Karlsruhe Institute of Technology

CLIMATE AND ENVIRONMENT news

Newsletter of the KIT Climate and Environment Center

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Dear Readers!

Students of the "Fridays for Future" movement are rigorously demanding German politics to enhance climate protection. At the World Climate Conference in Katowice in December 2018, scientists of KIT also emphasized that nothing will be won for climate protection as long as greenhouse gas emissions do not change. A possibility to reduce CO_2 emission is to use aquifer storage systems for groundwater-based heating and cooling of buildings. A pilot plant is presently being planned at KIT. Other scientists of KIT study the impacts of climate change on e.g. meadows and pastures in the Alps or on biodiversity of tropical mountain rainforest in Ecuador. In this way, KIT research contributes to the society's responsibility of climate protection. Enjoy reading!

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

Fine Dust Problem in West Africa

Nearly everything grows in West Africa: population, cities, economy, and, hence, also air pollution. But how polluted is the air and how does this affect cloud formation? KIT researchers around Professor Peter Knippertz of KIT's Institute of Meteorology and Climate Research have studied these questions for five years within the DACCIWA project. "We have collected valuable new data with which we will be able to continue our work for quite a few years," Knippertz says. The data are planned to improve climate and weather models that do not yet supply any reliable prognoses for this region in the world.

The air quality measurements made surprised the researchers. Ozone, nitrogen oxides, and sulfur oxides were indeed found to pollute the air, but the measured concentrations mostly were below the threshold values given by the World Health Organization (WHO). A much bigger problem is fine dust from the smoke of household fires as well as from traffic, waste combustion, and industry. Knippertz summarizes: "Even in the 4.5 million city of Abidjan in Ivory Coast, people still use mainly charcoal and firewood for cooking."

In West Africa, the cities and traffic are growing. (Photo: Sébastien Chastanet)

Researchers were also surprised to find high particle concentrations not only in cities, but in the complete region. This is due to the smoke that comes with the monsoon winds from fires in Central Africa. Fine dust particles act as cloud condensation nuclei. However, pollution in the region is so high that cloud formation would hardly be changed by any further increase, the researchers say. Impacts on human health, however, would be significant. Moreover, increased turbidity of the atmosphere might lead to a decrease in precipitation.

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RESPECT for Biodiversity in Southern Ecuador

Changes of Land Use and Climate Endanger the Ecosystem

The San Francisco research station in the province of Zamora-Chinchipe (Ecuador) with a typical pasture in the background. (Photo: Wolfgang Wilcke)

Hundreds of tree species and spectacular flowering plants – the tropical mountain rainforest in the South of the Ecuadorian Andes is among the biodiversity hotspots of the Earth. However, it is challenged by climate change, changed land use, and high nitrogen inputs. The new DFG research group RESPECT plans to study major ecosystem functions and to develop a land surface model that integrates water fluxes, plant growth, and climate properties. "It will be used to model coupled changes," says Professor Wolfgang Wilcke of KIT's Institute of Geography and Geoecology, who coordinates one of the eight subprojects.

