Karlsruhe Institute of Technology

Issue 1|2014

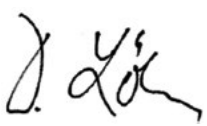
CLIMATE AND ENVIRONMENT news

Newsletter of the KIT Climate and Environment Center

Editorial

Competition of ideas: This is what research is. We scientists are used to dealing with ideas in a rather matter-of-fact manner. The better argument wins. The more surprising it is when substantiated scientific findings and their applications cause controversial or even emotional discussions in the public. A current example is hydraulic fracking.

When looking at it objectively and using it according to the state of the art, fracking has a big potential as a transitory technology in the German „Energiewende". At the KIT Climate and Environment Center, we are working on enhancing the knowledge about fracking and other technologies for energy production, such as the use of geothermal energy. However, our task also consists in bringing public discussion onto a more objective level – with good arguments as those provided by Frank Schilling in the commentary of this newsletter. For research to serve the benefit of mankind and the environment. This has to be our paramount objective.



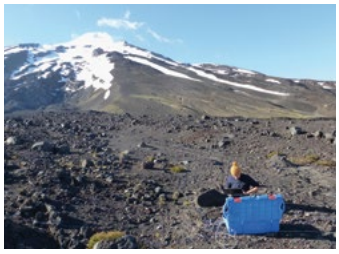
Yours Prof. Dr. Detlef Löhe
Vice President for Research and Information

Research for more Geothermal Energy

KIT Scientists Cooperate with Chile in Geothermal Energy Research

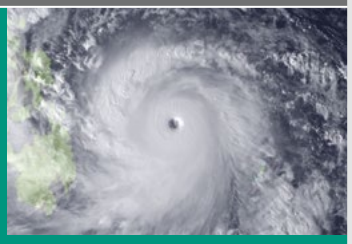
Geothermal energy researchers need seclusion. Not, because they are loners, but because their sensitive measurement devices otherwise would supply incorrect data. "Geophysical measurements serve to study the underground with the help of electromagnetic waves," says Sebastian Held, doctoral student of the Geothermal Energy Division of the KIT Institute of Applied Geosciences (AGW): "A washing machine in the cellar is a source of interference." To study geophysical processes without such interference or noise caused by civilization, KIT scientists conduct research near the volcano of Villarica in Chile, far away from any settlements. A new measurement campaign will start in spring this year.

"Although geology in Chile differs from that in Germany, of course, the studies there yield findings that will also advance the use of geothermal energy in Central Europe," says Professor Dr. Thomas Kohl, Head of the Geothermal Energy Division. Since 2012, the scientists have been cooperating with CEGA, the Centro de Excelencia en Geothermia de los Andos, an organization of the five most important universities of Chile. The joint project in which Dr. Eva Schill from the KIT Institute for Nuclear Waste Disposal (INE) also is involved and that is funded by the BMBF is aimed at studying and optimizing the use of geothermal energy in the Andes.



Geophysical research area of the KIT researchers: The Villarica volcano. (Photo: KIT/Held)

The planned research trip, however, will not focus on geophysics, but on geochemistry. Sebastian Held explains: "We will take water samples from the hot springs in the area of the Villarica and characterize them chemically. This will allow conclusions to be drawn as to how the water moves below ground, how it is heated up, and which geological processes play a role." In the long term, such findings are necessary for the design and planning of new geothermal power plants. So far, only about two dozens of geothermal power plants have been built in Germany, which is why knowledge on geothermal energy as a renewable energy source needs to be enhanced.



A Shrinking Sea

KIT Coordinates the DESERVE Virtual Helmholtz Institute

The Dead Sea is shrinking. "Every year, the sea level drops by about 1 m," says Dr. Ulrich Corsmeier of the Troposphere Research Division of the KIT Institute of Meteorology and Climate Research. This affects the ecosystem and the living conditions of the local population. These modifications and potential countermeasures are studied by the virtual Helmholtz Institute "DESERVE" – "DEad SEa Research VEnue." The project is coordinated by the KIT. Among the project partners are the Helmholtz Center Potsdam – German Research Center for Geosciences (GFZ) and the Helmholtz Center for Environmental Research, Leipzig (UFZ) as well as partners from Israel, Jordan, and Palestine. "We cooperate very closely with the universities there," Corsmeier says. "They contribute vast expertise, enabling reliable results and sustainable successes."

