Karlsruhe Institute of Technology

Climate and Environment news

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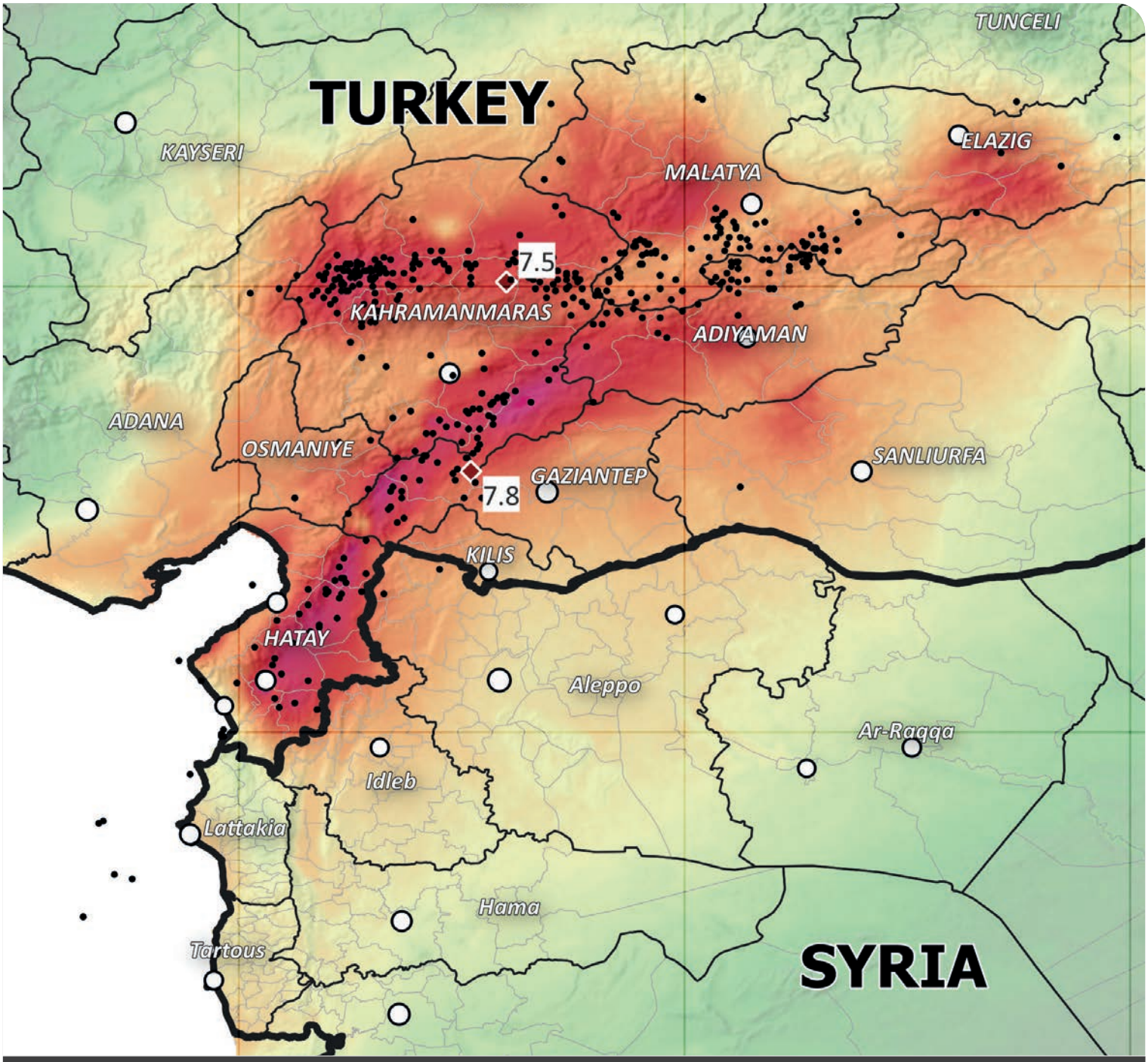

