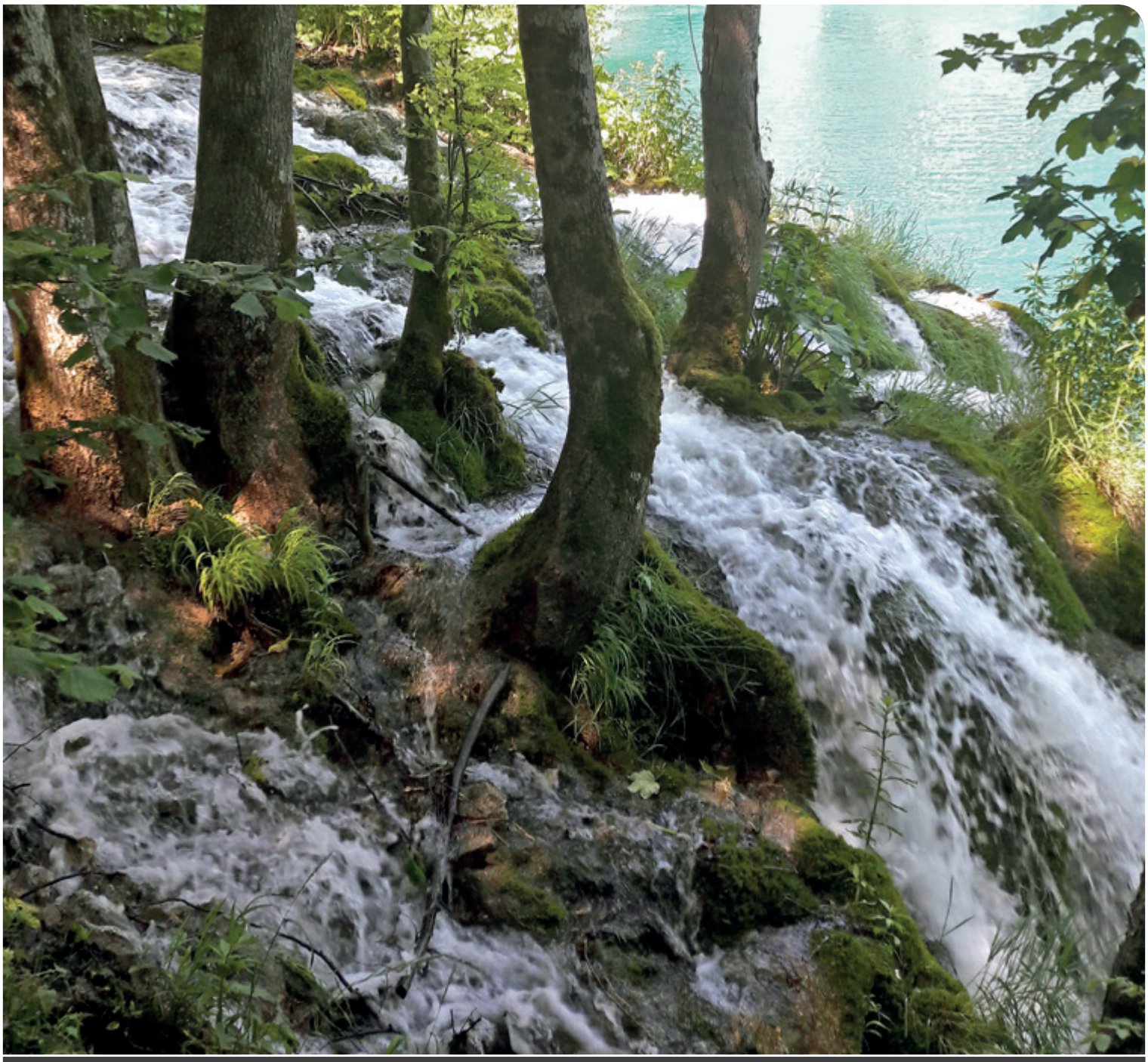
Karlsruhe Institute of Technology

Climate and Environment news

NEWSLETTER OF THE KIT CLIMATE AND ENVIRONMENT CENTER

ISSUE 03 | 2024



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December 2024

Cover Photo
Plitvice Lakes
(Photo: Susanne Benz)

Dear Readers,

As misinformation and fake news proliferate, the need for reliable information based on scientific evidence is becoming more pressing. Research must take more proactive steps to meet this demand and serve as a dependable compass helping us to strike out in the right direction and master the global challenges we face today.

It is vital that we interpret scientific data correctly and take action on this basis. We must draw on robust scientific sources to ensure that the steps we take are effective and have a lasting impact. Only by making *evidence-based decisions* can we ensure that we are on the right track to overcoming global crises and securing a livable future for coming generations.

As well as supplying information that can serve as a basis for sound decision-making, research also delivers practical solutions to specific problems. Whether we are seeking to combat climate change by developing new technologies for CO_2 reduction or finding innovative approaches to energy production, the insights generated by research give us tools for mitigating the effects of the climate crisis.

Topics such as *groundwater warming*, *microbial electrosynthesis*, and the investigation of *karst aquifers* supply impressive examples of the innovative research that is currently being undertaken. Precise *wind profiling close to the clouds* also has the potential to further advance the use of renewable energies. These technologies and research areas could prove crucial to understanding our natural resources more fully and using them more sustainably. Research into *polymetallic nodules* is also yielding valuable insights – although they represent a promising source of valuable raw materials, exploitation of the seabed is also fraught with risk.

