Karlsruhe Institute of Technology

Climate and Environment news

NEWSLETTER OF THE KIT CLIMATE AND ENVIRONMENT CENTER

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Title photo
Coral tree (*Erythrina*) in the dry forest of the Ecuadorian Andes. (Photo: A. Velescu)

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Dear Readers!

Is after the COP before the COP? With the measures adopted during the 2021 UN Climate Change Conference in Glasgow alone, the global warming limit of 1.5 degrees above pre-industrial times will not be reached. Still, I consider the goals agreed upon our mission. Now, it is our turn. It is the task of us researchers, but also of citizens to continue along this path.

That is why I was very happy to receive the clear signal by GeoKarlsruhe 2021 that earth sciences see a clear mandate. A very tragic event of last year in connection with climate change was the flood disaster in the Ahr Valley. Natural disasters like these show that we have to develop strategies to cope with the consequences of climate change. Urgent action is required, not only measures to slow down global warming, but also measures to mitigate its impacts, such as flood protection measures and improved forecast and warning systems.

Read about how our scientists with their passion for research continue to contribute to a healthy environment in the near and more distant future.

I wish you an enjoyable read of the present Climate and Environment News in their new layout.

Yours,
Professor Dr. Oliver Kraft
Vice-President for Research

Typical pasture on the Eastern side of the Ecuadorian Andes. (Photo: J. Knuth)

Biodiversity in the Ecuadorian Andes under Pressure

RESPECT Research Group Studies Nutrient Supply in Wet and Dry Forests and Uses the Data to Improve Land Surface Models

The Ecuadorian Andes are a hotspot of biodiversity and accommodate highly different ecosystems. While wet forests can be found on the outer flanks, dry vegetation is predominant in the valley between the Western and Eastern Cordilleras. The DFG-funded research group RESPECT has now succeeded in capturing essential nutrient supply processes in the mountain rainforests at the edge of the Amazon Basin. On this basis, a vegetation model is extended to describe biomass production and evaporation there. "This is a big progress. We can couple this model with hydrological and climate models to better estimate the impacts of increasing nutrient inputs, changed land use, and climate change in this region," says Professor Wolfgang Wilcke from KIT's Institute of Geography and Geoecology (IFGG).

The researchers want to analyze various scenarios, for example: What happens when even more nitrogen is input? Trade winds blow the nitrogen oxides and nitric acids released by forest fires in the Amazon Basin directly to the wet forests of the Northern Andes. Nitrogen input is also increased by local economy and growing transport. At the same time, precipitation patterns are changing: While the total precipitation volume remains the same, distribution varies to an increasing extent and longer drought phases occur. This enhances mineralization of organic matter in the forest ground. Wilcke explains what all this means: "Nutrient supply of plants is improved. But this threatens the forest and biodiversity, because plants use the nutrients to varying degrees. Plants adapted to rather scarce supply do not grow better when the concentration of nutrients is higher. They are the losers. The winners, by contrast, profit from increased supply, grow massively, prevent the light from reaching the losers and, in this way, eliminate the latter."

Tobias Fabian taking soil samples. (Photo: W. Wilcke, KIT)

Andre Velescu maintaining a data logger in the mountain rainforest. (Photo: W. Wilcke, KIT)

The eastern side of the Andes is characterized by steep terrain, dense jungle, and pasture farming. In the valley between both chains of the Andes, the situation is totally different: Vegetation gaps, dry cracks in the ground, little precipitation, and agroforestry with a mix of shrubs, fruit trees, and annuals, such as corn. To obtain a representative picture of the Northern

Flowering opuntia in the dry forest. (Photo: A. Velescu)

Andes region, the RESPECT research group is now studying the inner-Andes dry forest in a second project phase. There, biodiversity is also high, but biomass production is much smaller. The dynamics is characterized by the climatic seasonality of dry and rainy seasons. Wolfgang Wilcke expects findings similar to those obtained in the savanna in Brazil: "Most probably, highly soluble nutrients, such as nitrate and potassium, accumulate in the ground in the form of salts during the dry season. As soon as the rainy season starts, they are mobilized and for a short time, many nutrients are available. Vegetation explodes. However, the rain quickly washes the nutrients away and the supply dwindles again. Contrary to wet forests, where many nutrients are constantly available over the year, the plants in the dry forest have to use other strategies and to make the best of this short-term supply." With progressing environmental changes, the geoecologist expects to have winners and losers again. With their studies of this ecosystem, researchers want to broaden the basis of their model and to obtain a more differentiated description of biomass production and evaporation in the Northern Andes.