Water loss on the Dead Sea: With the help of such measurement stations, KIT researchers determine the extent of evaporation. (Photo: KIT/Corsmeier)

DESERVE is an interdisciplinary project. "We focus on geology, hydrology, and meteorology," Corsmeier, a meteorologist, says. He concentrates on the water balance of the Dead Sea, which is determined by water inflow, water outflow, water extraction, and evaporation. Together with the project partners, three meteorological measurement stations were built on the bank of the Dead Sea in early 2014. These stations are located in the dry area, in the reed area of a tributary, and directly near the open water. "For two months in the summer and in the winter respectively, measurements are also carried out using the KITcube," Corsmeier adds. "This is our mobile integrated observation system consisting of instruments for the detailed determination of the condition of the atmosphere."

Other teams study the sink holes, i.e. karst holes that are formed when tributaries meet with salt inclusions in the rocks and wash them out. "These sink holes have diameters ranging from 10 to 30 m. When they collapse, the sweep away entire houses," Ulrich Corsmeier explains. "Geologists and hydrologists analyze their development in order to better identify endangered areas." DESERVE also extends beyond research. "We cooperate extensively with local partners," Corsmeier describes his experience. "DESERVE brings them closer together and contributes to a better understanding of the people in this region."

INTERNET:
www.deserve-vi.net

"Haiyan": A Cyclone of Extraordinary Power

With a maximum wind speed of about 380 km/h, typhoon Haiyan was one of the most powerful tropical cyclones that devastated parts of Southeast Asia in November last year. In particular, the wind speed at landfall – it exceeded 310 km/h – was remarkable from the meteorological point of view. "Normally, typhoons reach highest wind speeds on the open sea," meteorologist Bernhard Mühr explains. "When they reach land, they often have already lost strength. As a result of friction effects above land and reduced humidity that affects the energy of the typhoons, they rapidly lose power."

"Haiyan" reached its highest power directly before landfall and passed the Philippines without slowing down. Mühr and his colleagues from the Center for Disaster Management and Risk Reduction Technology (CEDIM) quickly realized that the typhoon would cause extraordinarily severe damage. Directly after the beginning of the catastrophe that killed several thousands of people, they started to estimate the socioeconomic impacts of the tropical cyclone. To what extent will houses and roads be destroyed? Will power supply be interrupted? To what extent will industry be affected? These were only some of the questions the experts tried to answer by evaluating numerous data sets.

Weeks after the devastating cyclone, it became obvious that the models used had prognosticated the damage well. However, the analyses of the CEDIM researchers go beyond a mere description of the catastrophe: They provide information as to what has to be done in order to better prepare for comparable events in the future.

The image taken by the MTSAT satellite of the Japanese Meteorological Agency on November 11, 2013 shows the supertyphoon "Haiyan" moving from the east towards the central parts of the Philippines. (Source: NOAA)

INTERNET:
www.cedim.de/typhoon-haiyan.php
www.wettergefahren-fruehwarnung.de/Ereignis/20131109_e.html

Bad Climate above West Africa

KIT Scientists Work on Better Forecast Models for the West African Climate

Rapid growth regardless of man and the environment: Everybody will associate this with Southeast Asia at first. "In some regions of West Africa, however, the situation is similar and in some respect, even more dramatic," Professor Dr. Peter Knippertz says, who works as a scientist at the Troposphere Research Division of the KIT Institute of Meteorology and Climate Research. "There, the population increases rapidly, forests are cleared, industries and cities are growing. Often, outdated technologies and machines are applied. This is true in particular for road traffic, where cars that have been sorted out in Europe are rather abundant." High air pollution is the consequence. Its impacts on the climate are studied by KIT scientists together with cooperation partners from eight European and African countries under the DACCIWA project: Dynamics-aerosol-chemistry-cloud interactions in West Africa. The project coordinated by the KIT is funded by the EU with a total of EUR 8.75 million for a duration of four and a half years.

