Portal Wissen

The Research Magazine of the University of Potsdam

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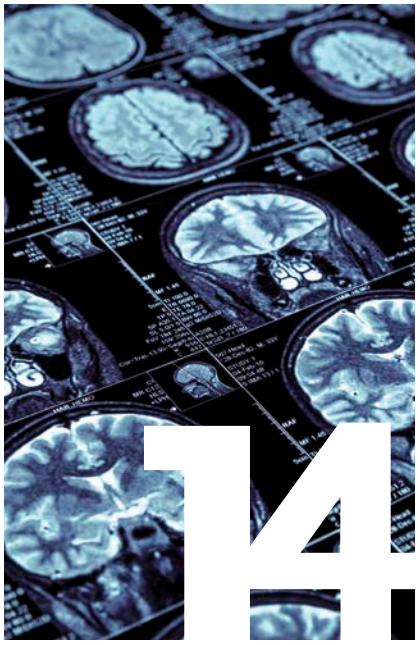

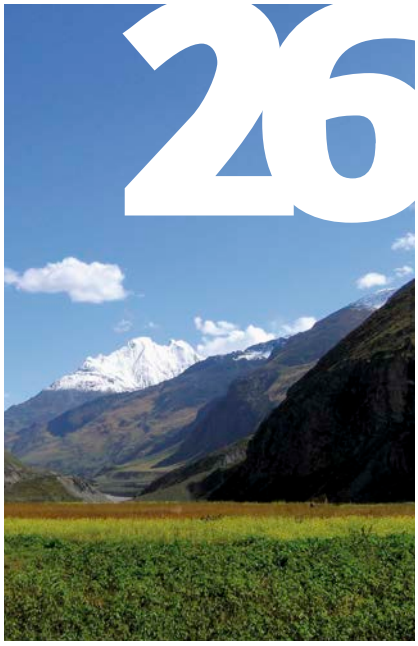

Contents

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rich

The current issue of *Portal Wissen* is entitled "reich", a German word with several meanings. Both an adjective and a noun, it can be translated as rich, wealthy, and abundant, or realm, empire, and kingdom. It is also part of words like *Reichtum* (wealth, fortune), *Reichweite* (reach, scope), *lehrreich* (informative, instructive) and *ruhmreich* (glorious, renowned*).

Realms – a complex subject. While the worldly empires of mankind come and go, even if they often claim the opposite, and the eternal existence of the kingdom of heaven has not been credibly proven, another and much older realm has an almost inexhaustible wealth – the animal and plant kingdom.

Speaking of wealth: Some people are rich and want to stay rich at any price. Others still want to become rich and are looking for a path to wealth – some for the fastest, some for the easiest, and some for the perfect path. There are even people who want to leave nothing to chance and use a scientific approach, for example the American author Wallace D. Wattles, who published the book *The Science of Getting Rich* in 1903. His essay was intended for "for the men and women whose most pressing need is for money; who wish to get rich first, and philosophize afterward." He was so convinced of his work that he even offered a guarantee of success. Anyone who followed his manual would "undoubtedly become rich because the science that is used here is an exact science, and failure is impossible."

Wattles has been almost forgotten, but the secret of wealth – at least financial wealth – seems anything but deciphered. Some have got it, others want it. There are worlds in between – as well as envy, prejudices and ignorance. More than enough reason for us to look again at Wallace D. Wattles and his self-confidently presented alleged relationship between wealth and science, and to say: Yes! Of course, science makes us rich, but primarily rich in perception, experience and – in knowledge. Science in itself is not glorious but instructive. The great thing is: All can equally benefit from the wealth created by science at the same time. Nobody has to get rich at the expense of others, on the contrary: You can often achieve much more together with others. Everything else comes (almost) by itself. "Those who acquire knowledge are richly rewarded by God," is the religiously informed praise of sciences by the Islamic prophet Muhammad.

The current issue of the *Portal Wissen*, however, focuses on facts, which is admittedly not in style at the moment. We therefore invite you to a tour of the University of Potsdam and its partners. It is about studies on the rich biodiversity of porpoises and lab mice. We present a historian who studies rich church treasures and talk with an education researcher about the secret of financial wealth. German philologists explain the rich language of literary criticism in the era of Enlightenment, and we follow a geo-scientist into the mountains where he moved large boulders to find the right stones. It is also about the cities of tomorrow, which have many high-rise buildings but are still (rich in) green, abundant water from once-in-a-century flash floods, and insects as an alternative to a rich diet of tomorrow. We take you to the border area of two disciplines where law and philosophy work hand in hand, talk with two literary scholars who are studying the astounding reach of the *Schlager* phenomenon of traditional German-language pop music, and learn from a sustainability researcher how to work together to achieve long-term solutions for pressing global problems.

We wish you a pleasant read!

THE EDITORS

* The editorial of the German issue plays on the various meanings of the word "reich" that are difficult to translate.

Mealworm muffins.