Research is based on long-standing close collaboration with the Ecuadorian partners, in particular with the NGO "Nature and Culture International" that operates the research stations and with Universidad Técnica Particular de Loja and Universidad Nacional de Loja. An agricultural engineer and a forestry engineer are currently working on their doctorates in Wilcke's working group. In the past years, numerous students graduated there. "We are building capacity: Meanwhile, some of our graduates are working at key positions of local universities," Wilcke says. During the current RESPECT phase, students from Ecuador can come to KIT and make laboratory analyses for their graduation theses. ■

Heliconia – also named lobster claw or false bird of paradise – in the mountain rainforest. (Photo: A. Velescu)

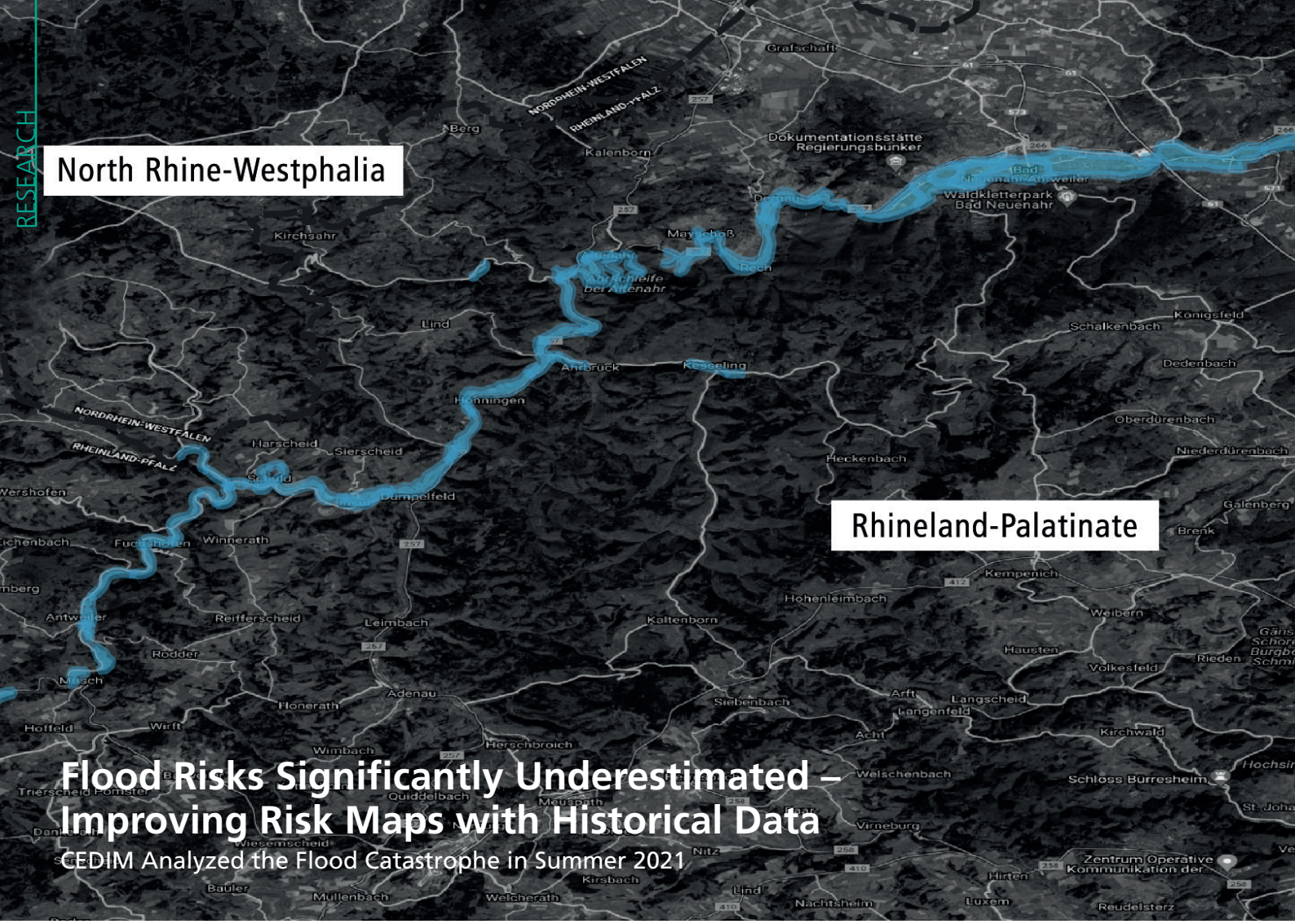
Mobile Power Trailer

Green Power for Around-the-clock Measurement Campaigns in Any Place

"MoSolFCA1" can autonomously supply mobile measurement systems for climate research with power without any emissions being produced. This was confirmed by field operation of the trailer over several months. On September 24, 2021, the new power system was presented officially on a TERENO measurement field of the Atmospheric Environmental Research Division of the Institute of Meteorology and Climate Research (IMK-IFU), KIT's Campus Alpine in Garmisch-Partenkirchen. The trailer was developed by the team of Frank Neidl, Head of the Information Technology Group of IMK-IFU, in cooperation with UMSTRO GmbH and Proton Motor Fuel Cell GmbH. "This development within the MOSES project enables us to make measurements and collect data independently of stationary power supply," says Dr. Peter Suppan, Manager of Campus Alpine.

Frank Neidl (IMK-IFU), Joachim Wilsdorf (UMSTRO), Anne Duval (Proton Motor), and Professor Hans-Peter Schmid (IMK-IFU) (from the left) present the new power trailer. (Photo: M. Frenz, KIT)

The mobile power trailer can be used all around the clock under any weather conditions. "We now have a CO_2-free power set that combines photovoltaics with a hydrogen fuel cell and a lithium-ion battery for energy storage. It is the first of its kind," Frank Neidl says. Compared to the usually applied diesel generators, the power trailer is climate-friendlier. Moreover, measurements are not influenced by exhaust gases. ■



