Bulgarien			186		
79	Stockholm / Schweden		B / 1	225		3492
80	Teheran / Iran		C / 5	162		2465
81	Tirana / Albanien		G / 8	66		
82	Tokio / Japan		F / 12	147		3265
83	Toronto / Kanada		A / 3	195		

timeter counted," Warda says. During the economic crisis in the 1980s, resources from partner countries became very attractive: The GDR was rewarded for its assistance with coal, coffee, cocoa, and tropical fruits.

In return, the MfS provided its expertise. "Relative to its population, the GDR's state security service was a huge apparatus," Warda explains. "Its know-how in surveillance was the country's real export." The MfS helped partner countries build up their own state security services and – in so doing – also brought surveillance technology to Nicaragua, Mozambique, and Zanzibar. Some of it remains: A few years ago, Warda spotted typical GDR border guardhouses at Managua airport – relics of the so-called development assistance.

In Potsdam, police from socialist partner countries were trained by the MfS

The MfS staff did more than just bring cameras, listening devices, and bugs to the partner countries; they also trained locals – both in their home countries and in the GDR – in how to monitor radio communication, telephone lines, and mail. One witness from Mozambique told Warda about his time at the Law College of the MfS in Potsdam-Golm. In the 1970s,

Photos: Fritze, Karla (2)

THE RESEARCHER

Anna Warda studied literature and history at the University of Potsdam. Since 2014, she has been a PhD student at the Department of History of the University of Potsdam. Warda is also an associated PhD candidate at the Department "Communism and Society" of the Center for Contemporary History.

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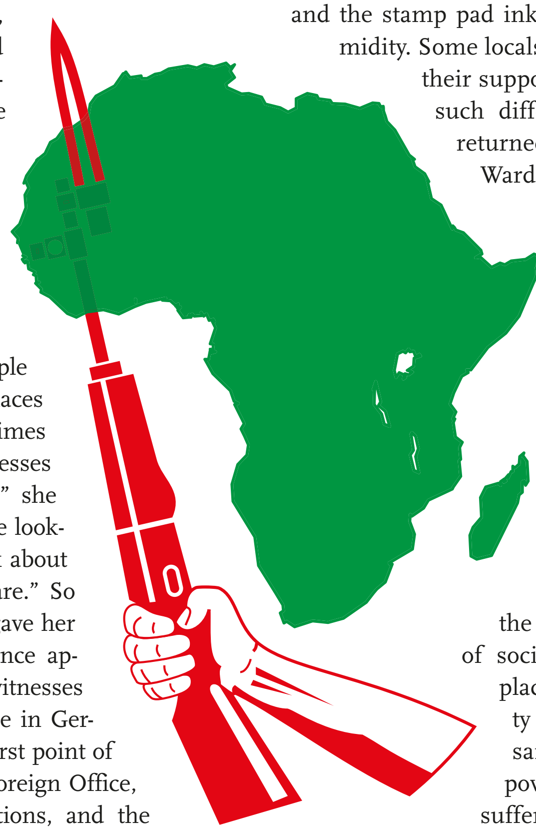
he was trained there as a police officer for six months. But back in Mozambique, his Christian faith stopped him from further collaborating with the country's state security service. He now works as a German teacher – and, thus, benefits from the language skills acquired from his contact with the MfS.



Warda spoke to some 15 witnesses and spent a couple weeks in each of the three places she is researching. "Sometimes I got into touch with witnesses through crazy coincidences," she says with a laugh. "If you are looking for witnesses, just speak about your project wherever you are." So the baker and her landlady gave her some hints, and she was once approached in the street by witnesses while speaking on the phone in German. But experts were her first point of contact in each place. The Foreign Office, embassies, political foundations, and the Goethe Institute helped her gain access to archives and pointed out other sources of information. However, many witnesses did not want to talk to her. "90% of former MfS staff refused to talk to me."