At a time when opinions are often louder than facts, one thing remains clear: Overcoming the major challenges of our time requires research as a reliable partner. Only by applying findings from research in a targeted fashion can we drive the changes that our world so urgently needs.

Yours,

Professor Dr. Oliver Kraft, Vice President Research

The groundwater-fed Plitvice Lakes in Croatia. (Photo: Susanne Benz)

Groundwater Warming

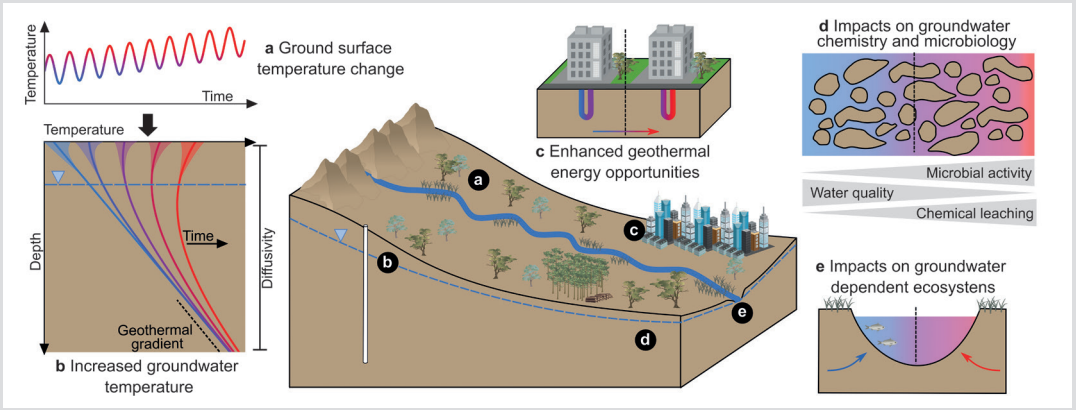
Climate Change Beneath Our Feet

Many people think of climate change as a phenomenon that occurs in the atmosphere. But gradual warming that could have far-reaching effects on the environment and on drinking water quality is now also taking place beneath our feet. Susanne Benz, junior group leader at the Institute of Photogrammetry and Remote Sensing (IPF), has analyzed data on global groundwater temperatures together with colleagues from the Institute of Applied Geosciences and published her findings in a paper that appeared in Nature in the spring. They have attracted the attention of researchers and also of a wider readership.

"Our Earth is like a joint roasting in the oven," Benz says: "The heat first strikes the outside surface and then penetrates deeper toward the center." Much the same thing happens with the heat that strikes the Earth. Rising atmospheric temperatures are warming its crust from the outside in – and the process is slow, but unstoppable. With the help of modeling, Susanne Benz was able to show that this process is now exerting influence on the natural temperature gradient between the Earth's surface and deeper layers. Temperatures below the Earth's surface normally increase with depth, but global warming has disrupted this geothermal gradient. So much warming is now occurring close to the surface that temperatures in the outer zone of the Earth are remaining permanently elevated. "This is happening irrespective of short-term weather fluctuations and therefore represents hard evidence for climate change," Benz says: "Even adherents of conspiracy myths can't doubt that."

The researchers have developed a model that analyzes ground temperature data from multiple decades and simulates the changes that can be expected in the coming decades based on different climate scenarios. The results are worrying. Temperature increases in the ground can already be measured down to a depth of 100 meters.

An important aspect of ground and groundwater warming is that it affects the quality and the ecological functioning of water. Higher groundwater temperatures can promote the spread of pathogenic microorganisms



Effects of elevated air and ground temperatures (a) on temperature (b), the chemistry, microbiology, and quality of groundwater (d), geothermal potential (c), and groundwater-dependent ecosystems (e). (Image with pictures from the UMCES IAN media library, https://creativecommons.org/licenses/by-sa/4.0/*)*

and endanger water quality. Benz warns that this could become a problem, especially in regions that use groundwater directly: "In rural areas in the global South, but also in parts of the United States of America, groundwater is often used as drinking water without any prior treatment. People in these regions are particularly likely to be affected by these changes." More than 100 million people worldwide could be affected.

Warmer groundwater could be a potential source of energy for geothermal plants, which would reduce energy demand for heating, at least partially, and thus promote sustainable development. But the large-scale deployment of these technologies is not yet widespread and not always financially viable. As such, the prospect of making widespread use of increasing ground heat as an energy source is currently a somewhat theoretical option and not an opportunity that negates the urgency of stopping climate disaster.

A groundwater well in India. (Photo: Susanne Benz)

Another important effect of groundwater warming relates to rivers. Cool groundwater flowing into rivers provides spawning grounds for many fish such as salmon. In regions like Canada, rising groundwater temperatures are already forcing salmon to migrate further north because their usual spawning grounds are becoming too warm. As well as affecting fish stocks, these changes also threaten the fishery sector and wider ecosystems.