Flood Risks Significantly Underestimated – Improving Risk Maps with Historical Data

CEDIM Analyzed the Flood Catastrophe in Summer 2021

The area along river Ahr was estimated to be flooded by more than 75 percent. (Figure: A. Schäfer, CEDIM/GPI/KIT)

More than 180 deaths, at least 800 injured people, and about 30 billion euros of damage to buildings, bridges, and roads – this is the devastating result of the flood disaster in July 2021 in Germany. The extreme precipitations hit the states of Rhineland-Palatinate and North Rhine-Westphalia extremely hard. "The shock of having underestimated the flood risk still runs deep," says Dr. Andreas Schäfer from KIT's Geophysical Institute (GPI), who also conducts research at the Center for Disaster Management and Risk Reduction Technology (CEDIM). To better estimate such risks in future, historical data should be included in risk assessment, he says.

Together with the Forensic Disaster Analysis (FDA) group of CEDIM, the geophysicist analyzed the flooded areas in the most affected districts of Ahrweiler and Rhein-Erft during the flood. First, Schäfer assessed the situation: Which areas are flooded? Which road or which fence is reached by the water? "Initially, the situation was rather unclear. I looked at about 200 photos published on Twitter and on the Internet. I screened videos and also consulted satellite data. On this basis, we produced a detailed map and derived a first damage estimate," Schäfer reports. In addition, CEDIM researchers analyzed records and photos of two severe floods in the Ahr valley in 1804 and 1910 and reconstructed their water levels and flow rates. They found that the flood of 1910 might have had a similar dimension than the flood of 2021. Current flood maps for the Ahr valley, however, are based on flow statistics starting in 1947. The historical documents also produced another surprising finding: A photo of 1910 shows water flowing through a road tunnel. In 2021, something strikingly similar happened. Schäfer emphasizes: "In future, historical data should also be considered, although they may be more uncertain than measurement data. When assessing risks of other natural disasters, such as tsunamis or earthquakes, we proceed in the same way. Such events may be rare, but have big impacts."