Exhaust gases emitted by road traffic, factories, households or fire clearing have a strong impact on cloud formation. Smallest particles in the air, the aerosols, are condensation nuclei for air humidity. If the aerosol concentration is high, cloud formation changes, and this may affect the climate system under certain circumstances. "Air circulation above West Africa is linked with the Indian monsoon system and influences Atlantic climate phenomena," Knippertz says. "Regional impacts of air pollution on the West African coast have hardly been studied so far, not to mention global impacts."

This is where DACCIWA comes in. The scientists first want to create a database by measurement campaigns on the ground, in the air, and via satellite. The measurements will help the meteorologists better understand which impacts air pollution and natural factors, such as evaporation, precipitation or solar irradiation, have on cloud formation in this tropical region. "In addition, they shall be used for the development of new climate and weather models," Knippertz defines a practical objective of DACCIWA. "Forecasts of monsoon rains and long-term climate changes will be improved for the local people to better prepare for the foreseeable climate change."

Old lorries that have been sorted out in Europe pollute the air in West Africa. (Photo: KIT/Knippertz)

INTERNET:
www.aerosols-climate.org

Research Goal: Weatherproof Roads

With more than 12,500 km of motorways, Germany has one of the densest motorway networks in the world. However, the condition of the roads partly is deplorable due to potholes, ruts, or cracks. With climate change, the problems will even aggravate in the future, experts think. Longer heat waves, extreme rainfall and snowfall, and more frequent changes between freezing and thawing will adversely affect the roads.

"In the winter, roads are exposed to temperatures down to -20°C. In the summer, temperatures reach up to +70°C," explains Professor Ralf Roos, Head of the Institute of Highway and Railroad Engineering (ISE). "We need construction materials that are more stable in these wide temperature ranges even when heavy goods vehicle traffic will increase as predicted."

At high temperatures and under high loads resulting from e.g. heavy goods vehicle traffic, asphalt is deformed and ruts develop. (Photo: KIT/ISE)

The problem: Asphalt containing bitumen "melts" at high temperatures. Under loading, the road cover may deform and ruts may result. Under cold conditions, the road surface cracks and water may enter. If this water freezes, it expands and the asphalt cracks. At ISE, researchers study new asphalt recipes. For example, they add polymers or nanoparticles to the mix of stones and bitumen in order to increase temperature tolerance.

Concrete surfaces also expand at high temperatures. "Stresses in the material increase to such an extent that individual plates are literally blown up," Ralf Roos says. "Our idea is to stabilize the road surface by a steel reinforcement and to cover it with a thin asphalt layer only. The entire construction is rather stable and survives the load much better."

Roos admits that the construction of such roads is much more expensive. However, the investment is worthwhile, as the number of repairs is reduced and associated traffic obstructions are prevented.

INTERNET:
www.ise.kit.edu

Alpine Karst – Tracking Traces in the Underground

A can with dye powder is among the most important items hydrogeologists of the Institute of Applied Geosciences take along when leaving for field studies in alpine karst areas. With the help of tracing experiments, they want to determine flow paths of water through the jointed rocks below ground.

Why? About 25% of the world population are supplied with drinking water from karst areas. Water supply of some cities, like Vienna, Rome, or Innsbruck, is entirely covered by karst aquifers. Karst water often has a good chemical quality. However, groundwater aquifers are highly susceptible to microbial pollution. Through thin soil layers or open crevices, germs from wastewater or agriculture may easily penetrate into the underground.

On its way through the underground network of tubes and caves in the rocks, the water is hardly cleaned. "If you want to protect water quality, you have to know the catchment area," Professor Nico Goldscheider explains. "In karst areas, this is difficult, because the catchment area may often be very large and geologically complex."

And this is where the can with dye powder comes in: At small creeks that disappear in the underground, the researchers dissolve the powder and pour it into the water.