Even seemingly dry files speak of intercultural conflict

The files on Warda's desk also provide clues on the behavior of MfS staff while abroad. Letters, telegrams, notes, reports from informal collaborators, planning papers on finances and exchanging diplomats, or endless delivery lists – every little bit is meticulously documented. The MfS spied not only on their enemies but also on their allies – and even monitored their own staff.

"I am also looking for intercultural moments in the files and what conflicts there might have been," Warda says. Frequently, the partnerships between the GDR and Zanzibar, Mozambique, and Nicaragua were characterized by mutual incomprehension. For example, an MfS officer expressed his anger about people in Zanzibar not taking an ill child to the hospital but rather to a village elder." And the MfS cadres – strictly trained in Marxism-Leninism and loyal to the party line – were surprised to find that some of the locals had never heard of Marx or Lenin.

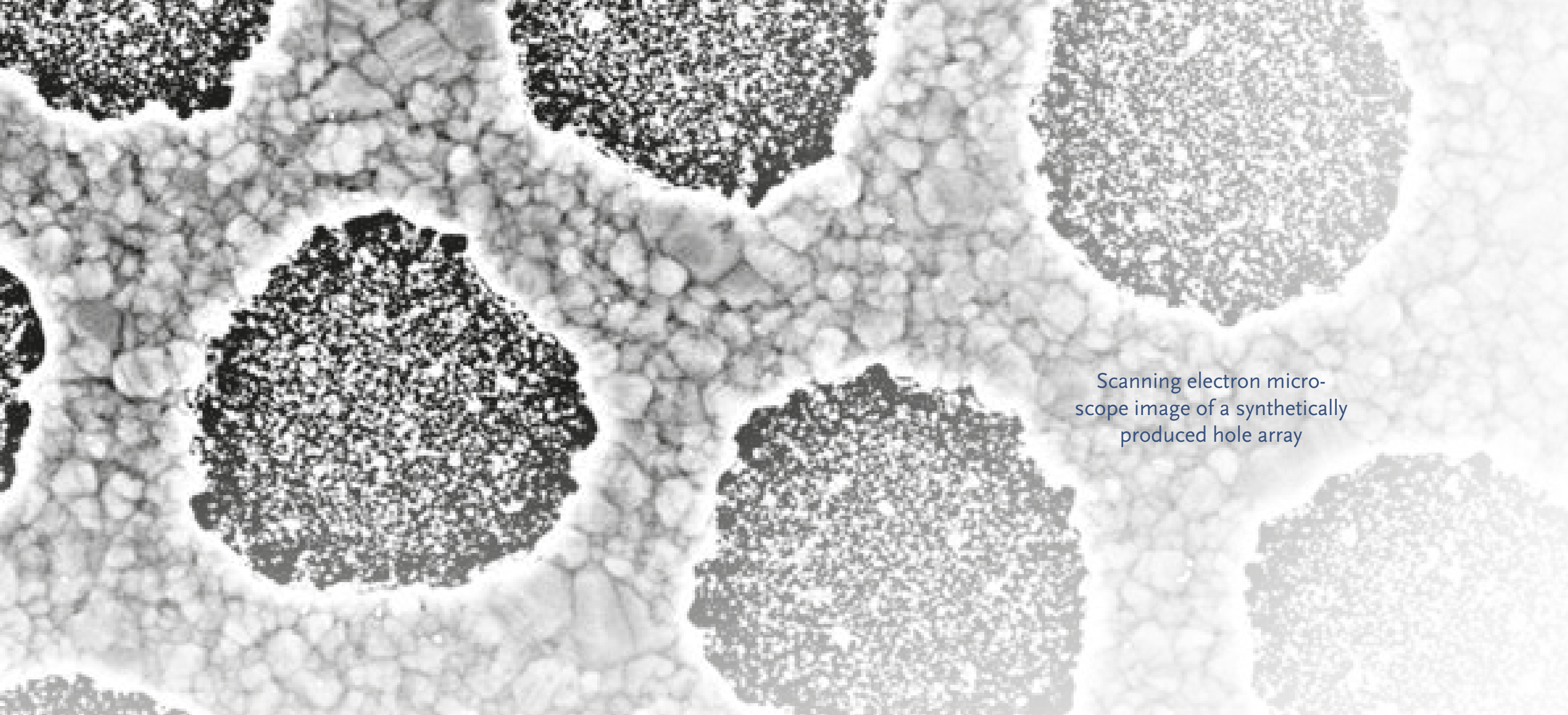
Conversely, the locals were suspicious of MfS staff, who were unfamiliar with the tropical climate. The surveillance electronics they brought rusted, and the stamp pad ink was not suited for high humidity. Some locals regarded this as sabotage by their supposed socialist friends. Despite such differences, many MfS officers returned to their country changed, Warda says. From East Berlin, they continued to do something for the country they had lived in. At least this is what the files say.