In view of this tragic flood incident and due to climate change, as a result of which extreme weather events will become more probable in future, the geophysicist also pleads for better technical flood protection. Moreover, best possible preparation for such events and clear communication are required. In an emergency, decision-makers and the population must know what to do and how to behave. ■

More information: The Center for Disaster Management and Risk Reduction Technology (CEDIM) is an interdisciplinary research institution of KIT in the areas of (natural) disasters, risks, and safety. It was established to better understand, earlier detect, and better manage natural and anthropogenic risks. **www.cedim.kit.edu**

First Use of the GLORIA Infrared Spectrometer on a Balloon

KIT Researchers Study Chemical Compounds in the Stratosphere

For GLORIA, it was the first measurement flight up to this height: In August 2021, a helium balloon took the infrared spectrometer up to an altitude of 36 kilometers. Dr. Michael Höpfner from the Atmospheric Trace Gases and Remote Sensing Division of KIT's Institute of Meteorology and Climate Research (IMK-ASF) is extremely satisfied with the measurement campaign: "GLORIA has worked well and we have obtained good data on various substances and gases in the stratosphere." The infrared spectrometer GLORIA was developed by KIT and Forschungszentrum Jülich and has already been used repeatedly on the HALO research aircraft. For its first balloon flight within the European research project HEMERA, the instrument had to be modified.

For a whole day, the balloon hovered over northern Sweden and GLORIA reliably collected data. At the moment, the researchers are evaluating them. Chlorine nitrate and bromine nitrate concentrations are of particular interest. Both gases are among the substances responsible for ozone degradation. "Then, we will check agreement with our atmosphere models," Höpfner says. "Presently, the models are not yet sufficiently good in modeling the concentration of some chemical compounds. With the help of our observation data, we can improve them." In addition, Höpfner and his team want to collect more information on polluting gases, such as peroxyacetyl nitrate (PAN) and ethene. These gases are released by large-area forest fires: Do they enter the stratosphere and how do they affect the ozone there? In Sweden, there were indications of high PAN concentrations at ten to twelve kilometers height. Now, measurements are being compared with air pollution models.

In 2022, another balloon flight from Canada is planned. KIT researchers then want to look down on the Earth's surface, measure the radiation emitted by Earth into space, and compare the measurements with the data of a test instrument for the next "Earth Explorer" mission of the European Space Agency (ESA). ■

Little wind is best for launching a balloon – conditions were finally good on the penultimate day of the launch period of two weeks. (Photo: H. Nordmeyer, IMK-ASF/KIT

Anti-aging Treatment for Infrastructure

KIT Innovation HUB Joins the New European Bauhaus

Preserving infrastructure: Laufenmühlen viaduct. (Photo: T. Bürkle, IONYS AG)

The KIT Innovation HUB has been working on prevention in the construction sector since 2016 already. Since June 2021, it has now been partner of the "New European Bauhaus" (NEB), an initiative of the European Union to support the implementation of the "European Green Deal". This partnership extends the scope covered by NEB by an important component, the infrastructure. "While nearly all other partners are working in the field of structural engineering, we are focusing on the main fields of infrastructure, namely, water, mobility, energy, information as well as industrial and municipal buildings," says Professor Andreas Gerdes, Scientific Director of the KIT Innovation HUB and Head of the Mineral Interfaces Group of KIT's Institute of Functional Interfaces (IFG). "Sustainable construction still misses out the infrastructure. But infrastructure mainly is in public ownership and is of high importance to the economic and social development. Infrastructure also means quality of life."