The model and the results reached by Benz and her team make it clear that climate change affects many more areas than is commonly assumed. As Benz herself says, "Our project shows how important it is to look holistically at climate change in a way that includes consideration of its invisible consequences." ■

Innovation Campus Sustainability (ICN)

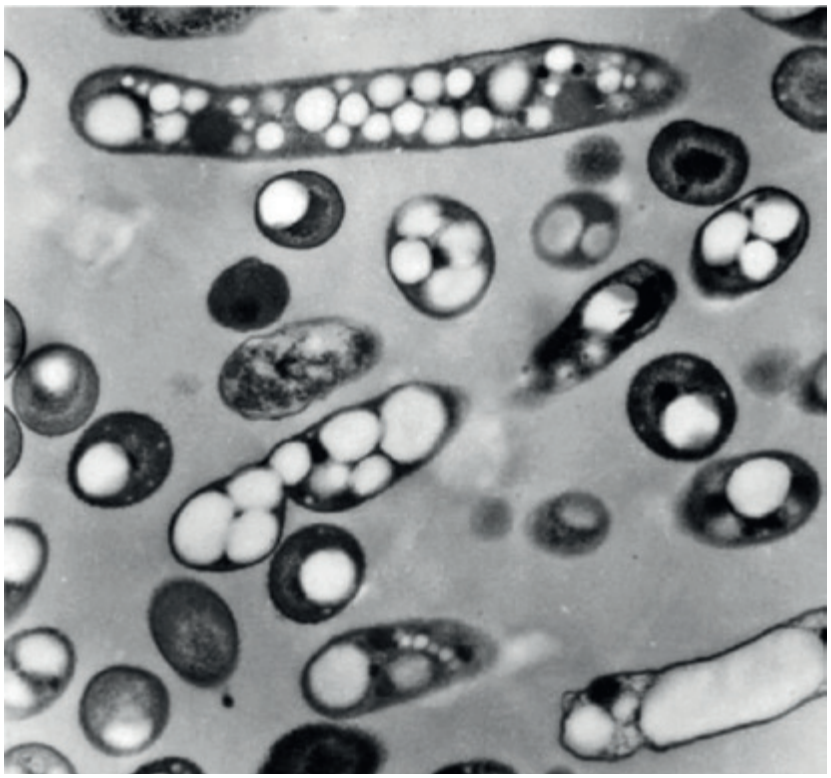
All Projects Have Started

An ICN networking event. (Photo: Miriam Jordan)

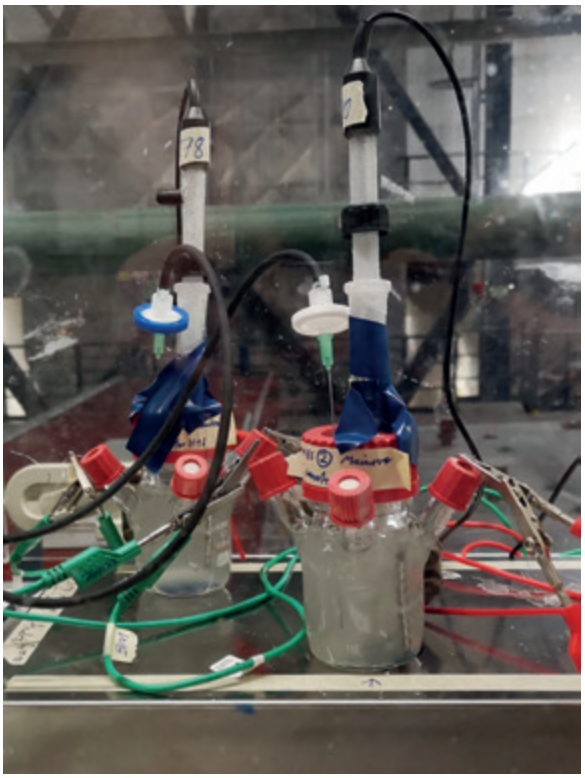
All the pilot projects that form part of the Sustainability Innovation Campus (ICN) launched early in 2024 have now begun. ICN is a joint initiative of the University of Freiburg and KIT with funding from the Baden-Württemberg Ministry of Science, Research, and the Arts. "Our aim is to drive the sustainability transformation in society by means of transdisciplinary research and systemic innovations," says Miriam Jordan, Managing Director of the ICN at its Karlsruhe location.

The first projects forming part of the ICN initiative include, for example: "PROLOK," which is developing heat resilience strategies for small municipalities, and "Sustainability Transformation of Community Catering," which aims to contribute to the sustainable transformation of the food system. The ICN projects all aim to foster more intense exchanges between society, politics, and research in order to accelerate the translation of research findings into practice. Events in various dialog formats will also contribute to this aim, with the first one taking place in December. "Making our projects highly visible is decisive, as it demonstrates that sustainable development is achievable when people work together," Jordan says. ■

The PROLOK pilot municipality of Ihringen. (Photo: Johannes Meger)



Cupriavidus necator *with PHB granules (Photo from: J Bacteriol. 2005 Jun; 187(11):3814–3824. https://creativecommons.org/licenses/by-nc-nd/4.0/)*



Experimental setup at the Mainova AG combined heat and power plant. (Photo: Dirk Holtmann)

Electrified Microbes

Production of Biopolymers by Hydrogen-oxidizing Bacteria Using Flue Gas Demonstrated in a Combined Heat and Power Plant

Carbon dioxide (CO_2) is chiefly viewed as a problematic waste product from the fossil fuel era. But its public image could soon be enhanced by a rebranding as a raw material for a cleaner future. "For environmental reasons, CO_2 from industrial processes should no longer be released into the atmosphere," says Dirk Holtmann from the Institute of Process Engineering in Life Sciences (BLT). At the same time, the chemical sector is seeking to identify a suitable carbon source for the post-fossil era. Electrobiotechnology professor Dirk Holtmann is working on a solution that responds to both challenges.