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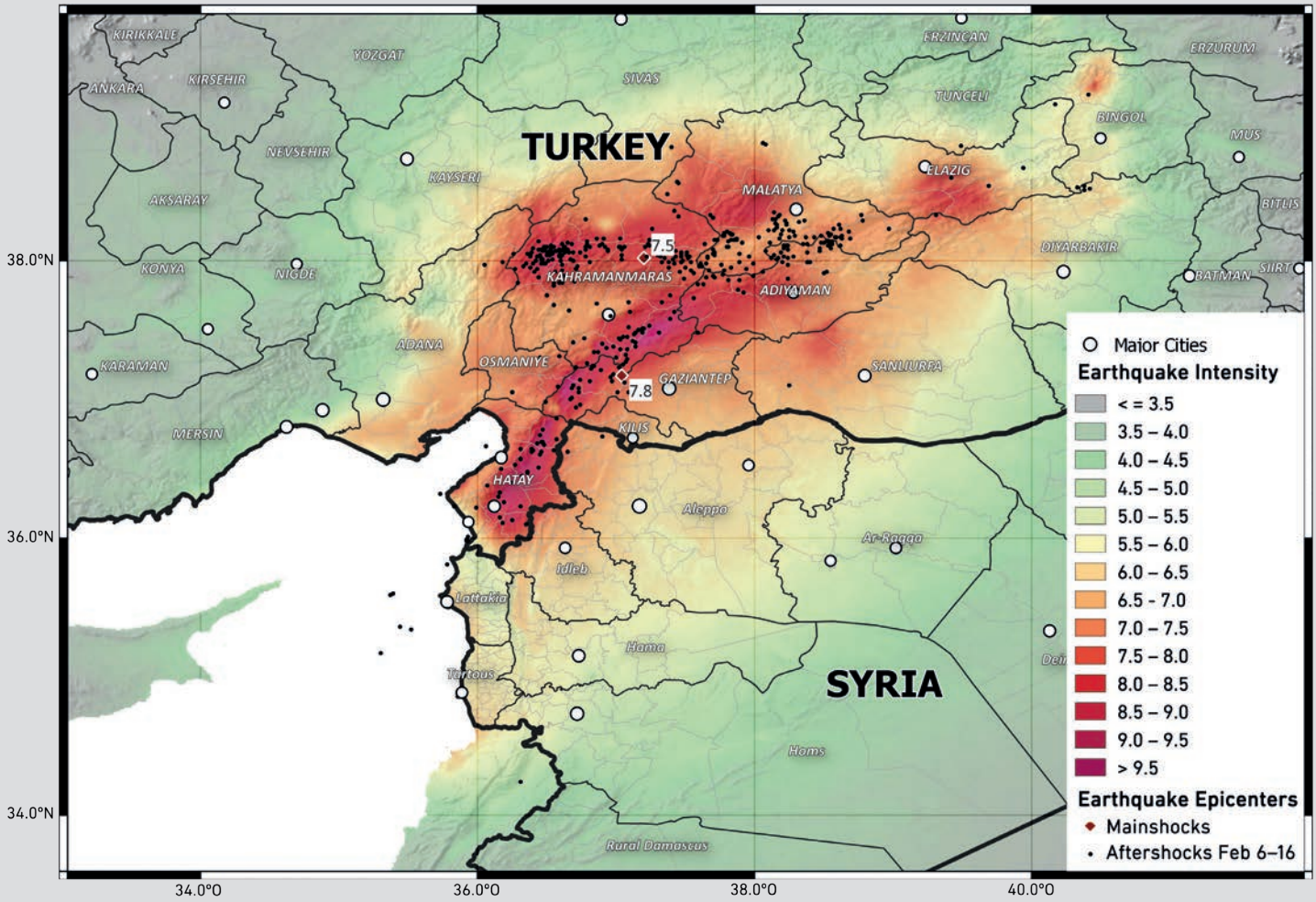
Dear Readers!

Energy costs, the "Heating Act," and supply security, on the one hand, and climate and environmental protection, on the other, play an important role in the media and in our everyday life. But basic relationships in the climate system and environment still remain to be studied and understood.

Fundamental research allows for a better understanding of the complex relationships, chemical processes, effects of anthropogenic activities on the environment, and interactions between the compartments. But environmental research should not only concentrate on gaining new findings that provide deeper insight in the functioning of nature. It is now required to reinforce our search for solutions. This is the only way to develop sensible and effective measures to protect both the climate and environment. Combining fundamental research with environmental technologies is of crucial importance. While research is the basis, innovation is achieved by using these findings for the development of new environmental technologies. With their help, we can implement sustainable solutions on a large scale and cause positive changes on a global level.

Researchers of the KIT Climate and Environment Center are involved in both basic and applied research. This newsletter presents some examples to create an environment worth living in for humans, flora, and fauna.

Yours, Professor Dr. Oliver Kraft, Vice President Research



Ground vibrations as perceived during the two main earthquakes on an intensity scale 0 to 12: As of an intensity of 3, humans feel an earthquake. As of 6, buildings are damaged slightly. As of about 9, large destructions occur. Red dots: Main quakes and their magnitudes. Black dots: Aftershocks during the first ten days (February 6 to 16). (Map: A. Schäfer, KIT)

Earthquakes in Turkey and Syria

CEDIM Researchers Were the First to Issue a Report on Potential Numbers of Victims and Building Damage

It was clear that it would happen, but not when: In the night of February 6/7, 2023, a strong earthquake shocked Turkey and Syria. To be more exact, two main quakes with magnitudes of up to 7.8 and 7.6, respectively, took place at an interval of about six hours, accompanied by hundreds of secondary quakes with a magnitude of at least 4.0.

"The region affected is located at a highly active tectonic boundary, where the Arabian plate collides with the Anatolian plate," says Dr. Andreas Schäfer from KIT's Geophysical Institute (GPI), who also conducts research at KIT's Center for Disaster Management and Risk Reduction Technology (CEDIM). The region is referred to as East-Anatolian fault. While the Anatolian plate moves West by about 20 millimeters per year, the Arabian plate moves northwards by about 15 millimeters per year and presses against the Anatolian plate. Both plates jam each other, as a result of which enormous stress has developed for centuries. The earthquake caused most of the energy to be released abruptly and produced a horizontal displacement of sometimes up to five meters along a length of nearly 300 kilometers.

For Schäfer, this night ended at 5 a.m. when he was informed by his mobile. His CEDIM colleague Dr. James Daniell in Australia had already started work at that time. First, the scientists wanted to understand the type of earthquake, its intensity, and the exact location of the start and end of the rupture. Using the data, photos, and reports available, they generated a so-called shake map. This map reveals the intensity of the perceived ground vibrations. It can be used to derive the degree of destruction. It took two days from them to obtain a more precise picture of the region affected. On February 9, they issued their first report on the casualties and structural damage expected.