TeneTRIO is a startup in the pre-setup phase that develops dog treats containing mealworms as protein source. The insects are highly nutritious and require just a fraction of the resources required for the production of the same amount of conventional meat sources. TenePops is, therefore, a healthy and sustainable alternative to the snacks currently available. TeneTRIO covers the entire value-added chain from the regional breeding of the mealworms to their processing and production as well as the marketing and sales of the final product.

http://tenetrio.de

Photo: Fritze, Karla

The Early Bird Catches the Worm

Nutritionists develop an insect-based dog treat

They are a healthy, protein-rich, and very common food in Asian and South American countries: Crickets, mealworms, and locusts enrich the daily diet of some two billion people and provide a sustainable alternative to conventional meat sources. After all, the production of an insect meal uses up only a fraction of the resources required for a steak or pork filet, yet it may be some time before insect snacks become a part of everyday life in Europe. There may be fewer obstacles, though, when it comes to pet food – such as mealworm-based dog treats.

You wouldn't notice them at first glance. Only every so often is there movement in the white flour, between slices of carrot and apple. Ina Henkel carefully brushes some of the flour aside in a flat plastic tub. Pale yellow worms writhe. The nutritionist points to other plastic tubs lined up on the shelves of the small room, which also contain mealworms. Some of them are mere millimeters long, while others are up to three centimeters. "These are in adult stage," the researcher explains, pointing to brown-black beetles crawling through the milled grain. "They can't fly," Henkel reassures. A female mealworm beetle lays some 500 eggs, ensuring the next generation.

Mealworm snack is healthy and sustainably produced

The mealworm breeding being done by Henkel and two colleagues at the Institute for Grain Processing (IVG) in Nuthetal is the basis of a business idea. The founders developed a mealworm-based dog treat that is both healthy and sustainably produced. The three women hope their startup "TeneTRIO" fills a niche in

THE RESEARCHER

Dr. Ina Henkel studied nutrition science at the University of Potsdam and obtained her PhD in 2013. In 2017, she founded the startup "TeneTRIO", which produces mealworm-based dog treats.

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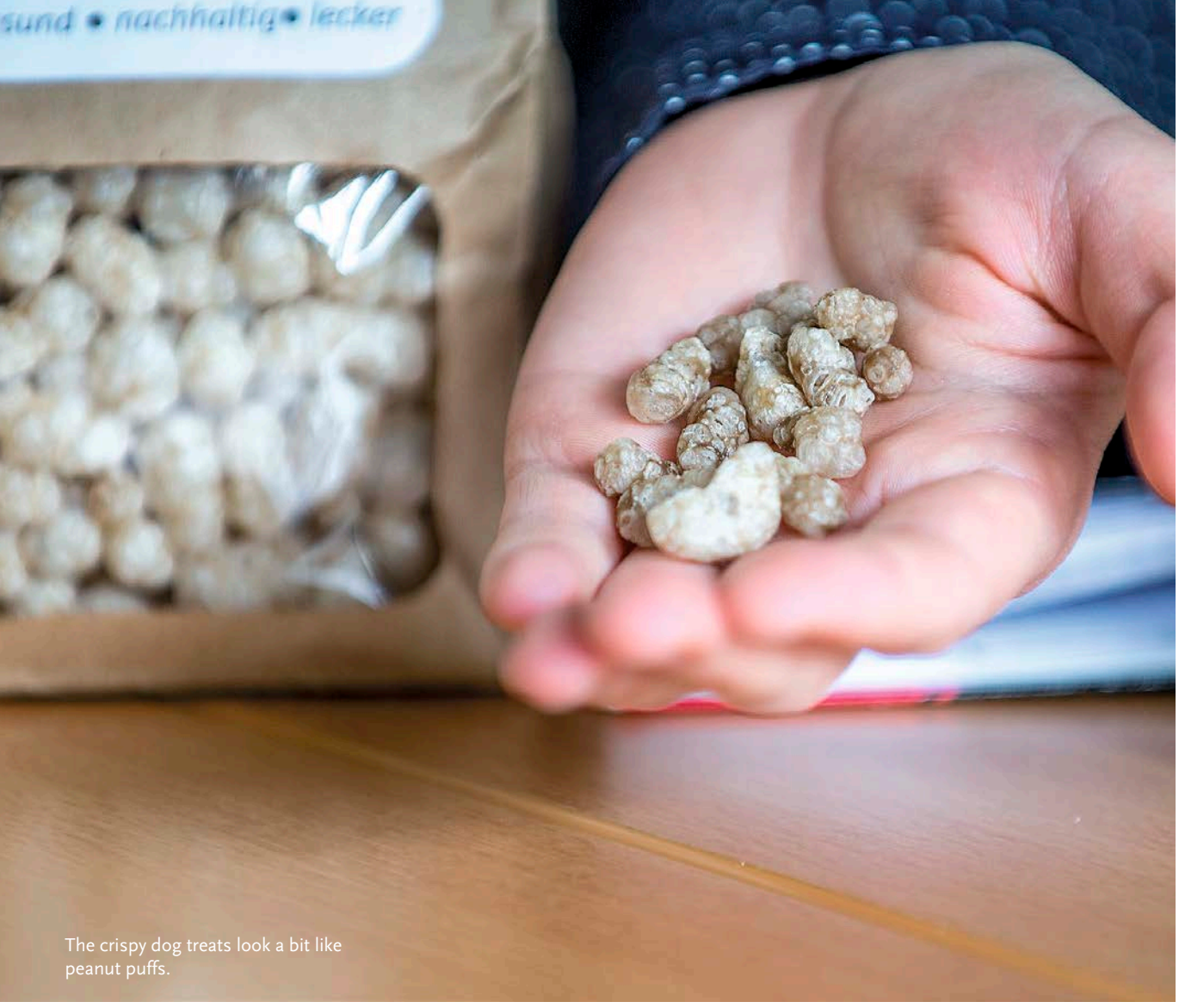
Photo: Fritze, Karla



The crispy dog treats look a bit like peanut puffs.

the booming pet food market, laying the groundwork for using insects as valuable protein sources.