Making carbon dioxide available as a raw material again always demands energy. Plants get this energy from sunlight. Dirk Holtmann's team uses an electric current – and a very special bacterium, the hydrogen-oxidizing ("knallgas") bacterium *Cupriavidus necator*. The researchers first break down water into its components and add a mix of gases containing carbon dioxide such as air or flue gas. *C. necator* uses hydrogen as an energy source and carbon dioxide as a carbon source. Oxygen serves as an electron acceptor. If the nitrogen content in the gas mixture is kept low, a special metabolic pathway is triggered. "The bacterium then produces polyhydroxybutyrate, PHB for short, as a storage material and accumulates it in its cells," the biotechnologist explains. "PHB is a well-known biopolymer with highly useful characteristics and strong relevance for industry."

Of course, the production process could be achieved without microorganisms, as chemical catalysts could perform the same work. But that would have two drawbacks: It would be a more energy-intensive process and it would need very clean CO_2. Dirk Holtmann and his team have confirmed in countless lab experiments that *C. necator*, in contrast, is not very fussy about its carbon dioxide sources. Now the team has moved beyond the laboratory setting to find out how well the bacterium handles harsh industrial conditions and copes with flue gas from a combined heat and power plant. Frankfurt-based electricity provider Mainova was an ideal partner for this investigation.

"The results surprised us more than we expected," Holtmann says. "Whether we fed the process with clean CO_2 from a gas line or with industrial CO_2 from flue gas made no difference to bacterial growth and PHB production." These results mean that the researchers have not only demonstrated successfully for the first time that their approach is suitable for industrial use – they have also smoothed carbon dioxide's transition from being a pollutant to being embraced as a resource. ■

Publication Information: Alexander Langsdorf, Julian Philipp Schütz, Roland Ulber, Markus Stöckl, Dirk Holtmann, Production of polyhydroxybutyrate from industrial flue gas by microbial electrosynthesis, Journal of CO_2 Utilization 83 (2024) 2212–9820, https://doi.org/10.1016/j.jcou.2024.102800

Good Karma

Fascinating Insights into One of the Most Important Drinking Water Supply Systems in the Mediterranean Region from the Consortium Project Karma

Seven project partners from Spain, France, Germany, Italy, Lebanon, and Tunisia have spent four years investigating one of the most important natural resources in the Mediterranean region: Drinking water. The consortium project Karst Aquifer Resources Availability and Quality in the Mediterranean Area was coordinated by Nico Goldscheider from the Institute of Applied Geosciences (AGW) at KIT. It set out to investigate the availability and quality of water in the karst aquifers in the Mediterranean region, to develop new models for the influence of climate change, and to generate mapping data.

"Karst is both a type of landscape and a type of aquifer," hydrogeology professor Goldscheider explains. "It usually consists of limestone with numerous clefts and caves created by the dissolving of the soluble bedrock." The Dinaric Alps are the prime example. But karst landscapes are also found in other areas around the Mediterranean and in the Alps – and they are of decisive importance for the water balance in these regions.

Rainwater and meltwater disappear completely underground very quickly in karst areas. "The regions therefore often look barren. But they have very rich underground water resources that are used around the world to supply large cities," Nico Goldscheider says. "Residents in Vienna get their water supply exclusively from these sources," the hydrogeologist observes. "But most of the drinking water in Rome, Beirut, and Damascus also comes from karst springs."

This poses certain challenges. The yield of karst springs fluctuates strongly. Ample precipitation causes them to flow abundantly, but they can run completely dry in extreme cases during arid spells. The quality of the water they supply also depends on weather events. Heavy rainfall, for example, can quickly carry pollutants such as fecal bacteria or agricultural chemicals into karst aquifers and contaminate drinking water.

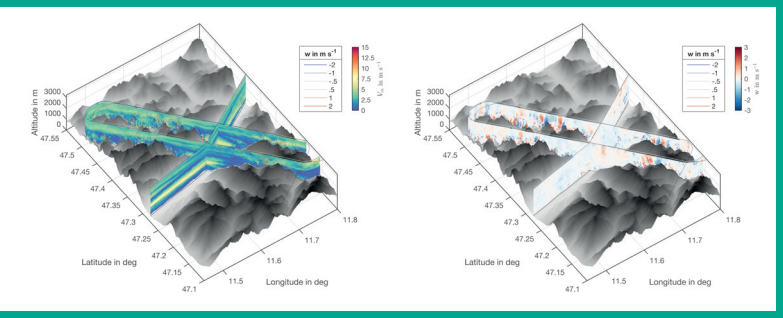
Nico Goldscheider's idea of researching these links in more detail was welcomed with open arms by his colleagues. Recalling the beginnings of the KARMA project, he remarks "It only took me half an hour to get the consortium together." And this dedication has now paid off with more than 20 publications. ■

The Source du Lison spring. (Photo: N. Goldscheider)

Wind Profiling Close to the Clouds

New Lidar Technology Takes Flight

An innovative new development in lidar technology from Karlsruhe Institute of Technology (KIT) is taking meteorological research to a new level: Dr. Philipp Gasch from the Institute of Meteorology and Climate Research – Troposphere Research (IMKTRO) and a team of cooperation partners from research and industry have developed an improved system for mobile wind measurement from aircraft. The airborne system is deployed on a TU Braunschweig research aircraft.