Earthquakes During Nights Are Far More Dangerous

"We realized soon that this would be one of the 20 earthquakes with the highest number of casualties worldwide since 1900," Andreas Schäfer says. According to their first calculations, the researchers expected 11,800 to 67,000 casualties. Latest figures show that more than 52,000 people were killed (March 2023). The high number of casualties was also due to the time: Earthquakes at nights are far more dangerous, because people are sleeping and need too much time to rescue themselves. Moreover, private houses

often are less earthquake-proof than institutional buildings, such as schools or office buildings, where people stay over the day.

According to first estimates, at least a million people became homeless. Another three millions initially could not return to their homes, because the risk of aftershocks was too high. It first had to be checked whether their houses damaged by one of the main quakes would withstand aftershocks. The CEDIM team estimated the damage to buildings and infrastructure to amount to ten billion US Dollars. In cooperation with the World Bank, total damage has meanwhile been determined to be 35 billion US Dollars. "This only includes direct damage based on the current value. Reconstruction costs will probably be far higher," Schäfer says. The province of Hatay in the South of Turkey was hit particularly hard, because here the rupture took a sharp turn. At some places, more than half of the buildings were destroyed completely.

The International Search and Rescue Team (ISAR) of the United Kingdom searches for survivors in Hatay two days after the earthquake. (Photo: UK-ISAR Team, Foreign, Commonwealth & Development Office)

Time for Earthquake-proof Reconstruction

But there also is a good message: "In the next decades, there most probably won't be such a strong earthquake again, as stress now is much smaller at this plate boundary," the geophysicist explains. Hence, the region has sufficient time to reconstruct buildings and infrastructure. However, researchers assume that earthquakes of comparable magnitudes will now become more probable in neighboring fault zones further South towards the Dead Sea and further East.

Schäfer emphasizes: "In any earthquake region, it is important to observe and control special construction regulations, even though this will not guarantee that buildings remain stable during a strong earthquake. In addition, it is needed to provide for fast aid in the case of disaster: The vital lines of a society must continue to work in cases of emergency. Critical infrastructures, such as hospitals, power supply systems, and important transport routes, have to be built such that they withstand earthquakes." ■

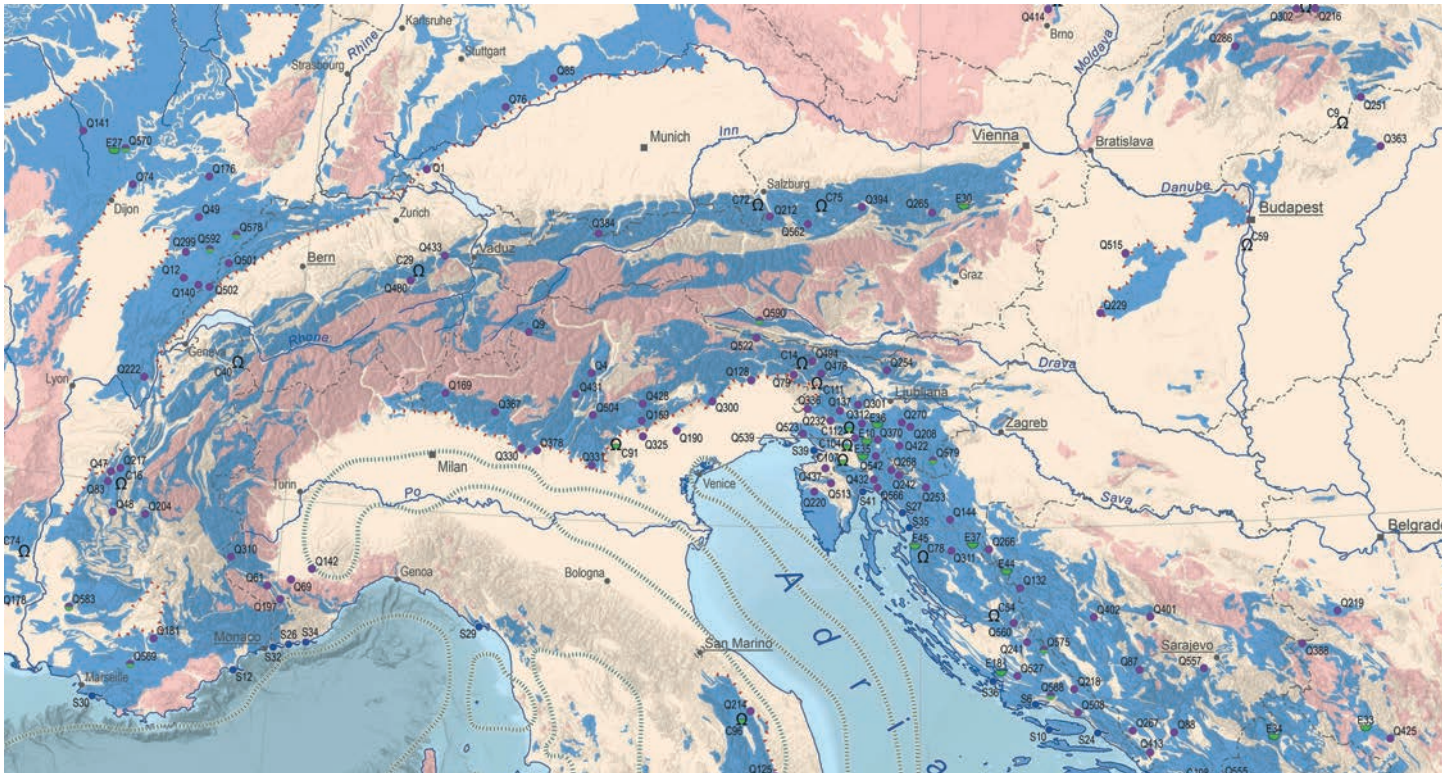
NECOC Project on the Road to Success

New Plant Produces Solid Carbon for Long-lived Products from CO_2

The new NECOC plant at KIT produces carbon, a high-tech resource, from climate-damaging CO_2 of ambient air. (Photo: M. Breig, KIT)