It all starts with a rather unpopular animal. Twelve weeks after hatching, just before pupating, the large mealworms are ready to be harvested and processed. The entrepreneurs mix the ground-up worms with rice. The mixture is then heated in an extruder and, under high pressure, converted into a product not identifiable as containing insects.

"Natural, healthy, sustainable, delicious" is written on the brown bag from which Henkel takes some of the small, crispy dog treats. They look a bit like peanut puffs. "What's special about our snacks is that they contain only two ingredients: ground-up mealworms and rice," the researcher explains. No additives such as flavor enhancers or preservatives are used, so dog owners can give their pets a guilt-free treat. According to Henkel, the mealworms taste "nutty and savory". To optimize their flavor, the researchers test out different flour mixtures: A worm fed on spelt flour tastes different than one fed on only wheat flour. "We use a special mixture," the researcher says. And that mixture resonates with pets, the entrepreneurs found out at initial 'tastings' at dog grooming schools.

Chocolate-covered worm snacks.

Also as a nutritionist, Henkel is convinced that the mealworm snack is healthy: Mealworms contain a higher percentage of polyunsaturated fatty acids than fish, more biotin and magnesium than spinach, and the quality of their protein is comparable to that of beef. They are also energy-rich: 100 grams of mealworm larvae fulfills a quarter of a human's daily energy requirements.

Photos: Fritze, Karla (2)

Dr. Ina Henkel.

Mealworms in "their element".

Insects as food – it just takes a little getting used to

Health considerations are not the only argument for using the insect as a nutritional source: "It takes just 4,000 liters of water to produce a kilogram of mealworm – compared to 15,400 liters for a kilogram of beef." Other comparisons of resource consumption speak in favor of the mealworm: only 15 square meters of land per kilogram is consumed in producing mealworm versus 200 square meters for beef. "The difference is drastic," the researcher underlines. And that's not all: For every kilogram of beef, farmers use 10 kilograms of grain as animal food, whereas mealworms need just 2 kilograms. Another environmental perk of using mealworms is that they can be completely utilized, whereas only 40 percent of a cow's body is fit for consumption. In short – the worm is a sustainable alternative to conventional meat sources.

This also holds for human nutrition. Insect meal in burgers or granola bars could very soon become a reality in Germany, too. In a survey, up to 80% of respondents appear open to using insects as protein source – provided that the creepy-crawlers are not recognizable as such in the food. In Germany, though, processed insects are not allowed for human consumption unless they have passed a complex – and expensive – approval procedure. "The Novel Food Regulation bans their use," Henkel explains. But things will be changing soon. Even today, Belgium and the Netherlands interpret the Regulation less strictly. In these countries, noodles containing insect meal are already available in supermarkets. In 2018, the EU Regulation will be reviewed. Henkel expects the go-ahead is likely to be given for insects in food.

But until then, a lot of educational work needs to be done. "The yuck-factor should not be underestimated," the researcher admits. Culturally, people are not used to seeing insects as either healthy or delicious ingredients. And the public is not yet aware of the extent of the environmental impact of rising meat consumption on the environment. "20% of all arable land is used for pet food production alone," Henkel says.

Insects on your plate? This idea may require some getting used to. "Eating insects for the first time took me quite a bit of effort, too," Henkel admits. But it is no longer unusual for her to use insects in her cooking. Nor is it unusual for her family. "The first thing my daughter eats from a quiche are mealworms," she says with a laugh.

HEIKE KAMPE
TRANSLATION: MONIKA WILKE

The University of Potsdam offers an accelerator program to enhance the **qualifications of entrepreneurs planning to start their own business** and optimally prepare them. Initial consultations are followed by an intensive 3-day workshop, and further training is available as needed. TeneTRIO received coaching during its business model development, competitive analysis, team development, and division of labor. The team's application for an EXIST grant was successful, testifying to the program's high standard. Under this grant, the Federal Ministry for Economic Affairs and Energy will be supporting TeneTRIO's innovative startup project for a full year.

www.potsdam-transfer.de

Photos: Fritze, Karla (2)

Daring to Take a Risk

Why wealth is also a matter of character

Photo: Fritze, Karla

"You don't talk about money – you just have it! Those who have money do not talk about it." Sociologist, social science education and social inequality researcher Prof. Dr. Wolfgang Lauterbach refused to accept this saying and dug deeper. And his digging proved fruitful: he is now researching social inequality, especially wealth in Germany, on behalf of the federal government. For the current poverty and wealth report of the German government, he did a study on "high net worth individuals in Germany" for which he interviewed 130 millionaires. The study focused not only on two frequently discussed aspects: How much wealth someone has, and how wealthy people deal with their assets. Lauterbach – as an educational researcher – was more interested in finding out whether the character and education pathways of the wealthy differ from those of the rest of the population.

Why do you study wealth and not poverty?