It is the goal of the KIT Innovation HUB to push innovations, to transfer them to marketable technologies, and to bring together all stakeholders of the chain of values added. Due to its close relations to construction industry, HUB represents a major enrichment for NEB. "In the end, we need highly performing companies to practically apply the innovations," Gerdes says. In particular, it is important to increase the durability of the existing infrastructure that often suffers from quality deficiencies. Repairs after a few years only should be prevented. This will reduce the environmental impact as well as costs. For example, concrete edges of bridges might be impregnated to protect the concrete and the steel reinforcement below from damage due to salt-containing splash water in winter. Gerdes underscores: "Our message is: Preserve the infrastructure. The plans of the new federal government now fit this purpose." ■

Coming with Gold

Geologist from Botswana Stays at KIT for Exchange on Research

Experienced geologist: Dr. Thierry Olivier Bineli Betsi. (Photo: BIUST)

KIT's Institute of Applied Geosciences (AGW) has a new member of staff from Botswana: In February 2022, Dr. Thierry Olivier Bineli Betsi came to spend 18 months with the team of Professor Jochen Kolb for research into gold deposits in Botswana. This exchange is possible, as the geologist was granted a Georg Forster Research Award for internationally recognized researchers by the Alexander von Humboldt Foundation. "I am very happy that such an excellent colleague comes to us and that we can engage in scientific exchange," says Kolb, Professor for Geochemistry and Economic Geology at AGW.

Bineli Betsi is an experienced geologist who worked in research and industry in Canada, Burkina Faso, Switzerland, Cameroon, and Botswana. Presently, he is associate professor at the Department of Mining and Geological Engineering of the Botswana International University of Science and Technology (BIUST) in Palapye. It is no coincidence that he now comes to Karlsruhe. Firstly, he can use an excellently equipped laboratory at KIT. Secondly, Jochen Kolb is an internationally recognized expert for gold deposits and studied them in Zimbabwe and Namibia.

At KIT, Bineli Betsi wants to analyze rock samples from Botswana and study how the gold can be extracted best from the rock. Kolb explains: "Gold exists in different forms in rock, visibly in the form of small grains, as nanoparticles, or embedded in the mineral structure of sulfides, such as pyrite. Various technologies are needed to extract the gold." Both researchers also want to study how the gold got to the place where it was found and they want to better understand how gold deposits are formed. These findings will then be incorporated in exploration models to predict the location and dimension of gold deposits. ■

2021 Water Resource Prize Goes to Harald Kunstmann

Last June, the Rüdiger Kurt Bode Foundation awarded the 2021 Water Resource Prize in the amount of EUR 100,000 to Professor Harald Kunstmann from the Atmospheric Environmental Research Division of KIT's Institute of Meteorology and Climate Research. With the prize, the Foundation honors Kunstmann's outstanding achievements in the area of sustainable water resources management in vulnerable regions of the global South suffering from water scarcity. Professor Kunstmann has studied this topic for many years now. Congratulations! ■

Prize winner Professor Harald Kunstmann (IMK-IFU). (Photo: KIT)

Urgent Need for Action

The kickoff event "Auf einem Ohr taub? Hört die Umweltpolitik genug auf die Umweltwissenschaften?" (Deaf in one ear? Does environmental policy sufficiently listen to environmental sciences?) of the new series Karlsruher Umweltimpulse took place online on October 27, 2021. The top-class panel extensively discussed this question. In spite of different viewpoints in the beginning, they agreed that more actions are needed for climate protection. For the recorded discussion, click: https://www.klima-umwelt.kit.edu/umweltimpulse.php. ■

BMBF Project FloodRisk – First Results

The FloodRisk project is aimed at studying microseismicity and earthquake risks as well as ground uplift and outgassing induced by the flooding of German coal mines. First findings will be published in a special edition of the Journal of Applied and Regional Geology in 2022. The partners of the cooperation project initiated and organized by KIT are EIFER, Ruhr-Universität Bochum, the Geological Service of North Rhine-Westphalia, DMT GmbH & Co KG, and other companies and authorities. ■

Podcast Series

The first ten sequels of the "Karlsruher Beiträge zur Klimaforschung" are online at: https://www.klima-umwelt.kit.edu/1226_podcasts.php ■