In early December 2022, the plant developed within the NECOC (**N**egative **E**missions through conversion of **C**arbon di**O**xide to **C**arbon) project was commissioned. The project is funded by the Federal Ministry for Economic Affairs and Climate Action. The plant was set up at the Karlsruhe Liquid Metal Laboratory (KALLA). Atmospheric CO_2 is directly filtered from ambient air and converted into methane with the help of regenerative hydrogen. In the so-called pyrolysis step, methane is then decomposed into its constituents and carbon powder is produced. "We are now testing various process parameters, such as different temperatures in the pyrolysis reactor, in order to study their influence on carbon modification," says Dr. Benjamin Dietrich from KIT's Institute of Thermal Process Engineering (TVT). Work is aimed at developing long-lived products for various applications in construction and polymer industries or for the manufacture of lithium-ion batteries. The Project Head underscores: "Combination of these process steps is unique worldwide and protects the climate in two ways. First, negative emissions are generated and second, a valuable material that has been based on fossil resources so far is produced for industry." ■

More information: www.tvt.kit.edu/21_3547.php



Excerpt from the map of Mediterranean karst aquifers (MEDKAM). Karst aquifers are colored blue. The numbered dots mark karst springs, caves, and groundwater-dependent ecosystems.

Thinking Internationally, Acting Locally – A Map of Groundwater Resources

Hydrogeologists of KIT Have Created a First Map of Karst Groundwater Resources in the Mediterranean

Permeable and soluble rock: Over time, flowing water erodes carbonate rock (e.g. limestone) and produces widely branched tubes. Such karst aquifers often contain large quantities of partly excellent groundwater. But which quantities are available at which places and in which quality?

Under the direction of Professor Nico Goldscheider from KIT's Institute of Applied Geosciences, MEDKAM, the Mediterranean karst aquifer map, was created within the KARMA project that covers the whole Mediterranean region. This map will now serve as a basis for new research and development activities relating to groundwater.

"Rainwater quickly seeps into the karst rock. There is hardly any runoff on the surface, the evaporation rate is low. Hence, underground water resources often are very rich," says karst expert Goldscheider. "It is rather spectacular to hear rivers rushing underground."

Groundwater from carbonate rock is important to drinking water supply. "The city of Paderborn, for instance, pumps the water directly into the supply network without any treatment, because it is of perfect quality. It is similar in Innsbruck." When pollutants enter karst systems, however, they spread quickly over many kilometers, as the water's flow rate is high and hardly any natural filtering takes place. Groundwater levels and spring discharges often vary strongly. For this reason, drinking water supply from karst aquifers is deemed to be rather challenging.

To create the new map of karst aquifers in the Mediterranean, a former, rougher world map was complemented by several data. "We tried to collect as much information as possible on where exactly what can be found," Goldscheider says. This included details on springs, caves, karst groundwater-dependent ecosystems, and undersea springs.

"All data together provide an overview of a large area and raise awareness of these valuable water resources," Goldscheider says and refers to international cooperation, cross-border negotiations, strategies, and agreements. An example is the EU Water Framework Directive. It defines uniform goals and standards for chemical or ecological water quality and quantity in entire political Europe. "International overviews are important to such relationships, although questions relating to concrete groundwater use always have to be agreed upon locally." ■

More information: The MEDKAM map is available cost-free in printed or digital form and as a web-based geoinformation system (WebGIS) at the Federal Institute for Geosciences and Natural Resources (Bundesanstalt für Geowissenschaften und Rohstoffe), www.bgr.bund.de/whymap/EN/Maps_Data/Medkam/medkam_node_en.html. For information on the KARMA project, click: http://karma-project.org/

More Knowledge, Better Environmental Applications

New Experiments with Metal Isotopes Will Unveil Secrets of Plants

Interactions among rock, ground, water, air, and living organisms, including plants, fungi, and bacteria, are highly fascinating for Dr. Sara Rose Kimmig. Since the beginning of this year, her research at KIT's Institute of Geography and Geoecology has concentrated on this "critical zone". She wants to better understand how plants take up and use certain nutrients and which role fungi and bacteria play in this process. "More knowledge about these processes will help develop concrete applications to support the nutrient cycle in agriculture, for instance, and to have healthier plants and increased yields. We can also develop new methods for environmental remediation," says the environmental scientist who has specialized in isotope geochemistry and experimental mass spectrometry.

Kimmig plans to use metal isotopes. These are forms of metals like calcium, magnesium, potassium, iron, and copper, which contain different numbers of neutrons and, hence, may be heavier or lighter. Use of metal isotopes in biogeochemistry is new. "So-called isotope fractionation, i.e. the change of isotope ratios, in the ground and in the plant provides valuable information on processes taking place during nutrient uptake and use. Isotope ratios are changed by chemical weathering, rainfall, rock dissolution, or the way a plant takes up, uses, and releases nutrients," Kimmig explains.