Researchers use dyes to track underground flow paths. (Photo: Goldscheider)

Then, they have to wait, take samples, and measure precisely. Where do which amounts of the traced water arrive? The measurement results allow conclusions to be drawn with respect to the flow rate and the flow paths. At the moment, the scientists are working in three alpine karst areas. One of them is the Bavarian Wetterstein mountain range where several large-scale tracing experiments in the past years helped to identify underground flow paths.

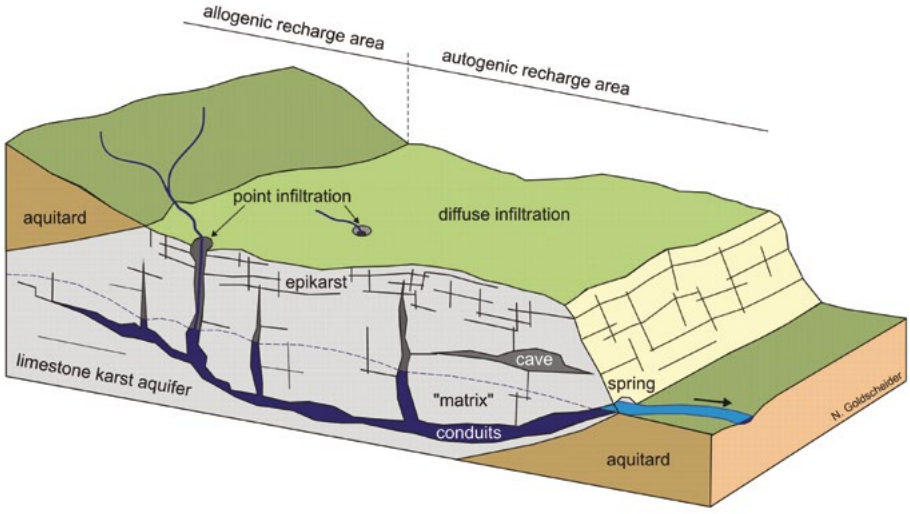


Diagram illustrating the hydrogeological function of a karst aquifer.
(Diagram: Goldscheider & Drew 2007)

An already well-studied karst area is Hochifen-Gottesacker in the border region of Germany and Austria. Here, KIT hydrogeologists are working on simulating the hydraulic behavior of this karst system by a computer model. In the future, this model may be used as a prognosis instrument: "It can be applied to model how the system reacts to climate change with earlier melting of the snow or longer dry periods," Goldscheider says.

Climate change also is in the focus of an EU-funded research project (IMKA) of Dr. Nadine Göppert. She wants to find out how extreme rainfall will affect water resources in the Lechquellen mountains. In the future, the number of extreme rainfall events is expected to increase on a regional scale. Apart from tracing experiments, Göppert continuously measures the water volume and quality of karst springs. Often, extreme rainfall causes the drinking water quality to deteriorate.

INTERNET:
www.agw.kit.edu/3851.php
www.agw.kit.edu/imka.php

(Photo: Private)

Peter Knippertz

At the beginning of this year, Professor Dr. Peter Knippertz came from Leeds in Great Britain to work at the KIT Institute of Meteorology and Climate Research (IMK). "I am interested in analyzing physical processes in the atmosphere," the meteorologist says. "Understanding these processes is important to further improve weather and climate models." The IMK offers perfect equipment for this work, such as the KITcube, a mobile integrated observation system for the detailed acquisition of the atmosphere. Or the COSMO-ART model that couples weather forecasting with air chemistry and aerosols. Application is of high relevance to Knippertz, an example being the DACCIWA research project that focuses on anthropogenic impacts on the climate in West Africa (Page 3).

(Photo: Westermann)

Zev Levin

Prof. Dr. Zev Levin has been working in the fields of cloud physics, atmospheric aerosols and weather modification for many years. He is for an open-minded debate about geoengineering for climate mitigation. In April, the former Vice President for Research and Development and Dean of the Research at the Tel Aviv University came to Karlsruhe to receive the "Helmholtz International Fellow Award". The topic of his lecture: Things we learned from cloud seeding. "There are conflicting assertions as to whether this technology, which is supposed to increase the amount of rainfall, actually works. I am sceptical about claims of success of cloud seeding, thus when it comes to geoengineering for climate mitigation, one should carefully research and weigh the benefits and potential side-effects", Levin says.