Actually, poverty is well researched and documented. There is a relatively precise definition of poverty, and we know comparatively well who is poor, how they became so, and what their level of education is. On the other hand, we know almost nothing about wealthy people: What is wealth? How can it be determined? Who is wealthy, and how do they become so? Is wealth based on personality, educational level, inheritance, or a brilliant idea and the competencies of an entrepreneur? We have no answers to these questions ...

Why is that?

"Wealth" as a phenomenon is not anchored in any particular academic discipline. It is generally addressed in connection with inequality. Very few people in Germany research this field, for historical reasons: After World War II, there was a clear cut. Wealth imbalances in Germany were more or less evened out by large-scale confiscations of wealth in the eastern part of Germany, also due to reparations, while wealthy people of Jewish faith had escaped to the US or been killed in concentration camps. As a consequence, inequality was discussed with regard to income only, if at all, for many years. Inequality based on wealth was not relevant before the 1990s.

Why is so little known about wealthy people?

Briefly speaking: Because the relevant data are not available. As Germany does not levy taxes on wealth, we cannot use data from the tax office; there are no registry data. The micro-census – a detailed survey of one percent of all German households – is of no help either, because it caps income data, with the highest income group being defined as "more than EUR 10,000 per month". Historically, it just did not matter for a very long time. And the group we are talking about here is very small: About 1.2 percent of the population is classified as materially wealthy according to the definition, i.e. having a net worth of at least one million Euro.

Why is it important to know more about the wealthy and about wealth in Germany?

For a number of reasons: First, we simply have more of them now. There are now about 1.1 million millionaires in Germany. Second, inheritance has long been high on the agenda. It plays a special role in Germany, where medium-sized companies form the backbone of the economy. These companies may employ some hundred people, but often they are the world market leader in their field, and they are family-owned. Since the 1990s, these families have increasingly had to grapple with who will run the company in the future. We can see the importance of this question in the high rate of ownership transfers. And third, social justice has become more important in Germany over the past years, particularly in the aftermath of the banking and economic crisis, and in many different contexts, such as soaring executive salaries no longer being acceptable for many. An early and prominent symbol of the initiation of the discussion on social justice is the introduction of the official poverty and wealth report of the federal government by the red-green coalition under Gerhard Schröder and Joschka Fischer.

What is the benefit of the report?

Since 2001, every federal government administration has submitted a report on the social situation of German households. The report documents the situation and distribution of the poor, the wealthy, and the middle class and offers – often international – comparisons. Public debate ensues, for instance on what the percentage of the poor would be without redistribution through social security systems. Or: Is the rising inequality between the wealthy and the poor fair? What's new is a debate launched by the U.N., in particular, on general societal hazards: An increasing percentage of poor and undereducated people may even impair a country's economic growth. So does this mean a society cannot afford to allow the gap between the wealthy and the poor to widen? The report has

been discussed, often controversially, for instance with regard to capping executive salaries or to introducing a wealth tax. Some results have found their way into legislation.

How did it come about that you are contributing to the report?

I am one of very few people in Germany who started researching wealthy people some time ago. The first poverty and wealth report of the federal government – referred to as the "poverty report" – was quickly criticized for containing 300 pages on poverty but only 30 on wealth. Even though the government's focus was on poverty and its alleviation, it soon became clear that too little was known about the wealthy, and this needed to be rectified. It was in this context that I was approached and asked to intensify my research. So our first study on high net worth individuals in Germany was compiled. In the current study, which also contributed to the 5th poverty and wealth report, we decided to include personality traits of the wealthy for the first time.

So, who is actually wealthy? Can financial wealth be defined?

It's very simple: the wealthy are those who don't have to work, those who have enough financial assets to live on the returns. However, it becomes clear very quickly that this, too, is relative. Where life "costs less", it takes fewer financial assets to be wealthy. Wealth also becomes more diversified as more and more people begin generating income from non-work sources. For instance, if you own three houses and can make a living off of rental income, you don't have to work anymore, yet you neither belong to the wealthy elite nor have – according to our definition – more than a million Euros in net financial wealth.

THE PROJECT

Comparatively little is known about Germany's wealthy. Empirically grounded knowledge of the wealthy and of wealth is also very scarce. The study **"Ultra-High Net Worth Individuals in Germany" (HViD)** hopes to increase quantitative, scientifically substantiated knowledge in this field. The results will be published in the 5th Poverty and Wealth Report of the Federal Government.

http://www.uni-potsdam.de/sozbildung/forschung/hvid.html

Who participates in this kind of study?

First of all, it has to be said that the 130 respondents in our survey are not representative of all wealthy people; they are just a part. To be included in the study, one had to have financial assets of at least one million Euros, which is why the typical family entrepreneur, for instance, is underrepresented in our study – his assets are invested in the company. But we also lack the "discreet millionaire", the "millionaire next door". They are often not interested in speaking about their wealth to anyone. For our survey, we cooperated with Infratest; they have a panel of wealthy people who are willing to share information.

photo: fotolia.com/Jezper

How was the survey conducted?

The interviews were conducted face-to-face at the respondents' homes using a 35-40-minute questionnaire. In addition to specific questions about wealth, the questionnaire also included typical psychological questions used to determine personality traits. The resulting dataset was analyzed with statistics software. For our study, we combined the interview results with data from the socioeconomic panel to facilitate a comparison with the rest of the population.

What did you look at in your study?