Dr. Sara Kimmig prepares ion exchangers used for the chemical purification of potassium for isotope analysis. (Photo: S. Kimmig, KIT)

She also wants to unveil a phenomenon: Why does the behavior of plants in the lab differ from that in nature? Why do changes of isotope ratios in the pot differ from those in the field? The researcher made this initially surprising finding when working with sugar maple. "I suppose that mycorrhizal fungi play a role. In nature, they live in a symbiosis with the plants," Kimmig says. She will now go into this matter and unveil the differences between laboratory and field species. ■

Progress or Setback?

Looking at the History of Wind Power Use

Opinions on the use of wind power have always differed sharply. Since the end of the 19th century already have there been proponents and opponents or the topic has hardly played any role in the public. "In particular during times of war and crises in the 20th century, wind power was discussed repeatedly," says Nicole Hess from KIT's Department of History. Hess is Doctor of History and has specialized in energy, technology, and environmental history. She has studied how the use of wind power has developed in Germany and France since 1880 and how the societies talked about it.

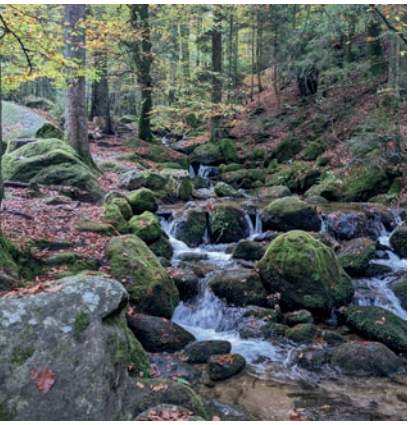
After the World Exhibition in Philadelphia in 1876, American wind motor technology came to Europe. Until the 1920s, wind energy had its share in regional energy supply as a matter of course. At the same time, operators of wind mills complained about a stagnating technology development. From the 1930s to the early 1970s, wind energy was considered to be a setback due to its locally and temporarily dependent availability. Plant operators, technicians, and engineers, however, deemed it a major resource when coal was scarce during the world wars or during the oil crisis of 1973. In the 1970s, environmental awareness grew and wind energy was reinterpreted as an eco-friendly resource. The energy industry initially remained unimpressed. Since the 1990s, wind energy has reestablished in Germany. Discussion still is animated. Wind power is regarded as either "the energy of peace" or a threat to nature, or unusable for industrialized countries.

"Historians can accompany current discourse and contribute historical knowledge. After the large-scale power system was established in the 20th century, users have lost much of their energy knowledge," Nicole Hesse says. Her research has shown that historical consumers, who also produced power, had a better understanding of energy topics. This more decentralized conception might also raise awareness of the necessity of the energy transition today. ■

Wind mills built in the first half of the 20th century can still be found in Southern France. (Photo: N. Hesse, KIT)

Protection of Biodiversity for Good Drinking Water

Science, Industry, and the Population Cooperate in the Project "BioWaWi"



Semi-natural section of a creek in the lower mountains. (Photo: C. Reichert, KIT)

Weather and ground humidity measurement station in the water protection area of Landmatt. (Photo: T. Degenhardt, KIT)

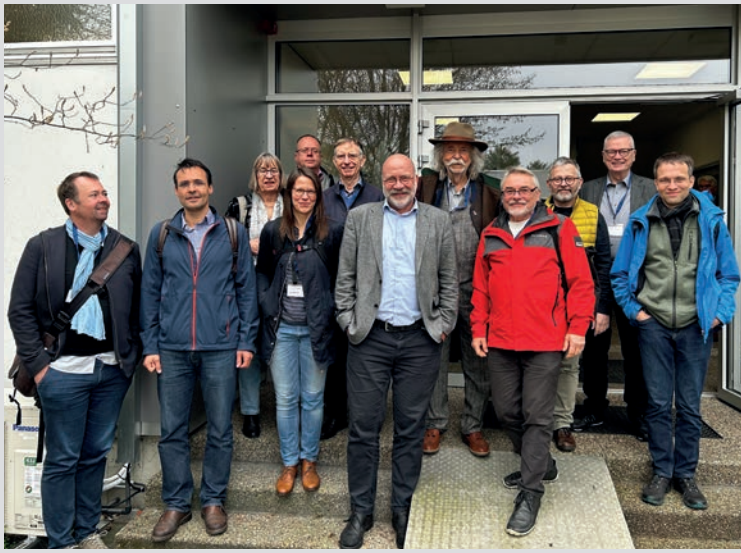
Field of sunflowers near Bühl with the Black Forest in the background. (Photo: C. Reichert, KIT)

Drinking water is our food number one. Functioning ecosystems with diverse and healthy flora and fauna supply clean raw water for drinking water production. "Protection of drinking water also is protection of nature," says Dr. Flavia Digiacomo from KIT's Institute of Applied Geosciences. She coordinates the project "BioWaWi: Biodiversity and Water Resources Management – Development of Innovative Action Options for Water Industry to Protect Biodiversity and Ecosystems." It is funded by the Federal Ministry of Education and Research. With the help of the population, the six project partners want to determine species diversity in water protection areas surrounding the municipal utility company of Bühl, establish a monitoring system, and develop methods to support the protection of ecosystems. The results will then be transferred to water industry throughout Germany.