(Photo: Private)

Bernhard Mühr

A strong windstorm or a powerful thunderstorm are preferred to weeks of boring sunshine by Bernhard Mühr. "I like it when it is a little turbulent." This love is also reflected by the professional activities of the meteorologist. At the Center for Disaster Management and Risk Reduction Technology (CEDIM), he regularly deals with natural disasters. Floods, hurricanes, winter storms, cold waves, and other extreme events are analyzed and assessed comprehensively and rapidly by Mühr and the other CEDIM scientists.

Ten years ago, the information portal www.wettergefahren-fruehwarnung.de was established. Since then, it has been run by Bernhard Mühr and several colleagues. Whoever needs information about unusual weather events, will find it there. Mühr and his colleagues provide detailed information about nearly 1000, also imminent, extreme weather events worldwide.

Professional studies of extremes possibly compensate the fact that Bernhard Mühr has spent most of his life in Karlsruhe, a "meteorologically rather calm region," as he says with a slight regret. Since the completion of his studies of meteorology at the University of Karlsruhe, Mühr has carried out a number of research projects and been active in teaching students at the Institute of Meteorology and Climate Research, IMK-TRO.

Apart from disaster research, the meteorological know-how of Bernhard Mühr is sought after, for instance during the Olympic Winter Games at Sochi. For the competitions, Mühr, together with a colleague from the Weather Center (www.wetterzentrale.de), made high-resolution weather forecasts, exclusively for the German Olympics and Paralympics teams.

And what about his private life? For his hobbies of mountain biking or climbing, Mühr prefers stable weather. As for the rest, his motto is: "Boredom of the weather is boring."

KIT Climate and Environment Center

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No Export of Risks!

An Appeal for a Differentiated Discussion of Fracking in Germany

By Professor Dr. Frank Schilling

Opponents of fracking fear that the chemicals used for drilling will contaminate the environment. (Photo: iStockphoto)

Cars, electricity from the socket, genetic engineering or fracking: Any technology is associated with opportunities and risks. Many technologies are used by us as a matter of course. We do not want to do without the advantages resulting for our speed, comfort or health. Some technologies, however, are discussed extremely critically and their use is highly difficult in Germany at least. An example is "hydraulic fracturing". A public, also controversial, discussion of this topic is needed, but it should be based mainly on facts rather than on emotions. Although it is a technology with various applications, I will refer to the extraction of shale gas by fracking exclusively.

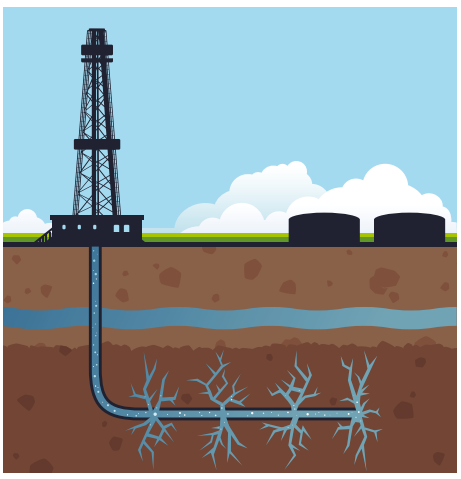
How does this hydraulic fracking work? First, companies drill boreholes. Depending on the geology, vertical boreholes are drilled down to a depth of about 1500 m. Then, they proceed in horizontal direction through the geological target formation for about the same length. There, the rocks are broken up with water under high pressure in predefined areas (hydraulic fracturing). Sand grains in the water are introduced into the cracks formed in order to keep them open. Up to 2% of mainly organic substances are added to the water-sand mixture to increase the viscosity, similar to a thin pudding. In this way, the sand can be transported horizontally and into the cracks. Without these additives, it would deposit at a deep point and clog the borehole.