We were especially interested in three points: the genesis of wealth, that is, how one becomes wealthy; the role of inheritance in the generation of wealth; and to what extent the wealthy influence policy. We wanted to find out: Who is this person? How do personality traits of the wealthy differ from those of "everyone else"?

What did you find?

Broadly speaking, ultra-high net worth is built up disproportionately, often through entrepreneurship and inheritance. Some 60 percent of ultra-high net worth individuals run their own business or do business, and two thirds of the respondents stated that inheritance had made an important contribution to their wealth accumulation.

You also looked at the educational attainment and personality traits of the wealthy. What traits does it take to become wealthy?

The wealthy perceive risk differently. They do not necessarily see the world more optimistically or live by the motto: "I can cope with anything!" But they see life changes as opportunities, rate obstacles lower than the rest of the population, and are defiant. And they are more willing to take risks, especially in their jobs. They are accordingly willing to take higher risks when it comes to investments. Fundamentally, there is a clear correlation with educational attainment. None of them had no professional training. Some 57 percent of the respondents held academic degrees, seven percent even a PhD, compared to only one percent of the total population, according to our calculations. In fact, remarkable differences become apparent when you look more closely at the educational biographies of the wealthy: We know that those who build up wealth are different even in school. They do well – though are not necessarily the best – but develop an iron will outside of school. In most cases, they are active athletes. Not at the top level, which they often fail to reach, but at a regional level: district champion in ballroom dance, German runner-up in judo, etc. And this interest, this ability to get things done, this investment, they carry over to their professional lives – and very early on. Many of the ultra-high net worth individuals start doing business at a young age. They weren't working as a supermarket cashier like other kids their age but rather generating their own business, like selling a self-made motorbike repair manual. Even in their early years, they develop a commercial and economic perspective.

What do the wealthy do with their money?

You mean, do they keep it? A significantly greater percentage of ultra-high net worth individuals donate – about 75% of them – and a greater percentage of their wealth – about 1.5% – than others. The most generous are family entrepreneurs deeply rooted in their region, where they also donate. Typical philanthropic motivations are tied to the region, biographical particularities – for instance donating to foundations researching a particular illness that affected the donor's family – or a general global interest. There is also a growing desire to engage with creative individuals. The wealthy are increasingly supporting creative and cultural projects. Many of them draw a clear distinction: The state is responsible for social support, while the wealthy use their money to shape society. This is also why many wealthy people say they would rather donate more than pay higher taxes. They want to influence what is done with their money.

THE RESEARCHER

Prof. Wolfgang Lauterbach studied sociology, political economics, and statistics at Freie Universität Berlin. Since 2007, he has been Professor of Sociological Educational Research at the University of Potsdam.

Speaking of influence: You analyzed whether and how the wealthy influence decisionmakers. Do they?

We asked the wealthy what level of decisionmakers they are personally familiar with. We found that the wealthy are first and foremost locally networked, such as at the level of state parliament, less so nationally or at the European level. To what extent they use these contacts, we don't know.

As a researcher, do the wealthy interest you more than the poor?

No. Poverty is a pressing, important topic. Who becomes poor and why is a sociopolitical challenge that also motivates research. What is different when we look at wealth – and also what makes it interesting – are the "additional" questions it raises: What personality traits are at play? There is a broad range, from very reputable millionaires to very fussy, self-styling characters. Or: What do the wealthy do with their wealth? And above all: What drives them? There is an ongoing debate as to why societies are "top" in some historical stages – and produce wealth as well. What are the drivers? Where does the creative potential come from? Let me give you just one example: Who would have thought 15 years ago that the weirdos putting up wind turbines would now be millionaires?

One conclusion of your study is: "All in all, the ultra-high net worth individuals we interviewed are more satisfied with their lives than the general population." – Does wealth make you happy?

Ask yourself: 9 out of 10 desires are money-related. Scientifically, happiness is measured as satisfaction. In this respect, our study reconfirms that the wealthy are happier than the poor. This is simply because they are relieved from the sorrows of life to a certain extent. They are much better equipped to cushion life crises such as illness, job loss, or something along those lines. Also, many rich people use their wealth to create something lasting, something to pass on. But how much wealth it takes to be happy clearly depends on the society you live in. A number of studies have quantified "happiness" in Western societies at 60,000 US dollars. To some Asian, South American, or African societies, however, this does not apply. Where many fight for survival, much less can suffice for happiness.

QUESTIONS FROM
MATTHIAS ZIMMERMANN.
TRANSLATION: MONIKA WILKE

Studies suggest:
Wealth makes you happy.

Photos: Fritze, Karla (top); Fotolia.com/anyaberkut (bottom)

MRI scan –
A brain in thousand slices.