"Research and practice go hand in hand. And we integrate citizens, as we all can contribute to protecting biodiversity and, hence, good drinking water," says Flavia Digiacomo. Having overcome first bureaucratic obstacles, the KIT team has meanwhile commissioned two of ten planned weather and ground humidity stations that measure air temperature, precipitation, wind, ground humidity, and ground temperature at various depths on an hourly basis. Other project partners map the biotopes on the basis of data that are collected by citizens using an app. An engineering office applies the data to create a water budget model for future decision-making. Municipal utilities or waterworks might then initiate measures to prevent overuse of water resources during drought periods, if certain measurement values are exceeded, for instance. ■

About Georesources and Geothermal Energy

On March 21, 2023, a group of the Wissenschaftspressekonferenz (WPK, science press conference) visited the KIT Climate and Environment Center. The Center's Scientific Spokesman Professor Christoph Hilgers spoke about global challenges in the geoenergy sector, namely, the associated resources, metals needed for the German energy transition, and the development of geothermal energy use on global and national scales. Then, Professor Philipp Blum presented examples of shallow geothermal energy use. The guests were given an overview of successes and failures of shallow and deep geothermal energy projects and of current large international research projects. ■



WPK members visit KIT. (Photo: K. Hennrich, KIT)

Bhutan Meets ZKU

On March 10, 2023, the Prime Minister of the Kingdom of Bhutan visited KIT and the KIT Climate and Environment Center in order to inform himself about latest climate research. The guests listened to presentations on georesources and natural disasters and then were highly fascinated by the AIDA cloud chamber and the information on impacts of aerosols on climate. ■

Dr. Ottmar Möhler (left, KIT) talking to Dr. Lotay Tshering (center). (Photo: K. Hennrich, KIT)

Professor Michael Janoschka


(Photo: Private)

Professor Michael Janoschka still is amused by the fact that his envy of a comrade in military service in Strasbourg set the course for his professional life. He also wanted to speak fluent Spanish. So, he joined a course in Mexico and fell in love with Latin America. During his studies, he often went there. When working on his doctorate, he concentrated on Spain. For more than 20 years now, the human geographer has studied cities and their societies in Latin America, Southern Europe, and Germany. After working in Madrid, Buenos Aires, Leeds, and Leipzig, he was appointed Head of KIT's Institute of Regional Science in June 2022. He is Spokesman of the Urban Science Topic of the KIT Climate and Environment Center. "Urban science is being advanced very dynamically at KIT, and I want to be among those in the lead," Janoschka says.

With his work, he wants to make the world a little better. For this, he studies how changing real estate markets affect social cohabitation in cities, how we can live more sustainably and protect social cohesion, and how prosperity and urban development are related. Janoschka emphasizes: "A working environment in which any opinion is appreciated is important to me, across all hierarchies and responsibilities." As Topic Spokesman, he wishes to more closely link technical and scientific urban research with sociological urban research in order to develop novelties. Creativity is needed. This is something Janoschka can learn from his four-year-old daughter. Every evening, she makes him leave the world of science and enter the world of painting, crafting, and music. ■

Dr. Tanja Portele


(Photo: T. Portele)

What will our next summer be like? As hot and as dry as in the past year? Dr. Tanja Portele says: Probably yes. Strong heat and drought can be forecast well several months in advance, knows the atmosphere researcher. For her doctorate on seasonal weather forecasts in semi-arid areas in Sudan, Ecuador, and Peru, she was granted the KIT Doctoral Award. In her work she combines meteorology with economy. "When dam operators consider seasonal forecasts in their decisions, they can save up to 16 million US dollars in a year of drought," Tanja Portele says. Weather has always fascinated the researcher. After studies in Innsbruck and a first employment at the German Aerospace Center, she returned home to Garmisch-Partenkirchen to work on her doctorate at KIT. At the Atmospheric Environmental Research Department of KIT's Institute of Meteorology and Climate Research (IMK-IFU) on KIT's Campus Alpine, she is now continuing her work on forecasts, this time for Kenya. In parallel, she wants to increasingly focus on Germany and its Alpine region. She plans to cooperate with users to improve water resources management in the Alps, for instance. Tanja Portele loves her home and the mountains, also during leisure time. In summer, she loves to go hiking. In winter, she makes ski tours. And Tanja Portele always enjoys the weather: "I am interested in any type of weather. Thunderstorms, for instance, are a great natural spectacle in the mountains." ■

Municipalities Are Important Partners in Climate Matters

Scientific Projects Support Municipalities

Municipal partners play a decisive role in matters of climate change. Why is this so? They often are at the end of a long chain of decisions on the federal and state levels and implement measures in the public service sector. Municipalities differ in terms of size, budget, and geographical location, which is why the approaches they pursue are very heterogeneous. Scientific findings can help municipalities extend the bicycle path network, push roof greening, or plan a climate-neutral administration building. This is where the South Germany Climate Office of KIT comes in. For quite a few years, we have been processing climate data for application.

Within the framework of a project together with the forestry office of the city of Karlsruhe, we process their data for an AI-based decision-making system that also takes into account the functions of a forest. In another project, we provide the scientific basis for adaptation measures of the city of Freudenstadt and its utility companies. Not least, an inquiry received from the municipal climate protection sector some years ago made us bring together several institutes of KIT to jointly assess municipal climate protection measures. Climate change is a topic that plays an important role on the municipal level and we at KIT and our science can make an important contribution. ■

Gainful discourse at Bad Herrenalb in 2022: The participants came from different disciplines relating to climate and the environment. (Photo: D. Lieber, KIT)

A Triad for Teaching

GRACE Focuses on Imparting Knowledge, on Discourse, and on Personal Exchange

Summer will start soon, as will the annual summer school of the GRACE Graduate Program. "Our approach is to find a topic on a higher level that is of interest to as many GRACE doctoral researchers as possible and can be discussed from many perspectives, such that all participants can take something along for their doctorate," says coordinator Dr. Andreas Schenk. This is achieved by a triad of imparting knowledge, interpreting scientific facts and forming an opinion, and the opportunity to do some personal networking. "This should be initiated by lecturers, who have made similar research findings, but interpret them differently as regards their political, ecological, or social implications."