The process described above in a rather simplified manner gives rise to various concerns in public discussion. Let us first concentrate on the potential hazards for the environment and health. At every drilling site in Germany, ground sealing and oil separators are required to prevent chemicals from being released into the environment in an uncontrolled manner. Still, the risk remains that some substances may enter the ground when they are decanted. When drilling boreholes, observation of water protection areas therefore is as important as when building petrol stations. The borehole is lined with concrete and steel in order to protect the groundwater aquifers. After extraction, the hole has to be closed with seals of concrete and clays that are several meters long. This prevents the fracking fluids from entering the groundwater.

How dangerous are the chemicals? Apart from water and sand which are both non-toxic, organic compounds are used, with and without biocides. The same biocides are used in skin creams and paints, with their concentrations exceeding that of the fracking fluid by far. From creams or paints, biocides easily enter the environment. During fracking, they remain deep down in the bedrock. Fracking fluids of high density do not rise automatically to the top, even less through concrete and clay seals. Moreover, the mixtures have been improved to such an extent that fracking now can be accomplished without biocides. The fluid is easy to decompose biologically.

And what about the damage of buildings due to tremors? This might be possible, in my opinion, but heavy duty road traffic and road construction cause much stronger vibrations than expert drilling of fracking boreholes. Moreover, operation companies are obliged to compensate damage, if cracks develop in walls or roads, as are road construction companies. I consider it to be nearly impossible that expert fracking causes structural damage of buildings.

My conclusion: Germany imports energy. At the same time, we export our "consumption of the environment", examples being the Niger delta, leaking pipelines in the Russian tundra, or oil production in the Gulf of Mexico. Shouldn't we extract gas in Germany according to our local standards with a far smaller environmental risk, and with high safety standards being required and observed? I am in favor of seriously examining fracking in potentially suitable geological formations in Germany as one element of a transformed energy system and secure energy supply.



Using a water-sand mixture, the rock is broken up under high pressure. (Photo: iStockphoto)

Urban Research at KIT: A Contribution to Sustainable Urban Development

Research at KIT contributes to the investigation and design of the city of the future. It is characterized by the existence of the required expertise for sustainable urban development. In an holistic approach all functional and life areas of a city are investigated. The researchers have identified the following challenges for urban areas:

- Efficient and sustainable use of resources
- Developing and connecting infrastructures
- Preserve and ameliorate quality of life
- To prevent risks in cities
- To plan and design a city
- To analyze, finance and control the urban system.

What Can Be Learned from the Past about the Relationship between the Development of the Population and the Climate?

Prof. Gerald Haug (ETH Zurich) gave answers to this question at the KIT Climate Lecture on "Climate and Man" on 15 October 2013. The audience of about 150 people got carried away by his talk at the Gartensaal of Schloss Karlsruhe.

Prof. Neumann (KIT), Prof. Haug (ETH Zurich), Prof. Wanner (KIT), and Prof. Schilling (KIT) at the KIT Climate Lecture, October 2013. (Photo: Westermann)

Audience at the Gartensaal on October 15, 2013. (Photo: Westermann)

In his talk Prof. Haug explains the influence of man-made changes such as greenhouse gas emission to the carbon cycle. He also describes the consequences of global warming like sea level rise or the shifting of climate zones. Prof. Haug further illustrates how analyzing drilling cores contributes to the investigation of cold and warm periods in the past. To slow down the recent man-made climate change it would be necessary to uncouple emissions from a rising world population. Prof. Haug reckons that energy efficiency and the use of renewable energies are key technologies for this.

KIT Fund-raising for Reconstructing the University of Tacloban

On November 7, 2013 typhoon Haiyan caused widespread devastation across the Philippines. One of the most severely hit area is the island of Leyte and the city of Tacloban with a population of more than 220.000. KIT scientists informed about facts regarding the disaster ranging from the origin of typhoons to a disaster analysis. More 100 people came to a fund-raiser event on November 19, 2013.

The fund-raiser was initiated by Jürgen Christmann (IfGG/WWF Aueninstitut) who used to work at a university at Tacloban. The collected money will be donated to the University of the Philippines Visayas Tacloban College, Regional Environmental Information System (REIS).

International Workshop for COSMO-Art Users

Back to school – this is what 21 participants from nine countries did on 24 and 25 February this year to join the international training course organized by the institute for meteorology and climate research (TRO) and the Deutscher Wetterdienst (German Weather Service).