Photo: Fotolia.com/Nomad_Soul

Multitasking in Old Age

A study researches the connection between balance and thinking

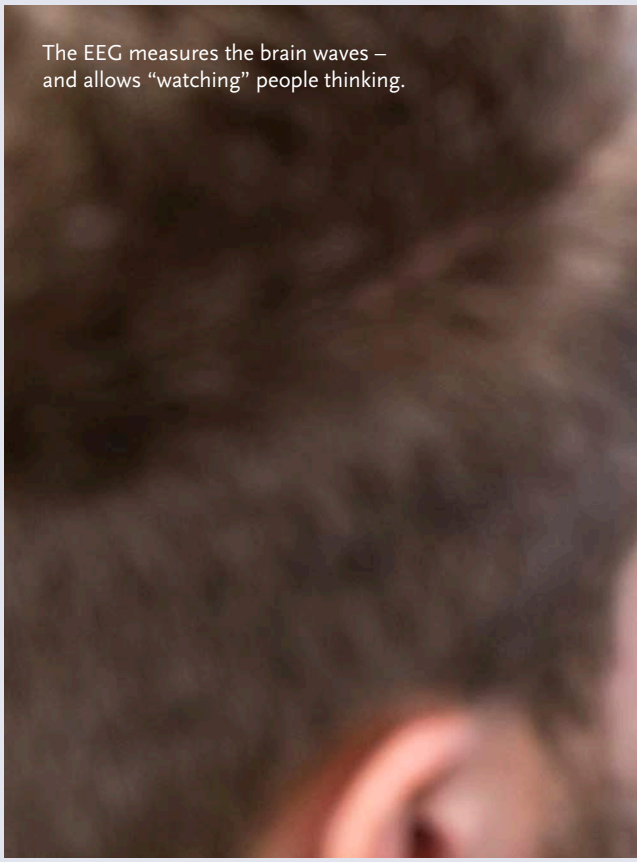
The University of Potsdam. Campus Am Neuen Palais. A bright 28°C. Today I'm going to be a test subject in a study on "the connection between movement and thinking" – and I'm quite curious to see what it's about. For more than two hours, I concentrate on a number of tasks. Admittedly, I switch to power-saving mode during the last one: Whenever squares on a screen pop up in the same place for a second time, I have to – alternately – press a button or speak "yes" into a microphone. But that's not all. While the squares are popping up, I hear sounds at three different frequencies. And here, too, my task is to indicate when a sound occurs for the second time in one ear by pressing the button or speaking into the microphone. As a test subject, I have to concentrate on two different but simultaneous phenomena – and decide whether to use my voice or my hand.

The German Research Foundation's (DFG) priority program "Human performance under multiple cognitive task requirements: From basic mechanisms to optimized task scheduling" supports 22 projects in Germany. One of them has been ongoing at the University of Potsdam since October 2015: "Effects of modality mappings within working memory on postural control, associated neural correlates, and training-induced modulation of dual-task performance in old age". The researchers work at the intersection of cognition and movement. "It is, thus, one of the partial projects doing truly interdisciplinary research," says Christine Stelzel, Professor of Experimental Psychology at the International Psychoanalytic University in Berlin. At the University of Potsdam, she and psychologist Gesche Schauenburg, are conducting their study on the connection between postural control and thinking, which is the focus of the Potsdam DFG project.

In addition to experiments on cognition and balance, the experimental part of the study includes EEGs and MRIs to find out more about what influences postural control in older people in particular. "The number of falls increases enormously in those over 65," the psychologist explains. The risk of falling is particularly high when older people do several things at the same time, that is, while multitasking. "With advancing age, abilities deteriorate at varying rates. Maintaining balance, mobility, and coordination require more attention than in younger years." At the same time, working memory – associated with the prefrontal cortex at the front of the brain and particularly important for flexible action control – is more cognitively challenged.