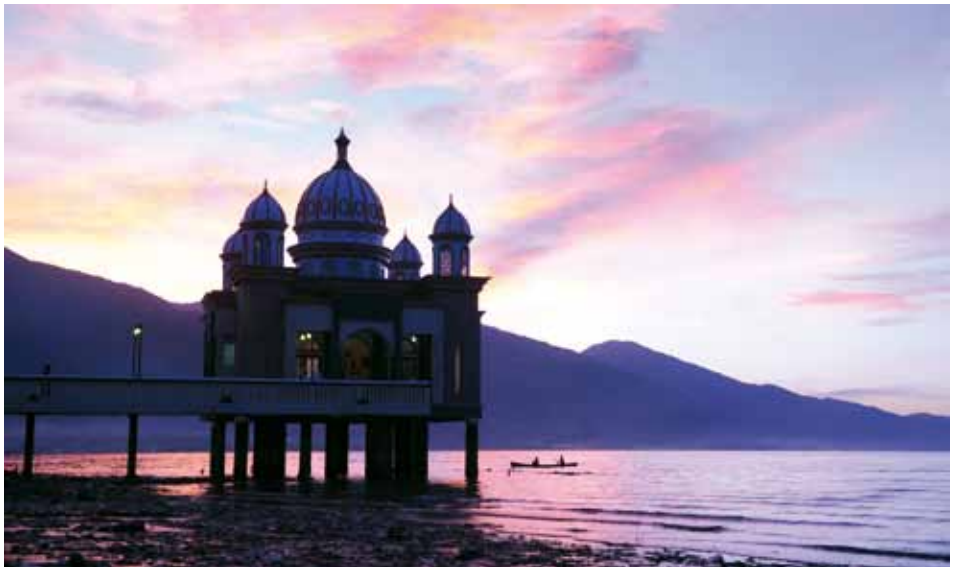
The Geomorphology and Soil Science Group will study the effect of climate and land use changes on the supply of nutrients in various land use systems. "Biomass production and evaporation largely depend on the availability of nutrients, such as nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur," Wilcke says. To obtain results more quickly, the scientists use the "space-for-time substitution" approach. They study neighboring areas that reflect the sequence of land use changes since the 1950s: from native forest to pasture to pine afforestation.

Tragic Chain of Special Circumstances

Why the 2018 Sulawesi Earthquake Triggered a Tsunami

When the earth quaked on the Indonesian island of Sulawesi on October 28, 2018, it took only five minutes until a tsunami with five-meter-high waves hit the coasts in the bay of Palu. More than 4,300 people lost their lives. The tsunami had not been expected to be so powerful. Its great power also surprised Dr. Andreas Schäfer of KIT's Geophysical Institute. "To trigger a tsunami wave, the seafloor has to be displaced vertically. As a rule, a horizontal displacement, such as that caused by this earthquake, does not give rise to a big tsunami."

However, this earthquake of magnitude 7.5 was special. The fracture went along the narrow bay of Palu, where the tsunami developed. Schäfer compares this with a bathtub: "If you displace half of the water by a few centimeters, a wave develops. It will move along the entire bathtub and gain height." Schäfer's tsunami simulations are used for further risk research by the Center for Disaster Management and Risk Reduction Technology (CEDIM). According to the simulations, the event most probably was a chain of unfortunate circumstances: a large horizontal offset, a small vertical displacement, and maybe landslides. For CEDIM, this now means to identify similar constellations on Earth, where an earthquake may cross a bay and probably trigger a similar tsunami.



The famous "floating" Apung mosque in Palu was destroyed by the earthquake and tsunami. (Photo: Adobe Stock)

Clean from the Spring to the Tap

Lake Monitoring to Maintain Drinking Water Quality

China has a problem: drinking water. Many water bodies are polluted by hazardous substances and nutrients. Under certain conditions, blue-green algae may reproduce quickly and release toxic substances. This is what happened on a large scale in Lake Tai in 2007. This lake, among others, supplies Wuxi with water, a city with a population of more than 3 million. Local waterworks were unable to control the algae-borne pollutants. As a result, fresh water flow stopped for days.

Since 2015, KIT's "Environmental Mineralogy and Systems Analysis" working group has developed technologies and forecast models for better monitoring of the lake within the joint project SIGN (Sino-German Water Supply Network). "Our motto is: clean water from the spring to the tap," geoecologist André Wilhelms says.

His doctoral thesis covered use and further development of multi-sensor systems that collect data on e.g. blue algae, suspended matter, or the oxygen content of water over the area as well as at certain points with a high temporal resolution over lake depth.

"Our goal is to enable forecasts," Wilhelms says. "Solar panels and wind converters are to be used for energy supply of the systems. They are to be designed such that the data collected are transmitted automatically to our computers and the waterworks." In case of an emergency, warning would be accelerated, water flow into the waterworks would be stopped, and existing reserves would remain clean.

Measuring buoy for water sampling from Lake Tai by the SIGN partners (KIT, IWW, RWTH). (Photo: André Wilhelms)

Nature and Culture: Green Economy in the Alps

Photos and Measurements Serve as a Basis for a Decision Support Tool Relating to Fertilization

On the way towards to work at IMK-IFU with the investigation object in view. (Photo: SusAlps, KIT)

Exchange is important – round table with stakeholders at IMK-IFU. (Photo: SusAlps, KIT)

Lush meadows and pastures, green Alpine grassland... How long will they last when climate change and land use changes will modify this cultural landscape? The SusAlps project studies how grassland management in the (Pre)Alps can be made sustainable.