AIRflows measurements on flight transects along and across the Inn Valley. Wind speed on the left, vertical wind on the right. (Illustrations: Philipp Gasch)

Doppler lidar systems measure wind flows by using laser pulses to measure the movement of aerosol particles such as dust, pollen, or salt crystals. "We have integrated our system into the aircraft in a way that allows five lidars aimed in different directions to take simultaneous measurements," Gasch says.

The combination of data from the five lidars enables precise conclusions to be drawn about the speed and direction of the wind below the aircraft and all the way down to the ground – with a spatial resolution of 100 meters that was never previously attained. Older systems using only one lidar can only achieve a spatial resolution of one kilometer. Gasch: "Especially in complex terrain such as mountain ranges, high resolution data provides valuable information that can be used to improve the accuracy of weather predictions in the future." Initial successful measurements during test flights in the Alps have confirmed that the new system delivers the expected high spatial resolution.

The capability to detect fine-scale atmospheric details is crucial for research into wind patterns and the development of improved weather and climate models. "Our lidar system illustrates the importance of large-scale research infrastructure for the research landscape," Gasch says: "The total investment of around one million euros will now also benefit our partners, for example at other universities that can now also make use of the lidar for their research." ■

Conference on Hail

International Experts Meet at KIT and Share Their Perspectives on an Underestimated Natural Hazard

KIT hosted the European Hail Workshop for the second time in March 2024, when experts from research and practice met for the fourth time to discuss this important but still widely underestimated topic. "Reports on severe weather generally foreground the damage caused by wind and water," says Michael Kunz, Professor of Climate Research and Head of the Working Group "Atmospheric Risks" at KIT. "But severe convective storms and especially hail are responsible for most of the damage to buildings today. And that is true across the whole world." Kunz goes on to explain that the problem is not simply more frequent hailstorms or larger hailstones, but also the increased susceptibility of modern buildings. The strong vulnerability to hail damage of buildings with roof windows, conservatories, and façade insulation – and also of installations like huge solar parks – increases the extent of hail damage.

In this light, KIT expert Kunz aims to foster closer collaboration between researchers and practitioners from areas like the insurance sector and construction planning. "We achieved that again this time," reports Susanna Mohr from the Institute of Meteorology and Climate Research (IMK) at KIT, who was responsible for organizing the conference: "We brought together 180 participants in these sectors from 23 countries."

The conference attendees exchanged views on the latest findings from research and practice in seven themed panels and two podium discussions. The detection and prediction of hail events was discussed, as was the influence of climate change. As hail events are often highly localized, it is still quite difficult to predict exactly where they will occur and what size the hailstones will be. "And the role of artificial intelligence in hail research is also expanding rapidly," Michael Kunz observes. "We also had a dedicated panel on that at our conference that was led by early-stage researchers." ■

Hailstones the size of a 2-euro coin. (Photo: KIT)

Time to Act: KIT Climate Lecture with Professor Dr. Daniela Jacob

Professor Dr. Daniela Jacob, who heads the Climate Service Center Germany (GERICS), gave a gripping and personal lecture on climate change in the Garden Hall at Karlsruhe Palace on November 5, 2024, that got listeners thinking: We have all the facts, we know what should be done, and we know how we could halt climate change successfully. Why are we not doing anything? Intensive discussion of these questions continued at the reception that followed the talk. ■

Professor Dr. Oliver Kraft, KIT, Professor Dr. Daniela Jacob, GERICS, Professor Dr. Johannes Orphal, KIT (from left to right). (Photo: Djavadi/KIT)

Visits from Politics

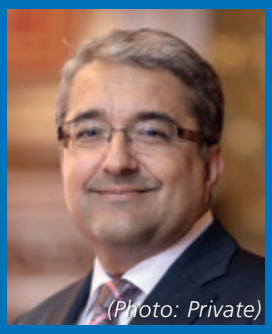
On August 28 und September 17, we welcomed politicians from Germany's FDP (Free Democratic Party) and CDU (Christian Democratic Union of Germany) to the KIT Center for Climate and Environment (ZKU) so that they could inform themselves about the circular factory and about how ZKU's research is advancing the transition to a circular economy. ■

Ingo Wellenreuter, Nicolas Zippelius (both members of the German Bundestag), and Ansgar Mayr (a member of the Baden-Württemberg State Parliament (from right to left), all CDU members, paying a visit to the circular factory operated by KIT's wbk Institute of Production Science. (Photo: Hennrich)

Finding Somewhere to Put CO_2

The question of where CO_2 should go was taken up by this year's Karlsruher Umweltimpulse evening held on October 9, 2024, and dedicated to discussing an environmental issue in the Triangel Transfer open space. Representatives from business, organizations, and science explored the possibilities, opportunities, and risks associated with carbon capture and storage (CCS) and carbon capture and use (CCU). The issue is of burning relevance, as the target of remaining within 1.5° of warming is unachievable without negative emissions. A recording of the discussion is available here: https://www.youtube.com/watch?v=3nkzp4tJow4 ■

Associate Professor Dr. Alik Ismail-Zadeh


(Photo: Private)

Geophysicist Alik Ismail-Zadeh from the Institute of Applied Geosciences at KIT has been appointed Chair of the Scientific Committee of the Integrated Research on Disaster Risk (IRDR) program.