Dr. Nadine Rühr


(Photo: KIT)

She always loved trees: As a child, she climbed them. Later, she joined a tree climbing course and after her diploma, trees from the root to the crown became her focus of research. "When looking out of the window, I see trees, the air, the sky. And between the atmosphere and biosphere, CO_2, water, and other substances we cannot see are moving all the time. It is fascinating for me to measure these substance flows and to understand what is behind them," says Dr. Nadine Rühr, Head of the Plant Ecophysiology Group of the Atmospheric Environmental Research Division at KIT's Institute of Meteorology and Climate Research (IMK-IFU), KIT's Campus Alpine in Garmisch-Partenkirchen.

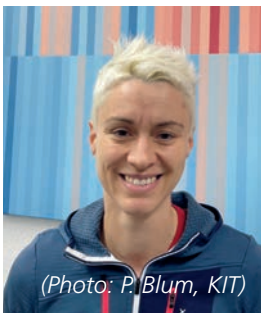
With funds from the Emmy Noether Program of the German Research Foundation for highly qualified early-stage researchers, her team studies how extreme drought and heat influence the physiology of trees and when irreversible damage develops. The researchers study young trees in the greenhouse and, on the other hand, they use process-based models. Rühr explains: "We need an answer as to when a drought period may lead to a massive dying of trees. In case of deciduous trees, this is a rather creeping and slow process. To model long-term damage due to heat, we need to know more about plant physiology." Also in her private life, the environmental scientist is attracted by forests and nature, where she loves to go hiking or skiing together with her family. ■

Dr. Emma Järvinen


(Photo: © E. Järvinen)

After her first physics lesson, she wanted to become a physicist. At that time, Dr. Emma Järvinen was twelve years old. Today, she is heading a junior research group at KIT's Institute of Meteorology and Climate Research (IMK) and studies optical and microphysical properties of cloud particles, in particular ice particles. "I would like to extend our knowledge and to contribute to better climate prognoses," says the atmosphere researcher, who has an eye for beautiful things: "Every ice crystal we photograph in cirrus clouds fascinates me." For her work, she often travels with research aircrafts. But also on the ground, Järvinen is attracted by ice and snow, as she loves cross-country skiing. With her family, she spends the summer at her summer house in Finland, her home country, and enjoys the silence. ■

Dr. Kathrin Menberg


(Photo: P. Blum, KIT)

Thinking and working across disciplines is in the blood of Dr. Kathrin Menberg from KIT's Institute of Applied Geosciences. After her studies and doctorate at Karlsruhe University, she moved to ETH Zurich to work in the area of earth sciences and then cooperated with engineers at Cambridge University. With funds from the "Margarete von Wrangell Habilitation Program for Women", the geologist is now researching the sustainable use of geoenergy. Work covers the entire lifecycle of the systems: "We want to develop concepts and methods to design thermal energy systems with minimum environmental impacts: From planning to construction to operation to decommissioning," says the passionate biker. ■

From Paris to Glasgow and Sharm El-Sheikh

KIT as Observer at the UN Climate Change Conference

At the end of last year, the UN World Climate Change Conference took place again. After being canceled in 2020 due to the COVID-19 pandemic, a hybrid format was selected for COP26 in Glasgow. Negotiations took place not only on site, but on an especially created platform to allow people to follow the events from their homes. KIT participated as well, with a small delegation consisting of Alexander Reyes-Knoche – a KIT alumnus – and Dr. Hans Schipper, Head of the South German Climate Office in Karlsruhe. Even more than in the years before, the South German Climate Office followed the events closely, supported by intern Lotta Fröhlich. Every day, an Instagram story was created, processing and summarizing the activities in Glasgow. After two weeks of negotiations, the countries agreed on further details of the 2015 Paris Agreement Rulebook. Additionally, the "Glasgow Climate Pact" puts an end to coal as an energy source – phasing out coal had not been discussed explicitly at any other Climate Change Conference. The developing countries, however, were disappointed by the lack of sufficient assurances regarding loss and damage compensation and aids for climate change adaptation. COP26 was therefore not the desired turning point and fell short of reaching an agreement that would limit global warming to less than 1.5 °C. But the meeting demonstrated that climate is, and must remain, a topic on the international agenda. Next year, the conference will take place (virtually) in Sharm El-Sheikh in Egypt – and KIT again wants to participate as an observer. ■