An example is fertilization. "General limitations of fertilizer amounts are not reasonable. Site adaptation is required," says Dr. Anne Schucknecht of the Atmospheric Environmental Research Division of KIT's Institute of Meteorology and Climate Research (IMK-IFU) on KIT's Campus Alpine.

Schucknecht uses remote sensing. Presently, data are being collected by drones, later, she will use satellite data. Depending on the amount, composition, and state of vegetation, light is reflected differently. Several photos per year, combined with measurements of e.g. exchange processes of substances between the ground, plants, and the atmosphere, will be the basis for a planned decision support tool for farmers.

"You enter your location and your planning for fertilization and cutting. The app will then compute the yield and the environmental impacts and how these values will change when alternative management concepts are applied." It may be worthwhile to harvest three times instead of four. This is an example of how grassland can be made fit for the climate change and valuable soil functions will be maintained.

Too Hot in Summer, Too Cold in Winter?

The Solution Lies Underground

Heat downwards, cold upwards – and vice versa: Five million Euros were invested in the closed heating and cooling circuit based on an aquifer storage system at Stockholm airport. Thanks to CO_2 savings of 7,700 t per year, among others, the investment will pay off after five years. (Graphics: Underground Energy LLC, USA; www.undergound-energy.com/our-technology/ates/)

"We have no problem with energy, we only have to store it," quotes Professor Philipp Blum of KIT's Institute of Applied Geosciences. "A Swiss energy expert said this ten years ago. And he is right. Today, everyone in the world speaks about heat storage. And this is where aquifers come in."

Environmentally compatible heating and cooling: a hotel and two office buildings in the "Bonner Bogen" district use an aquifer storage system – one of only four examples in Germany so far. (Photo: Paul Fleuchaus)

Aquifers are groundwater-bearing underground layers. They have a great potential whenever cooling and heating are needed at the same time or in the same season. For cooling, water is pumped upwards through a well. There, it takes up the waste heat of e.g. a building. Through a second well, it flows back into the underground, where the thermal energy is stored. If heating is required, the heat is pumped upwards again. Water in the aquifer cools down with time – the higher water flow is, the more is the water cooled down. But so-called retrievability still ranges between 60 and 80 %. Moreover, investment costs are compensated by a reduction of CO_2 emission: such type of energy supply is associated with far reduced emission levels.

This is worthwhile, in particular for large buildings, such as shopping centers, office buildings, universities, airports or hospitals. For the Karlsruhe Municipal Hospital, Blum and his team analyzed the costs and benefits. They found that an aquifer storage system would pay off after three years already.

In the Netherlands, such figures convinced many people. More than 2500 facilities have been built so far. In spite of similar conditions in Germany, not more than four facilities exist. "An example is our parliament in Berlin. But this is hardly known to anybody. Even the scientific community does not know," Blum says.

Why? Maybe, because the systems are hardly visible. "The head of the well can be seen only. Everything else takes place underground in some pipeline systems." Moreover, transforming the energy supply scheme always affects existing business areas. Energy utilities are presently focusing on cogeneration units and district heating. "This works, the methods are mature, supply is organized centrally, and customer retention is excellent. Why should they replace something successful by a decentralized method that has hardly been tested so far and still requires technical optimization?"

KIT might set a good example. Blum and his team are planning a demonstration facility on Campus North, licensing and decision processes are under way. "KIT stands for scientific innovations," Blum says. He wishes that KIT "should take a lead in the transformation of heat and cold supply and be more innovative itself. "

The aquifer storage system in Bonn supplies up to 80 % of the heat and cold in three buildings covering a total area of 60,000 square meters. (Photo: Paul Fleuchaus)

(Photo: KIT)

Dr. Susanna Mohr

Dr. Susanna Mohr is General Manager of the Center for Disaster Management and Risk Reduction Technology (CEDIM) of KIT. The main goal of CEDIM is to advance scientific understanding of natural and man-made hazards and to detect them earlier and manage them better. Mohr supports the spokespersons in organizing and scientifically coordinating the interdisciplinary research institution. The benefit of CEDIM: "Here, natural scientists, sociologists, economists, and engineers work together and learn from each other," the meteorologist says. Presently, research focuses on forensic disaster analysis in near real time, on evaluating causes and impacts of disasters in more detail, and on estimating the damage. In this area, CEDIM cooperates with the World Bank. "This is how science produces direct benefit."