This year, the summer school will focus on regenerative energy sources and central as well as decentralized energy supply. Is it better to have many small power plants or better to have one big and more efficient power plant with possibly greater impacts at a single location only? The example: Use of water power at the Enguri dam in Georgia. GRACE cooperates with the two universities GTU and TSU in Tiflis. "We are currently working on the concept, registration will be opened soon." ■

More information:
www.grace.kit.edu

New Concrete Recipes

Using More Raw Material Sources

Besides water, concrete is the most consumed material. But when producing cement, a basic ingredient of concrete, large quantities of CO_2 are produced. New recipes are needed. According to the THINKTANK "Industrial Resource Strategies," crushed concrete might be of increasing importance in future. "To establish circular economy in the concrete sector, we will have to close gaps," says Professor Frank Dehn of KIT's Materials Testing and Research Institute (MPA). "This means using recycled material instead of natural gravels or crushed stone and using the fine fractions as well." They result from processing coarse material, but are presently considered waste and have to be disposed of – an unused source of resources. Cements can also be modified with the fine materials, such that their CO_2 footprint is reduced. "We want to push cements and cement substitutes from recycled materials," Dehn says.

KIT research findings show how the use of fine recyclate fractions can be implemented technically and how concrete crushed sands can be reactivated mechanically or thermally to increase the strength and durability of cement and concrete. Frank Dehn underscores: "Our approaches are aimed at reaching two goals: Saving resources and reducing CO_2 emissions." The engineer expects that building supervisory authorities will soon publish the corresponding regulations to enable use of the fine fractions. For this, the THINKTANK has created a good basis. ■

Establishing a circular economy for concrete. (Photo: agshotcretes-er-vices pixabay)

More information:
www.thinktank-irs.de
(in German only)

Who Are We – And If Yes, Why and What for?

ZKU Has Asked Itself Key Questions Regarding the Basis and Orientation of Institutional Science

The lignite mining example: ZKU contributes to solutions to heal anthropogenic wounds in nature. (Photos: C. Hilgers, KIT)

The Climate and Environment Center (ZKU) collects data to understand processes. This is what climate and environmental sciences have always been standing for and this also is the DNA of ZKU. But what about solutions for the situations identified? "After I became Scientific Spokesperson in 2022, we sharpened and complemented our mission statement together with the researchers of ZKU," says Professor Christoph Hilgers.

The basic idea of ZKU was and still is to bring together researchers across disciplines. "ZKU wants to be home of KIT's applied researchers." Bringing together rather than dividing. ZKU is living what Leopoldina demands using the keyword of earth systems sciences: Understanding the Earth scientifically in its entirety and in the process of change.

Together with colleagues at ZKU, Hilgers started to rethink: "Who are we? Where are we standing today? Where do we want to be tomorrow? What are the steps needed to go there? And how do we want to go there?" This self-conception was laid down jointly in the form of a vision, mission, and values: Studying climate and the environment, developing solutions. For a future worth living. Respectful discourse to advance responsible research.

ZKU topics have changed. In addition to the long established topics of atmosphere, water, ecosystems, natural hazards and risk management, and georesources, the new topics of data science, environmental technologies, and urban research have been launched. In the latter case, civil engineering and social sciences cooperate to study fundamentals and to transfer the findings to application.

Hilgers compares the commitment to using not only nature-based, but also technological solutions to reach the 17 sustainability goals with healthcare: "No matter to what an extent CO_2 emissions or energy- and resource-intensive industries are reduced at some places: Worldwide, emissions and use of the environment will unfortunately further increase. This and other interventions leave wounds in nature. Hence, we also need interdisciplinary solutions and technologies to live with these interventions and to make these wounds heal as well as possible. Not only here, but also for people in other countries, who are not so well off."

This is also reflected by communication to the outside. New impetus in the current debate on climate and environmental issues will be provided via different channels, such as podcasts "Klimaforschung" (climate research) and "Umwelt. Wandel. Wissen.Nutzen" (Environment. Change. Knowledge. Use), newsletters, and events. "Data are reported. But still, a lot of information is provided without facts." For many persons, it is therefore difficult to distinguish data-based from opinion-based information. "The press strongly mixes data and opinions. To attract a maximum of attention, opinions are often listed only. But science does not work in this way. We create data. They exist and do not change ad hoc."

ZKU wishes to contribute to providing clarity: As an internal interdisciplinary science platform, as an interface between science and society, as a contact partner for companies, authorities, schools, and as a companion in kickoffs – for the people in their environment.

In this sense, the public will be invited soon to meet the ZKU again or for the first time: On July 27, the Annual Conference of ZKU will take place with the presentation of the Sparkasse Environmental Award and the final certificates of the GRACE Graduate School as well as with a public lecture on CO_2 underground storage. Before that, from July 3 to 8, ZKU will organize the Wissenswoche Umwelt und Ressourcen "sicher.sauber.nutzen" (week of environmental and resources knowledge "safe.clean.use"). On July 6, the dialog Karlsruher Umweltimpulse "Rohstoffe, Ethik und Kreislaufwirtschaft" (environmental impulses in Karlsruhe "resources, ethics, and circular economy") will take place. The public is cordially welcome. ■