Land is a finite "resource": Agriculture, settlements, renewable energy, and several other factors are competing for it. (Photo: KIT)

Dr. Andreas Schenk, Scientific Coordinator of GRACE. (Photo: KIT)

Balance Is the Key

Use, Overuse, Conflict: GRACE Is Looking for an Equilibrium

It started with agriculture and animal husbandry, then came factories and mining, now the post-industrial economy: For 10,000 years, humans have used and formed the land, with increasing intensity. This has left the environment depleted. Biodiversity is dwindling and, in many areas, yields are declining as the land is slowly turning into desert. "Today, land degradation affects about one quarter of ice-free areas globally, with consequences for up to three billion people," Dr. Andreas Schenk of the graduate school GRACE warns.

The turn toward sustainability for water, resources, and energy is long overdue. At the same time, social and economic differences and interests have to be balanced. "Research has developed technologies and methods, now we have to find the optimal combination to balance meeting all goals and allowing for the most extensive land use possible."

GRACE also adopted this current focus of science. "Many participants are working on topics that contribute to it. In our courses, they come together and learn to pursue an interdisciplinary approach when analyzing and modeling." In the future, this advance will go beyond the internal graduate program. ■

More information:
www.grace.kit.edu

Potential for More

Plastics and Building Materials under Examination

Funded by the State Government of Baden-Württemberg and the industry, the THINKTANK Industrial Resource Strategies at KIT has been advising politics and industry since 2018. The first funding phase ends in 2022. "The THINKTANK is now well established in its focus areas and there is still a lot to do, because resource efficiency is a highly relevant topic for the economy, science, politics, and society," says Professor Dieter Stapf, Spokesman of the THINKTANK steering committee and Head of the Institute for Technical Chemistry (ITC).

For further funding, the KIT researchers already have several topics in mind. Especially needed are technological solutions for a climate-neutral circular economy for plastics. "How can we contain the plastic flood and recycle more plastics – this is where the THINKTANK can make an important contribution," Stapf emphasizes. "Another topic we want to address more intensively are economically strategic resources and materials: What are the materials available, where do we use them, and how do we achieve a higher recycling rate?"

At the moment, the THINKTANK group on sustainable construction and recycling of building materials is being set up. Stapf explains why this is important: "The production of building materials requires a huge amount of resources. Especially the cement industry produces large amounts of CO_2 emissions. We are recycling far too few aggregates, whereas, for high-quality cement recycling, there are at least some first concepts." KIT has a lot of research experience to offer in this area and wants to focus more on the recycling of building materials – a major topic for the second funding phase. ■

Many plastics from the automobile industry currently cannot be recycled. (Photo: M. Breig/KIT)

More information in German:
www.thinktank-irs.de

For a Sustainable Tomorrow

Energy, Resources, Storage: Geosciences Change the World

How do we produce enough emission-free energy to meet our personal and industrial demands? What do we do when at certain times there is more energy being produced than needed: How can we store it reliably? What are the opportunities offered by geothermal energy, and is there natural hydrogen to be found underground? How do we remove CO_2 from its natural cycle and store it permanently, ensure reliable mobility without fossil fuels, meet the growing global resource demand, and which resources are especially critical? Where do we get the volumes of groundwater needed for drinking but also for agriculture as the world population keeps growing? What are the necessary regulatory policies for all of this?