(Photo: Irina Westermann, KIT)

Dr. Hans Schipper

"Building awareness, promoting dialog, coupling sciences." These are the guiding principles of the South German Climate Office of KIT and its head Dr. Hans Schipper. As a convinced "liaison officer," the meteorologist communicates the climate knowledge developed by KIT to the public by presentations, work in bodies, and much PR work. He never tires of explaining the same things again and again. And this pays off. "After ten years of work of the Climate Office, it is quite obvious that people remember a lot." His personal credo is: exchange instead of one-way communication. "Research should not only say what is. It should also listen. The region has gained quite a lot of experience in coping with a changing environment. We should consider this experience at our institutes."

(Photo: KIT)

Dr. Andreas Schenk

Surface, not superficial: Dr. Andreas Schenk studied applied geophysics. "I use remote sensing methods to investigate the Earth's surface," Schenk describes his work. It focuses on remote sensing using radars and satellites. "Then, I will make available these data to other geoscientists, as a service, so to speak."

This close, interdisciplinary cooperation requires knowledge not only of his own realm, but also of other fields of geosciences. "I know their languages and their current research topics." A good basis to build bridges.

And this is what Andreas Schenk does, not only between different disciplines, but also for young scientists: as scientific coordinator of KIT's GRACE Graduate School. He considers this position "a question of philosophy." Is the Graduate School an institution that has to be managed?

This perspective does not open up the entire potential of such a school. For Schenk, GRACE rather is an association of doctoral researchers working on topics in the area of climate and environmental research. He encourages the doctoral researchers to network and to further qualify scientifically. "This concept is flexible. You can move freely inside." Hence, his work covers both science management and project work in research. "I very much enjoy looking into various fields." And he succeeds perfectly in doing so.

KIT Climate and Environment Center

Scientific Spokesperson:	Prof. Dr. Erwin Zehe
Deputy Scientific Spokesperson:	Prof. Dr. Thomas Leisner

Spokesperson of Topic 1:	**Atmosphere and Climate:**	Prof. Dr. Thomas Leisner
Spokesperson of Topic 2:	**Water:**	Prof. Dr.-Ing. Franz Nestmann
Spokesperson of Topic 3:	**Georesources:**	Prof. Dr. Jochen Kolb
Spokesperson of Topic 4:	**Ecosystems:**	Prof. Dr. Almut Arneth
Spokesperson of Topic 5:	**Urban Systems and Material Flow Management:**	Prof. Dr. Stefan Emeis
Spokesperson of Topic 6:	**Natural Hazards and Risk Management:**	Prof. Dr. Michael Kunz

Good Start and Mixed Emotions

For the First Time, KIT Directly Sent Observers to the World Climate Conference

Dr. Christof Lorenz, Romy Durst, and Professor Harald Kunstmann (from the left) took part as official observers in the 24th World Climate Conference. (Photo: KIT)

When 197 parties of the United Nations Framework Convention on Climate Change (UNFCCC) met for the 24th Conference of the Parties (COP) in Katowice, Poland, in late 2018, scientists of KIT for the first time took part as official observers. Professor Harald Kunstmann, Dr. Christof Lorenz (both from the Atmospheric Environmental Research Division of KIT's Institute of Meteorology and Climate Research, IMK-IFU, Campus Alpine), and Romy Durst (Project Management Agency Karlsruhe, PTKA) attended the Conference from December 2 to 5 after the KIT Climate and Environment Center headed by Dr. Kirsten Hennrich had succeeded in accrediting the KIT. "This was an important step. It is a strong strategic signal that KIT can now directly send scientists to the COP conferences and contribute its research findings," Kunstmann summarizes.