The modeling system COSMO-ART was developed at KIT and has been adopted by several weather services, universities and research institution worldwide. The special feature of this system is the implementation of modelling distribution and transport of aerosol and emissions and their influence on clouds and radiation.

The next international training course will take place in early 2015.

Rain Enhancement by Cloud Seeding?

Presentation of the Helmholtz International Fellow Award (left Prof. Levin, right Prof. Löhe) (Photo: Westermann)

In an intriguing lecture Prof. Zev Levin talks at the KIT Climate Lecture on April 8, 2014 about the history of cloud seeding and the Israeli experiences since the 1960s. First apparent success could not be proven statistically or be reproduced in other countries.

In the frame of this event, Prof. Löhe (KIT Vice President for Research and Information) presented the Helmholtz International Fellow Award to Prof. Levin for outstanding scientific research in his area.

App "Dein Klima" (your climate) showing "Klima Standpunkte" in Karlsruhe (in German only)

App "Dein Klima"
www.sueddeutsches-klimabuero.de/1472.php

The South German climate Office's first app "Dein Klima" can be downloaded. In the app twelve locations having a special significance for the climate of the city of Karlsruhe are presented. The user can easily find the fastest way from his current position to the chosen "climate location" (Klimastandpunkt) in an interactive map. "Dein Klima" is available for mobile devices iPhone, iPad and Android.

GRACE Supports Young Careers

Fadwa Alshawaf (Photo: Private)

In the past year, nine doctoral students successfully completed the GRACE Graduate School. One of them was among the youngest Muslim female doctoral students of a technical discipline. At the age of 29, Mrs. Fadwa Alshawaf completed her doctorate in November last year and will now continue her research work at the KIT until the end of next year at least.

Fadwa Alshawaf was born in Palestine. In 2007, she came to Germany with a DAAD scholarship and together with her husband and her little son. At the Technical University of Munich, she completed her studies of communications engineering by a master in 2009. In the following year, she moved to the KIT in Karlsruhe. In cooperation with the Geodetic Institute, she started her doctorate at the Institute of Photogrammetry and Remote Sensing and completed it successfully last November. "I was very lucky," Mrs. Alshawaf describes her rather swift career so far.

And she was also lucky to attend the GRACE Graduate School. "With its focus on climate and the environment, GRACE fit well to my doctoral thesis," Mrs. Alshawaf says. Based on satellite-based remote sensing data, her thesis concentrated on the precise determination of atmospheric water vapor. This will allow for more correct weather forecasts or climate estimates. "The different events, intensive courses, and lectures by experts were a great help," Fadwa says. "And it was highly useful to discuss with the other doctoral students, to exchange information, and gather ideas."

With the support of GRACE, Fadwa attended the EuSAR conference in Nuremberg in 2012 and presented her research project. She has not yet been able to conduct research abroad. With a small child, this has to be organized very much in advance. But Fadwa Alshawaf keeps at it: "We will see, maybe this year."

Water Research at KIT

From Fundamental Research to Technology Development

A newly established coordination office will sharpen and enhance KIT's water research profile in the future. Last fall, Dr.-Ing. Ulrike Scherer started work at this office that is part of KIT's Division IV, Natural and Built Environment.

Water research at Karlsruhe has a long tradition and plays a central role within KIT's environmental research activities. In all areas extending from water supply to wastewater technologies to impacts of climate change on the water cycle to the protection of water resources, water is in the focus of research conducted by numerous KIT institutes. Apart from fundamental research, KIT is committed to developing mature technologies and services for the benefit of society.

In the next months, Ulrike Scherer will interlink research activities on the University Campus South with those of the Research Campus North. She plans to help intensify cooperation and to coordinate joint proposals. Her work will also focus on the development of an international master's program that is to start next year.

In autumn this year, one highlight will be organized for water researchers: An AGU Chapman Conference on "Catchment Spatial Organization and Complex Behavior" in September will take place in Luxemburg. It will be organized by scientists of the German-Luxemburg DFG research group CAOS (Catchments as organised systems).

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