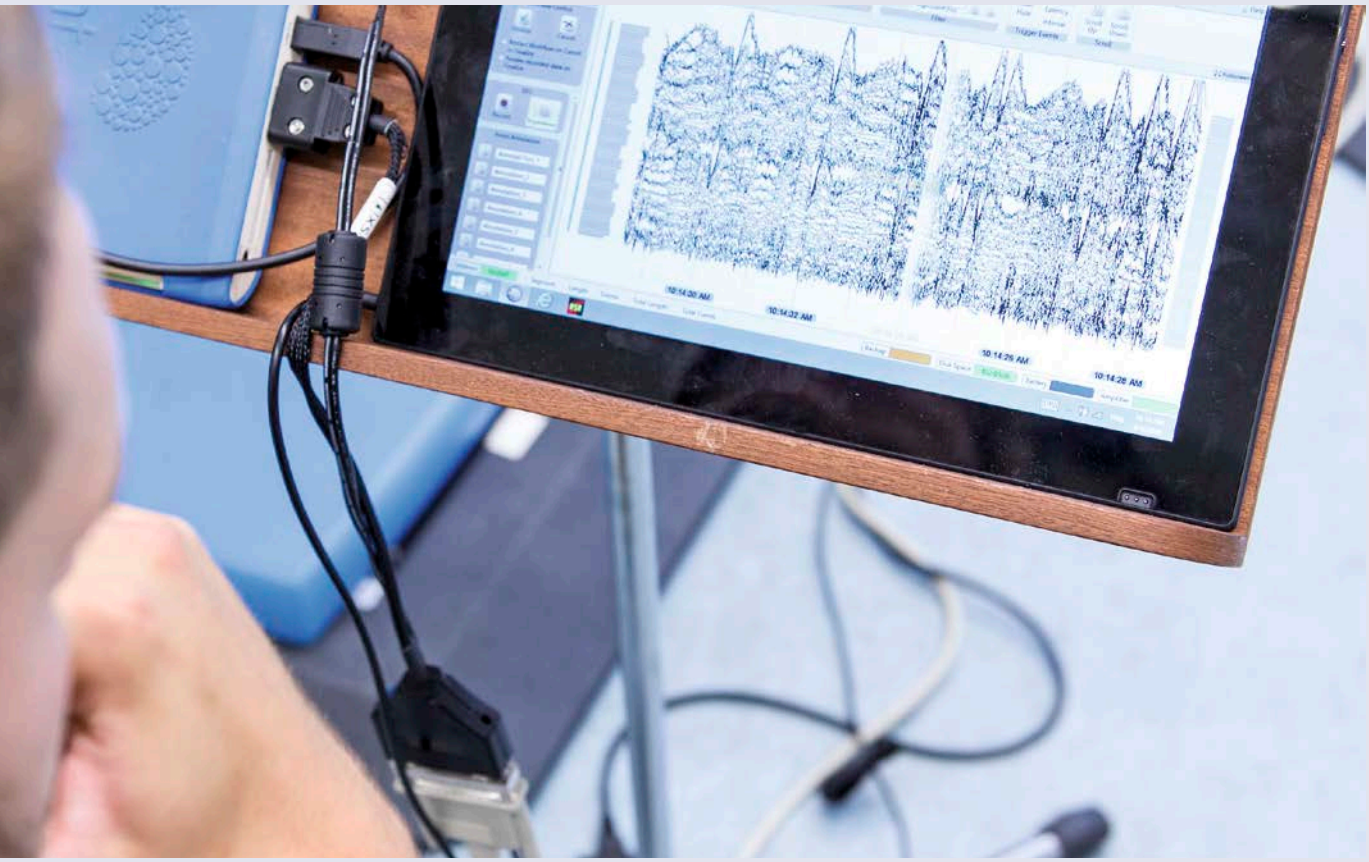
THE PROJECT

Through the DFG priority program "Human performance under multiple cognitive task requirements: From basic mechanisms to optimized task scheduling", researchers at the University of Potsdam and the International Psychoanalytic University Berlin (IPU) have been researching the connection between thinking and posture control since autumn 2015. The project **"Effects of modality mappings within working memory on postural control, associated neural correlates, and training-induced modulation of dual-task performance in old age"** is intended to prevent falls in older age. It will initially run through 2018 under the oversight of Prof. Dr. Urs Granacher (Training and Movement Science), Prof. Dr. med. Dr. phil. Michael Rapp (Social and Preventive Medicine), and Dr. rer. nat. Stephan Heinzel (senior researcher at the chair of Social and Preventive Medicine).



The EEG measures the brain waves – and allows "watching" people thinking.

Photos: Hölzel, Thomas (3)



Okay, so this one's about fall prevention. At the beginning, balance plays no role in my tasks. I'm the first test subject of the day for the student doing the testing, who tests my hearing ability and then my vision, like an optician would. He skips the "Mini Mental State Test" that checks for signs of dementia. After all, this first test run looks at 18- to 30-year-old test subjects – as a reference group – before the actual study with the target group of 65-80 year olds begins. After a couple of exercises that remind me of geometry class, we step out into the corridor. Here, the student first measures my normal walking speed. He then asks me to count backwards by seven while walking; now I need about double the time for the same distance. This test points to the study's objective: The researchers want to demonstrate that "dual tasks" are harder for older people – and to understand why this is the case.

So why do older people fall? The hypothesis is that because postural control requires more attention with advancing age, processing additional information is more difficult. If, for instance, an elderly person in a shopping center hears, "Please bring a shopping basket!" working memory has to decide how to react: verbally – by answering – or motorically – by grabbing

THE RESEARCHERS

Prof. Christine Stelzel studied psychology at Philipps-Universität Marburg and Humboldt-Universität zu Berlin. She is currently Professor of Experimental Psychology at the International Psychoanalytic University in Berlin and is working on the Potsdam DFG project.

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Dipl.-Psych. Gesche Schauenburg studied psychology at Universität Hamburg and is preparing her doctoral thesis at Freie Universität Berlin. She is currently a staff member at the chair of Training and Movement Science at the University of Potsdam and is working on the Potsdam DFG project.

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Photos: Fritze, Karla (top); Hölzel, Thomas (bottom)

a basket. This decision-making process is done by working memory. Researchers assume that balance in elderly people drops when faced with a cognitive task. This means multitasking is more challenging.

Next comes the test with sounds and squares: The researchers also assume that certain stimuli are more strongly correlated with certain reactions. So when hearing an auditory stimulus, it is comparatively easy for us to react verbally, whereas in the case of a visual stimulus we tend to react motorically. "It is much more difficult, however, to react manually to an auditory information and verbally to a visual one," Stelzel says. Thus, responding verbally to the visual stimulus of a square with a "Yes" and motorically to a sound with the press of a button is particularly challenging. These are the very situations in which older people in particular lose their balance, Stelzel notes.

The University of Potsdam. Campus Am Neuen Palais. A rainy 17°C. Today, the electroencephalography recording will be taken. It takes two students 45 minutes to install an EEG cap on my head and set the electric voltage to below 5 kilo-ohms at each recording point. When I swallow, blink, or speak, I see the curves measuring the electrical activity in my brain deflect on the tablet PC in front of me. Then the test begins. I again have to react to squares and sounds by pushing a button or saying, "Yes". In contrast to the first test series, I do this task first relaxed while seated, and then on a force plate in semi tandem position, with both feet touching and my left foot a little forward. For me, too, the task is to maintain my balance! While one student coordinates the tests on the desktop, the other observes my balance on the force plate. And the EEG records how my brain regulates these tasks. After some three hours of mind-body training, enough data has been collected.