Together with Wroclaw University of Science and Technology, the scientists organized the side event "Climate Proofing Strategies" at the EU pavilion. The event focused on strategies and instruments to adapt to the increasingly variable climate and to better prepare decision-makers. KIT's SaWaM project served as an example. With the help of seasonal forecasts and in close cooperation with local water suppliers, this project develops methods to adapt to increasing water scarcity in dry regions. SaWaM, part of the initiative "Global Resource Water – GroW" of the Federal Ministry of Education and Research (BMBF), was presented by Romy Durst. Under GroW, twelve joint projects are dedicated to studying global water management aspects and reaching the UN sustainability goals in the water sector.

And what did they achieve? "Massive attention in the media," Dr. Christof Lorenz says. "We gave a number of interviews to radio stations and newspapers. Climate proofing is a topic that has met with the interest of journalists, because it is rather new." According to Professor Harald Kunstmann, however, scientific impact on the conference proper was even smaller than at the COP 23 in Bonn in 2017: "At Katowice, generally less 'hard' science was presented than during the daily 'German Science Hour' of BMBF in Bonn. And during the media interviews, we felt that basic findings on global warming meanwhile play a rather subordinate role. They are largely known and the necessary coarse direction for climate protection is clear. Now, political and economic implementation is more important."

"It was obvious that all want to pull the rope together," Lorenz underlines. He was impressed by the fact that the countries of the world met for two weeks to intensively discuss how emissions can be reduced. Still, it became obvious that this is a painstaking process. At Katowice, i.e. three years later, implementation of the decisions of the 2015 Paris Agreement was talked about. Hence, Kunstmann has rather mixed emotions: "On the one hand, it is good to see the flags of all states in the big conference halls and you personally feel that you are part of the big global community. On the other hand, greenhouse gas emissions are still increasing continuously. In 2018, more greenhouse gases were emitted than ever before. As long as this does not change, nothing is won for climate protection."

The next years will show whether the results and measures agreed upon in Katowice will have an effect. The fact that countries that do nothing against climate change can be denounced openly is a step in the right direction, Lorenz thinks. "Moreover, the big presence in the media that was also reached with our side event is a constant reminder for us to do even more for climate protection."

197 parties ratified the UN Framework Convention on Climate Change. Kunstmann: "You personally feel that you are part of the big global community." (Photo: Harald Kunstmann)

The KIT scientists are convinced that the efforts associated with COP accreditation and the organization of the side event were worthwhile. It was quite obvious that the presence of science at such political conferences is important; science owes this to its research funding institutions. "COP 24 was a good start for KIT as a UNFCCC-accredited organization. Its presence should be further increased at future conferences," Kunstmann and Lorenz agree.

K3 Congress on Climate Change, Communication, and Society on September 24 and 25, 2019 at KIT

"Climate Communication in Times of Societal Transformation" is the title of this year's congress. The background of the conference is a persistent discrepancy: climate change is one of the biggest threats to humankind that often appears to be interested marginally only. Researchers constantly develop more knowledge about climate change and promising countermeasures – but politics and the society do much less than necessary. About 400 participants are expected, registration will be possible from late April/early May 2019.

Workshop "Karlsruhe – unterwegs in Richtung Zukunft"

On October 25, 2018, the joint workshop of the city of Karlsruhe, the KIT Energy and Climate and Environment Centers, and, for the first time, the KIT Mobility Systems Center, has taken place for the fifth time since 2010. Nearly 60 employees of KIT and the city presented their project ideas, discussed potential exchange and cooperation formats, and reported about successful projects. First project meetings for new initiatives have already taken place.

New Scientific Spokesperson of the KIT Climate and Environment Center

In February 2019, Professor Erwin Zehe took over the office of the Scientific Spokesperson of the KIT Climate and Environment Center. He replaced Professor Frank Schilling, who had been in office since February 2015. We cordially thank Professor Schilling for his commitment and his enthusiasm and look forward to cooperating with Professor Zehe.