The fall of the Berlin Wall also meant the end of the GDR's so-called development assistance. Some MfS officers boarded planes home; others decided to stay. For Zanzibar, Mozambique, and Nicaragua, however, the end of the Cold War was not the end of socialist surveillance. "In these places, the national state security services are still active. The same socialist parties are in power, and the people are still suffering governmental reprisals."

While Warda was living in Zanzibar, some of the witnesses she had spoken to disappeared during the elections; they were arrested as opposition members. When the young historian finishes her dissertation, she plans to continue her research on the ongoing ramifications of the MfS' activities in the Global South.

JANA SCHOLZ
TRANSLATION: MONIKA WILKE

Photo: Fritze, Karla · Illustration: Töpfer, Andreas

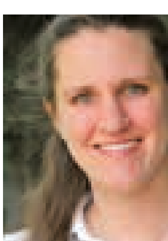


Scanning electron micro-scope image of a synthetically produced hole array

All about Chemistry

Heisenberg Fellow Dr. Claudia Pacholski is at home in many laboratories

She is active, goal-oriented, welcomes new challenges, and enjoys teaching and research. Food chemist Dr. Claudia Pacholski has been teaching and doing research at the University of Potsdam since 2014. Funding from a Heisenberg Fellowship of the German Research Community (DFG) – which she raised herself – has enabled her to initiate new research projects and to extend existing ones.



THE RESEARCHER

Dr. Claudia Pacholski studied food chemistry at the University of Hamburg. Since 2016, she has worked as Heisenberg Fellow at the Institute of Chemistry of the University of Potsdam.

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Claudia Pacholski's CV is quite exceptional. Before she came to Potsdam, she had already left her scientific marks in various fields at several universities and research institutes. This was not always easy for her because she and her partner, also a chemist, had to “cope with things separately”. After her studies in Hamburg, Pacholski did not change the university but her research focus for the first time.

“I was very interested in food chemistry but it was too much analysis for my liking. I quickly realized that I wanted to work more broadly.” Even in her first state exam, she was already working on organic synthesis. She looked at impurities in the production of pharmaceuticals and wrote her dissertation on the synthesis and characterization of semiconductor nanoparticles. Pacholski successfully applied for several scholarships. For two years, she was a postdoc at the University of California, San Diego, USA and later, she worked at the Max Planck Institutes for Metal Research and Intelligent Systems, where she focused on developing structured surfaces for biosensor applications.

Tiny biosensors as the future of measurement technology

Pacholski has been working at the University of Potsdam since 2014, initially as a principle investigator of

Photos: Pacholski, Dr. Claudia (top); Hölzel, Thomas (bottom) a project funded by the Volkswagen Foundation. Since 2016, she has been a Heisenberg Fellow and heads the research group "Functional Nanostructures". The research team synthesizes nanomaterials – i.e. chemical substances or materials whose particle range in size from 1-100 nanometers – and is interested in both chemical and optical properties. "We are focusing on the preparation and self-assembly of inorganic materials in combination with polymers to produce materials with new, extraordinary properties." Pacholski and her group specifically investigate how to use the material they developed as biosensors – sensors with biological components. They are based on the coupling of a biologically active system, for example, antibodies or enzymes, with a signal transducer and an electronic amplifier and are used in biotechnological measurement technology.