More information:
https://www.klima-umwelt.kit.edu/english/index.php

KIT Climate and Environment Center

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Spokesperson of Topic 5:	Urban Research:	Professor Dr. Michael Janoschka
Spokesperson of Topic 6:	Natural Hazards and Risk Management:	Professor Dr. Michael Kunz
Spokesperson of Topic 7:	AI in Environmental Sciences:	Professor Dr. Stefan Hinz

A Butterfly Flutters over East Asia …

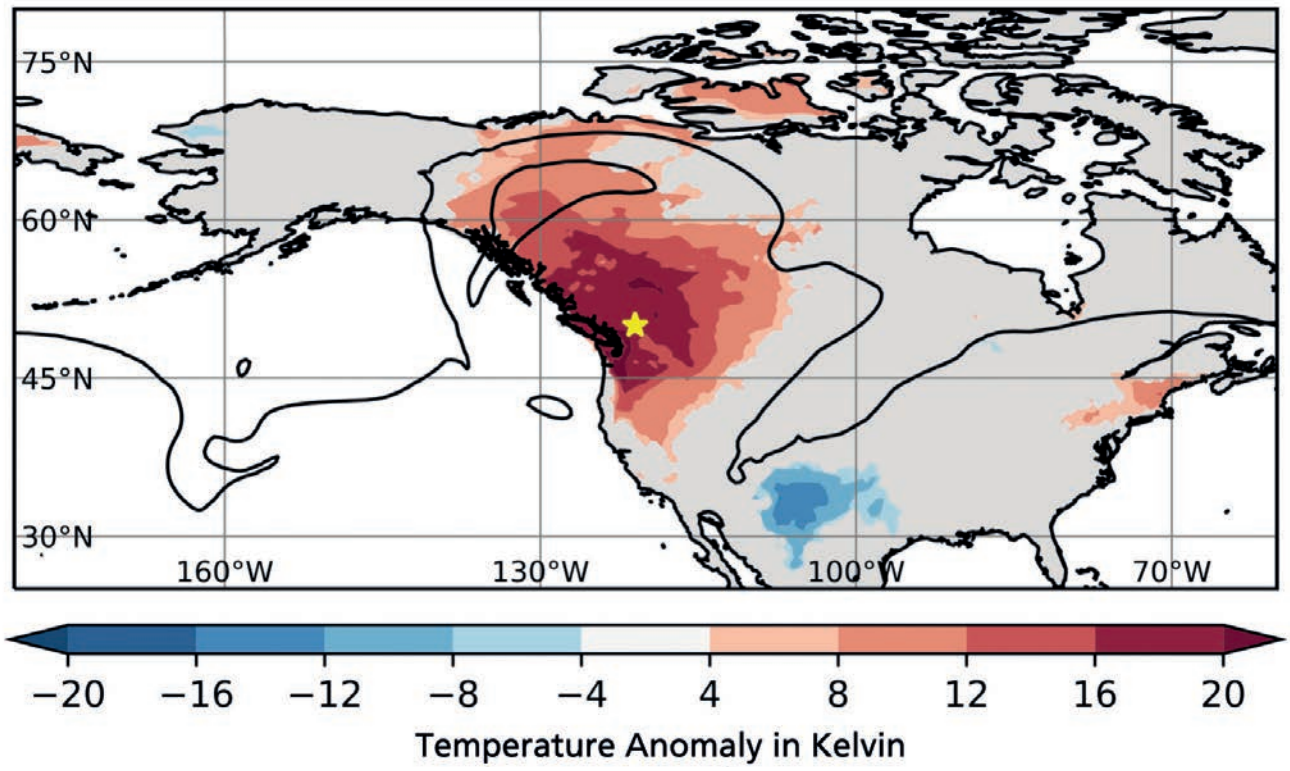
… and America Groans under the Heat? This Is Possible, Because Remote Effects Play a Major Role in Weather

Drought, forest fires, hundreds of casualties: In 2021, North America and West Canada experienced enormous heat of locally up to 50 degrees Celsius. Some weather forecasts had been very precise, others not. Why? Annika Oertel and Christian Grams and their working groups "Large-scale Dynamics and Predictability" and "Cloud Physics" at KIT's Institute of Meteorology and Climate Research (IMK) and the European Centre for Medium-Range Weather Forecasts studied more than 700 forecasts.

"A stationary, gigantic high-pressure ridge developed and was reinforced by thrusts of warm air from the West Pacific. They were decisive on the other side of the ocean. All good forecasts detected their traces," Oertel says. To identify them, many more data than those archived by weather services are needed. "We have developed a neural network that detects such ascending air masses even in reduced data with a comparably small calculation expenditure," Grams points out. The lesson: It is necessary to pay more attention to the interaction of different weather scales and to have more robust statistics. Single events, such as ascents of warm air at a remote place, may influence developments over several days, such as high-pressure areas elsewhere, and cause extremes. To enhance visibility, ensembles of 100 instead of 50 individual forecasts will be calculated in future.

Oertel, A.; Pickl, M.; Quinting, J. F.; Hauser, S.; Wandel, J.; Magnusson, L.; Balmaseda, M.; Vitart, F.; Grams, C. M. (2023). Everything Hits at Once: How Remote Rainfall Matters for the Prediction of the 2021 North American Heat Wave. Geophysical Research Letters, 50 (3), Art.-No.: e2022GL100958, DOI: 10.1029/2022GL100958 ■

More information: https://www.klima-umwelt.kit.edu/english/index.php



During the 2021 heat wave in North America, temperature strongly deviated from the long-time June average. The pronounced high-pressure ridge is colored black. Record temperatures were measured in Lytton (yellow star). (Graphics: © Oertel et al., KIT)