IRDR is jointly funded by the International Science Council (ISC) and the United Nations Office for Disaster Risk Reduction (UNDRR). IRDR's main aims are to advance knowledge and understanding of disaster risks, find effective solutions for reducing such risks, and build institutional capacity for risk-aware development. The program plays a key role in the crossover area between science, politics, and society. Germany is represented in IRDR by the German Committee for Disaster Reduction (DKKV).

"I am pleased to contribute to the activities of this important committee and to chair it to promote inclusive, safe, and sustainable development," says Alik Ismail-Zadeh, who has already dedicated his career to the connection between science and society for 20 years.

He has just returned from the first meeting of the new committee and the 2024 international IRDR conference in Beijing. "As the program enters its second decade, we discussed and adopted a new action plan for the period from 2025 to 2027 there. This action plan takes in the areas of climate change, disasters, and public health." ■

Professor Dr. Nico Goldscheider


(Photo: Private)

The Geological Society of America (GSA) has appointed Nico Goldscheider from the Institute of Applied Geosciences at KIT as an Honorary Fellow. The hydrogeology professor's research focuses on the hydrogeology of karst aquifers, groundwater quality, and groundwater protection. "Receiving this award was a great honor, a great pleasure, and also a great surprise for me," Nico Goldscheider says. "Even though I have been working together intensely for more than 20 years with my American colleagues, I hadn't expected this." The Geological Society of America was founded in 1888 in Ithaca, New York, and has over 25,000 members in more than 85 states around the world today. Its aim is to promote the geosciences. ■

Associate Professor Dr. Elisabeth Eiche


(Photo: Private)

The German Geological Society (DGGV) has awarded Dr. Elisabeth Eiche from the Institute of Applied Geosciences the Hermann Credner Prize. The prize is awarded to outstanding early-career researchers to support the continuation of their research. One focus area of Eiche's research is the chemistry of thermal waters. This research zones in on both the potential utilization of thermal waters as a resource supplying raw materials and on the potential for mineral precipitation and the methods that can prevent mineral deposits causing blockages in geothermal power plants. Its objectives relate to extracting valuable chemical elements such as lithium for industrial use and also to ensuring the operational stability of geothermal power plants. ■

Listening to Understand Needs

Greenhouse Gas Emissions and Associated Environmental Changes Reach Record New Levels

Figures for greenhouse gases in 2024 will reach a new record high. Yet again. According to the NASA Goddard Institute for Space Studies (GISS), average global temperatures in the last 15 months were all more than 1.5 degrees Celsius higher than in the period 1881–1910. As the oceans have been absorbing higher levels of carbon dioxide from the atmosphere, ocean acidity has also reached higher levels than ever before. And many more examples of broken records could be given.

"The effects of these changes are hurting our environment and ultimately also ourselves. And with emissions continuing unchecked, we are not in the middle of the climate crisis, but still only at the beginning. The story is familiar to us. But that familiarity was not always there," says Dr. Hans Schipper, Head of the South German Climate Office at KIT. He remarks that requests for an introduction to climate change and an appraisal of it were ubiquitous fifteen years ago but have become much rarer now. "Many people are familiar with the topic, and some of them are tired of it and no longer want to hear about it. Other people want guidance on how to cope with the changes." Supplying this guidance is an important task for climate science and related fields. While a huge amount of expertise on the climate and climate change exists, that only represents a very limited subset of the totality of research. Schipper adds: "If we want our results to get out there and reach society, we must first understand what society needs. And that means listening, learning, and applying. Only by taking the needs of society seriously can we build trust and perhaps manage to answer the questions that society has to some degree. Then we can move toward a more climate-friendly world together, step by step." ■

Participants of the Fourth HEPTA Autumn Workshop 2024 in Karlsruhe (Photo: GRACE)

HEPTA and GRACE

Temporary Collegiums Within the Graduate School GRACE Promote Project-related Scholarly Exchanges. The Binational HEPTA Project Represents One Successful Example.

With almost 90 participants, GRACE at KIT is a relatively large graduate school. This not only enables intensive exchanges between the different participating disciplines but also lays down a foundation for courses with an interdisciplinary focus. But size is also a challenge – for instance in connection with anchoring facets of individual topics firmly in the graduate school program.

GRACE meets this challenge by setting up doctoral research collegiums for time-limited periods. The impetus for founding these groups is often sparked by a project that brings a group of doctoral students together. Dedicated provision is then created for them on the initiative of the graduate school team or out of the project itself. Following other successful collegiums such as the one dedicated to urban research, doctoral students from the HEPTA project have now come together within GRACE. HEPTA stands for Helmholtz European Partnership for Technological Advancement. This joint project at KIT and the Aristotle University of Thessaloniki was launched in 2019 and has since been successfully extended. It aims to enable both universities to harness their combined strengths to develop advanced technologies in the fields of atmospheric physics, air quality, biomass, and smart cities.