Pacholski's projects defy neat categorization. The interdisciplinary approach of combining physical inorganic chemicals, colloids, and biosensors is very important but is not always easy to do. "A successful application must convince all expert reviewers, and this can be difficult when there are many disciplines involved," the researcher explains. That she was able to raise third-party funds proves her right.

She is currently working on chemically producing periodic metal hole arrays in gold film. "As opposed to conventional methods used for the generation of such hole structure –s, for example electron-beam lithography and ion-beam etching, this method is fast, cost-effective, and can be done in any chemistry laboratory." These hole arrays have already been successfully tested as sensors.

Nanomaterials with novel properties

Another research project deals with photonic nanomaterials, which include metamaterials, artificially produced structures, and so-called photonic crystals. They can have optical properties, which were only recently discovered, for example negative refractive indices. The Potsdam group is focusing on the production and characterization of photonic nanomaterials through self-assembly: small building blocks, which form well-ordered structures. The "Lego principle" allows large quantities of innovative material to be quickly and cost-effectively produced, resulting in tailor-made materials for specific applications.

Porous silicon is also of scientific interest to Pacholski. It is a form of the chemical element silicon with a specific structure. Porous silicon is suitable for producing solar cells and rechargeable batteries due to their special optical and electrical properties. An expert selection of various manufacturing parameters – such as the type of silicon or the concentration of fluoride ions – results in porous nanoscale and microstructures that are particularly interesting for optical applications such as filters or sensors.

It is helpful for Pacholski that she does not have to buy expensive equipment and materials for these projects. The researcher is strongly supported by the research group of Prof. Hans-Gerd Löhmannsröben and the innoFSPEC research network team. In addition to good research opportunities, contact with students and doctoral students is very important to her. This exchange, the search for answers to unusual questions, and exploring the unknown all inspire and motivate her.

DR. BARBARA ECKARDT
TRANSLATION: SUSANNE VOIGT

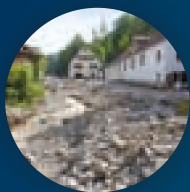
THE PROJECT

Bottom-up fabrication of tailor-made plasmonic sensors for the specific and sensitive detection of target analytes in complex matrices

Duration: 2016–2019
Partner institutions: University of Stuttgart, Karlsruhe Institute of Technology (KIT), University of Konstanz, Friedrich Schiller University Jena, Universidad Autonoma del Estado de Morelos, Mexico


Dr. Claudia Pacholski in the lab

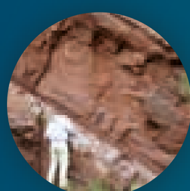
Photo: Hölzel, Thomas



NatRisk-Change – Natural Hazards and Risks in a Changing World (DFG 2043)
www.uni-potsdam.de/natriskchange

BioMove – Integrating Biodiversity Research with Movement Ecology in dynamic agricultural landscapes (DFG 2118)
www.biomove.org

5



StRATEGy: Surface processes, Tectonics and Georesources: The Andean foreland basin of Argentina (DFG 2018)
www.irtg-strategy.de

WIPCAD – Wicked Problems, Contested Administrations: Knowledge, Coordination, Strategy (expiring)
www.uni-potsdam.de/wipcad

5 DFG RESEARCH TRAINING GROUPS

for young researchers do their work at the University of Potsdam. The University is also involved in four DFG-funded graduate schools, two EU-funded doctoral student networks, as well as 18 structured doctoral programs in its faculties or with the University's participation.

https://www.uni-potsdam.de/forschung/profile-programme-projekte/graduierten-programme.html

Minor Cosmopolitanisms (DFG 2130)
www.uni-potsdam.de/minorcosmopolitanisms

FIGURES presents one of the many figures that describe the research work at the University of Potsdam, offering a glimpse of the hustle and bustle behind the scenes.

Photos: Agarwal, Ankit (top left); Ullmann, Wiebke (top right); Montanes, Joan Pascual (middle); Fotolia/Mopic (bottom left); pixabay/stokpic (bottom right)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