The questions are manifold and increasingly urgent. What is at stake is nothing less than the preservation of our livelihoods. Against this backdrop, an energy transition and a mobility transformation are not merely optional, they are desperately needed. And they will not happen naturally but require lots of resources and large storage systems, as is demonstrated by the overwhelming majority of studies. Applied interdisciplinary solutions are therefore needed more than ever. "We will have to rely on expertise from geosciences," KIT President Professor Holger Hanselka is certain and, in this light, he opened the virtual conference GeoKarlsruhe21 "Sustainable Earth – from processes to resources" hosted jointly by KIT and Deutsche Geologische Gesellschaft – Geologische Vereinigung (DGGV, German Geological Society) in September 2021. "Whether it is drinking water or food, metals or plastics, building materials or storage caverns for hydrogen – without geosciences, neither the energy transition nor modern life in general would be possible," says Professor Christoph Hilgers of the Institute of Applied Geosciences (AGW), who chaired the conference.

Around the globe, the conference was met with a positive response, as was reflected by the high number of participants: Around 700 scientists from basic and applied sciences as well as representatives of economy, industry, institutions, and ministries from 36 different countries gathered online for talks and, more importantly, for discussions. "Communication between science, economy, and society is especially vital," KIT Vice-President Professor Thomas Hirth states after participating in the panel. "After all, knowledge transfer to technical and industrial applications will become even more important in the future."

This was one of the reasons for the foundation of a national expert section of the DGGV-FUTURE during the conference. The section is pooling expertise on geothermal energy, resources, and deep underground potential. The founders, including professors as well as expert institutions, want to promote scientific, social, and political debate. "Many global challenges are geoscientific topics. We want to embrace the responsibility to utilize the environment and the planet sustainably," Hilgers says.

New hydrogen stores underground, vital resources like drinking water, new materials for batteries: Geosciences are significantly contributing to reaching numerous sustainability goals. (Photos: C. Hilgers, N. Goldscheider)

At KIT, the AGW contributes to this with its work focusing on energy, storage, resources, and groundwater. ■

KIT Climate and Environment Center

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Deputy Scientific Spokesperson:	Prof. Dr. Thomas Leisner	
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Spokesperson of 2:	Water:	Prof. Dr. Olivier Eiff
Spokesperson of 3:	Georesources:	Prof. Dr. Jochen Kolb
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Spokesperson of 5:	Urban Systems and Material Flow Management:	Prof. Dr. Stefan Emeis
Spokesperson of 6:	Natural Hazards and Risk Management:	Prof. Dr. Michael Kunz
Spokesperson of 7:	AI in Environmental Sciences:	Prof. Dr. Stefan Hinz

Measured Remotely

Satellite, Drone, or Sensor Mast: How Water Quality Can Be Measured Remotely

The next summer is not far away – and so is the alarm: Algae will bloom and the lake or reservoir will be about to "collapse." Algae concentration is determined by chlorophyll measurements. For this purpose, random samples are analyzed at the laboratory. In future, measurements will be "easier and cover wider areas," says Professor Stefan Hinz from KIT's Institute of Photogrammetry and Remote Sensing.

His team uses data from satellites, drones, or high sensor masts. However, these data are disturbed. "The water surface reflects, there are waves. And the air contains water vapor. This distorts the measurements." For the allocation of the value measured to chlorophyll concentration, a system is needed that takes these distortions into account. "We use a neural network, artificial intelligence so to speak."

But the network needs example data to "learn." Actually, this would mean taking thousands of samples, evaluating them, and entering the data in the system – a time-consuming effort and very expensive. "Our network used a physical model instead. This model simulates concentration data and environmental conditions." Classical laboratory tests have shown that this works. Will such tests no longer be needed in future? "Certainly not," Hinz says. "But the new method will reduce manual work."

Maier, P.M.; Keller, S.; Hinz, S. Deep Learning with WASI Simulation Data for Estimating Chlorophyll a Concentration of Inland Water Bodies. Remote Sens. 2021, 13, 718. https://doi.org/10.3390/rs13040718 ■

The Elbe river is a real-world lab for studying the precision of hyperspectral measurement methods: Measurement boat with hyperspectral sensor and parallel sampling. (Photo: Keller, S. et al., Hyperspectral Data and Machine Learning for Estimating CDOM, Chlorophyll a, Diatoms, Green Algae and Turbidity, Int. J. Environ. Res. Public Health 2018, 15(9))