The collegium affords wide-ranging opportunities for interdisciplinary and international exchange to the doctoral students involved in the HEPTA project. The EcoHive hackathon was undoubtedly a recent highlight. Doctoral students from KIT and Aristotle University in Thessaloniki took part in this 24-hour team challenge (Hackathon for Innovation, Venture and Exploration of Environmental Data) in April 2024. The focus was on data sets with particulate matter levels measured in Augsburg and Thessaloniki. The teams delved deep into climate and environmental science with their analysis of the data. In October, the doctoral students then met for the fourth HEPTA Autumn Workshop to present and discuss the results of HEPTA sub-projects and doctoral projects. They also explored further opportunities for cooperation between KIT and Aristotle University. ■

Lecture during this year's Summer School on the Circular Economy. (Photo: GRACE)

For further information, see: www.grace.kit.edu

Scenes from a Treasure Hunt

Deep-sea Mining is a Highly Current Topic, but Its Roots Go Back More Than 100 Years

They lie in the depths of the oceans where no sunshine ever penetrates. Four or five kilometers below the surface, fist-sized lumps shaped like potatoes or blackberries litter the seabed. They grow by only a few millimeters in a million years, and they are regarded in some quarters as the salvation of the energy transition. That is because the valuable raw materials they contain could be used in electric cars or wind turbines. We are talking about manganese nodules.

Dr. Ole Sparenberg comments that the prospect of deep-sea mining to extract these nodules is often presented as a very new development even though "the topic has a long history that is often not considered." The environmental and economic historian from the Department of History at KIT wants to change this and has dedicated a book to the subject. The strange concretions were first discovered in 1873 when they filled the trawling nets of HMS Challenger during its first deep-sea oceanographic cruise. "They were exhibited in museums back then much in the way the moon rocks were later on," Sparenberg says. "They only began to be seen differently after the Korean War." Fears of raw materials shortages were especially prevalent during the 1960s and 1970s. The Western world's hunger for raw materials had risen sharply. More and more colonies that had previously been relied on as cheap sources of raw materials were breaking away from their former rulers. The industrialized world was alarmed by the prospect that this redistribution of political power might enable the states where mines were located to gain the kind of commodity power that the oil price shock in 1973 had already demonstrated. That brought the nodules on the seabed into focus as an alternative source of raw materials.

Manganese nodules: A raw material extraction zone or a habitat? (Photo: Ifremer, https://creativecommons.org/licenses/by/4.0*)*

"The formation of manganese nodules is very complex," Sparenberg says. "We know that metal ions precipitate out of seawater and cluster around a crystallization nucleus." The most diverse metals come together in this way. The nodules contain nickel, copper, cobalt, lithium, and rare earth elements as well as manganese. Polymetallic nodules is therefore a more appropriate name for them. But it has only partly prevailed (along with manganese nodules, ferromanganese nodules, and various other terms).

In the 1960s and 1970s, it seemed that it was surely only a matter of time before commercial exploitation of these concretions would commence. Some people regarded them as a virtually inexhaustible source of raw materials that simply needed to be picked up. The fact that many of them lie under 4,000 meters of water scarcely registered as a problem. On the eve of the moon landing, a spirit of optimism prevailed. "However, the whole thing turned out to be far more complex, technically challenging, and susceptible to glitches than anticipated and it was, above all, more expensive," Ole Sparenberg comments.

Polymetallic nodules, a topic of interest to German industry from as early as more than 50 years ago. (Photo: Ole Sparenberg)

"And it was also gradually becoming apparent that the feared raw materials shortages were not actually about to materialize in the short run." A pilot mining operation confirmed the feasibility of extraction in 1978, but after that the hype died down.

Today we have returned to the same point once more. The question of when commercial mining will start is being posed again. "The path that developments will take is still open," the environmental historian says. "But I can easily imagine things turning out as they did in the 1980s and the manganese nodules remaining on the ocean floor."

The reasons would be different now, however. A few decades ago, the bottom of the deep sea was thought of as a bleak and largely lifeless place, but today we know that it supports a diverse and sensitive ecosystem. Mining enterprises could not expect to tamper with this ecology and emerge unscathed. As the life cycles of organisms unfold extremely slowly in the darkness of the deep sea, any harm caused would be lasting. Ecological issues are therefore at the top of the agenda for opponents of deep-sea mining today. But its proponents also advance environmental arguments. They contend that the collateral damage caused by deep-sea mining is lower than that caused by conventional terrestrial mining operations.