Professor F. Schilling (KIT), Professor T. Stocker (University of Bern), and Professor C. Kottmeier (KIT) at the KIT Climate Lecture on September 19, 2018. (Photo: KIT)

KIT Climate Lecture 2018: Professor Thomas Stocker – What if Paris Fails?

In his very thrilling presentation on September 19, 2018 at the festival hall of the Students Cultural Center, Thomas Stocker, Professor for Climate and Environmental Physics at the University of Bern, talked about his long work in the Intergovernmental Panel on Climate Change (IPCC). In a rather impressive way, Stocker outlined the relationship between sustainable development and climate change. His conviction: the sustainable development goals formulated by the United Nations will not be reached, unless climate change and global warming will be limited. Nearly 200 listeners came to the Students Cultural Center. This shows: climate change is a topic that concerns us all.

Professor Arneth. (Photo: KIT)

Professor Butterbach-Bahl. (Photo: private)

Scientists of the KIT Climate and Environment Center Were among the "Highly Cited Researchers" in 2018

Professor Almut Arneth and Professor Klaus Butterbach-Bahl of the Atmospheric Environmental Research Division of the Institute of Meteorology and Climate Research are ranked among the "Highly Cited Researchers" by the Thomson Reuters media group. The ranking includes 6000 scientists, whose publications are cited most frequently. For the current ranking, Reuters evaluated publications from 2006 to 2016. A publication is considered "highly cited" when it is among the top one percent of total citations in the respective discipline and year of publication.

Among others, Almut Arneth studies interactions between ecosystems and atmospheric processes, whereas Klaus Butterbach-Bahl focuses on atmospheric trace gases and their sources and sinks as well as on biogeochemical processes subject to biosphere-atmosphere exchange.

Sun, Beach – and Learning

Learning, discussing, and networking where others spend their holidays: this year's summer school of the GRACE Graduate School will take place at the studies camp of Aristotle University of Thessaloniki in Kalandra, Greece, for the first time in scientific and organizational cooperation with another country. "This is very exciting for us," says GRACE spokesperson Professor Stefan Hinz. "It is always good to keep the horizon wide."

In particular, this applies to the spectrum of disciplines. So far, the summer school has concentrated on the topics of soil, water, climate, and urban research. This time, the topics of energy and socioeconomic assessment will be in the focus. "This is where the University of Thessaloniki contributes core competencies."

From September 2 to 5, 2019, up to 80 doctoral researchers will enjoy a sunny work environment on the Greece peninsula of Kassandra. (Photo: vasiliskritos on Pixabay)

In case of a positive feedback, GRACE plans to repeat this project at regular intervals, in line with the strategic decision of KIT to extend cooperation with Greece. "The country will develop as a science nation," Hinz says. "Hence, we are very happy that our partner project will pave the way in this respect."

From April 1, 2019, registration for the summer school is possible on the GRACE website.

Antibiotic Resistance Bacteria Deposit in Sediments

Aeration basins of a large sewage treatment plant for biological wastewater treatment. (Photo: Thomas Schwartz working group)

Conventional wastewater treatment is not sufficient. From municipal sewage treatment plants, major bacterial loads enter the environment. According to findings of an interdisciplinary research group of KIT, many antibiotic resistance pathogens deposit in river sediments. "And this is not dependent on whether hospitals, slaughterhouses, or lifestock husbandry facilities are located in the catchment area of a sewage treatment plant," says Professor Thomas Schwartz of the Institute of Functional Interfaces (IFG).

Bacteria, for instance, may be bound to minute sand particles that are not removed effectively from the treated water. "Depending on the concentrations, sewage treatment plants have to be improved – this is healthcare," Schwartz underscores. By means of membrane technology, i.e. ultrafiltration, microbiological pollution can generally be reduced down to the detection limit. Moreover, scientists want to study whether high-risk resistance genes enter the sediments and how quickly the bacteria and their DNA are decomposed.

Brown PC, Borowska E, Schwartz T, Horn H: Impact of the particulate matter from wastewater discharge on the abundance of antibiotic resistance genes and facultative pathogenic bacteria in downstream river sediments. Science of The Total Environment, 649, 1171 – 1178, 2019. https://doi.org/10.1016/j.scitotenv.2018.08.394

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