"One of the most interesting findings I came across during my research is the fact that none of the parties see another failure as a desirable perspective for the future," Ole Sparenberg remarks. We can certainly learn from history here – even if the lesson turns out to be simply that more possibilities exist than we care to acknowledge. ■

KIT Climate and Environment Center (ZKU)

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Spokesperson of Topic 8:	Circular Economy and Environmental Technologies:	Professor Dr.-Ing. Volker Schulze

Tsunami in East Greenland

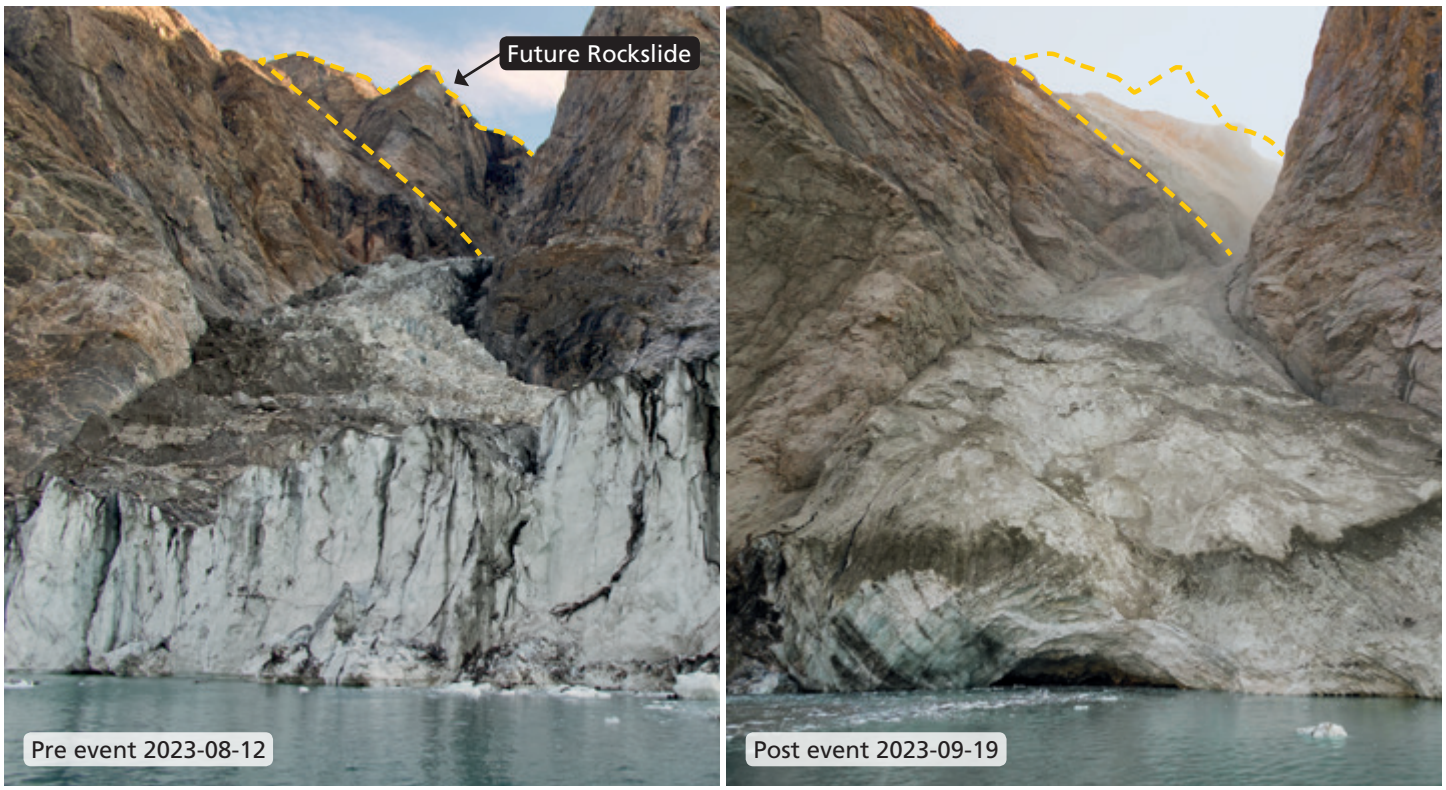
Researchers from Diverse Disciplines Are Investigating the Dynamics of a Rare Natural Event

A seismic signal that persisted for nine days was recorded in September 2023. It was caused by a rockslide above Dickson Fjord in East Greenland that triggered a tsunami when it swept 25 million cubic meters of rock and ice into the fjord, which is 540 meters deep and 2.7 kilometers wide. Although such events are not unusual in Greenland, one like this had not previously been observed on the island's east coast.

An international and interdisciplinary research team that included participants from the Geophysical Institute (GPI) at KIT combined observations at the site of the event with images, seismic data, and modeling to reconstruct the event and its seismic signal. "High-resolution numerical modeling of the fjord shows that the tsunami turned into a seiche," says Thomas Forbriger from the Geophysical Institute at KIT. The slide, in other words, generated waves that sloshed back and forth in the narrow fjord for days. "The properties of a seiche are suitable," Forbriger observes, "for explaining the origin of the seismic signal we analyzed."

As major landslides continue to become more likely due to climate change, especially in the polar regions, the investigation of this event is of particular relevance. "Climate change is already creating new natural hazards that also threaten areas that are more densely populated than East Greenland." ■

Original Publication: Kristian Svennevig et al., A rockslide-generated tsunami in a Greenland fjord rang Earth for 9 days. Science 385, 1196-1205(2024). DOI: 10.1126/science.adm9247



Images of the mountain peak and glacier above the fjord before and after the rockslide that triggered a seismic signal that could be detected worldwide. (Photo left: Søren Rysgaard; photo right: Danish Army; collage: Elias Kobel, KIT)