"We know that the working brain of older people can also be trained," Stelzel says. This is why the older participants stay after the study to train both their balancing and cognitive abilities. "Using the neuroscientific parameters recorded in the EEG and the MRI, we hope to be able to predict which cognitive tasks disrupt one's balance," the psychologist explains. While Stelzel analyzes the MRI scans, Gesche Schauenburg focuses on the EEG datasets. The force plate on which the test subjects stand continuously measures the

Experiment in an MRI scanner.

Photos: Fritze, Karl (2)

Prof. Christine Stelzel.

force application point of both feet on the plate and records precisely when they sway. The researchers assume there is a correlation between swaying and the difficulty of the cognitive task. In fact, multitasking is not easy for anyone. Some even argue that, in principle, doing several things at once is impossible: Although one can perceive several stimuli, deciding on how to react to them requires interrupting a task – be it for only a very short time.

Berlin Center for Advanced Neuroimaging. Charité. A sunny 25°C. The last part of the study awaits me: In Berlin's Charité Hospital I have to perform the tasks while in an MRI scanner. First, a staff member explains the procedure: I must not have any metal on or in my body, have to take off my shoes, and can press an emergency button if necessary. Claustrophobic people will certainly not feel well inside the scanner. I am not allowed to move my head –stabilized with two cushions – during the test. Above my head is a screen displaying the exercises. Stelzel and her colleague cannot hear me while I'm doing my tasks in the tomograph. Only during breaks can we communicate via an intercom. Because it's very noisy inside the scanner, I'm given earplugs and sound-absorbing headphones. These are necessary, since my task is to recognize a "target sound" and a "target square" and confirm by pressing a button. Many sequences of the task follow, as I lie still in the scanner for 90 minutes. Outside again, my fingers are somewhat cold, my legs have fallen asleep, and my neck is a bit stiff. Otherwise I feel fine. As a farewell gift, I'm given an MRI scan of my brain.

"Functional MRI is a method that offers good spatial resolution," Stelzel explains to me. "It shows oxygen consumption in the brain and, thus, activity changes in certain brain regions." Specific regions demand a lot of oxygen during particularly difficult tasks. In contrast, EEG has a high temporal resolution and records electrical activity changes in milliseconds, so both methods are well suited to visualizing the difficulty of tasks. In addition, MRI indicates the connectivity between brain regions, thus making visible which regions cooperate during which tasks. The researchers ultimately hope to combine the two datasets for each test subject. It is conceivable that particularly difficult tasks lead to significant voltage swings (EEG) and high activity in certain brain regions (MRI) as well as more swaying on the force plate. Conclusions could, then, be drawn as to which cognitive tasks impair a person's balance, and suitable forms of training (so-called "multitask balance training") could be developed to ultimately reduce the risk of falling.

JANA SCHOLZ
TRANSLATION: MONIKA WILKE

Photo: Fritze, Karla

Destroyed house in Braunsbach (Baden-Wuerttemberg).

Flash floods are sudden inundation events triggered by local, convective heavy rain. They differ from floods on larger rivers in the time lag between the precipitation and the arrival of the flood peak. In the case of flash floods, these span a few minutes to six hours; river floods develop considerably slower.

Photo: Razzo Victor

A ONCE-IN-A-CENTURY EVENT

PhD Students of the Research Training Group "NatRiskChange" Examine Causes and Consequences of the Braunsbach Flash Flood

According to climate experts, the summer of 2016 – from a global perspective – was the hottest summer since weather began being systematically recorded in 1781. Germany and Central Europe, however, were only slightly warmer than weather observations between 1961 and 1990. The average rainfall was also normal. A notable exception were those days in May when heavy rains caused severe damage in many communities in Bavaria and Baden-Württemberg. The most intensive thunder cell responsible for the torrential rain raged in the catchment area of the stream Orlacher Bach in and around Braunsbach (Baden-Württemberg). On May 29, 100-140 mm/m² fell within only two hour, resulting in a strong flash flood that hit with full force. A task force of the Research Training Group "Natural Hazards and Risks in a Changing World" ("NatRiskChance") at the University of Potsdam investigated the event.

The main road was swept away

"There was a lot of debris along the stream; large excavators and trucks were driving back and forth. Everything was smeared with a layer of clay," remembers Berry Boessenkool, who was among the first group of the task force "Flash Floods" to visit the area on June 3 and 4. Their task was to get an impression and estimate how much water (runoff) had gushed through Braunsbach. A difficult mission. How would the people, many of whom had just lost their possessions, react to scientists wearing University of Potsdam T-shirts? The flood forecasting center of Baden-Württemberg and the mayor had approved of the researchers presence, but would the inhabitants also accept them? "We met people who were still in shock but had already vigorously cleaned up the area," Boessenkool describes the situation at that time. "The moment called for a can-do approach." For the young researchers, as well. Their workdays were far from routine. They had to improvise, deal with the unexpected. "The main road had been swept away, so the detours alone took us a long time," says Boessenkool.

He and the whole team were facing a challenging situation. Five days after the worst of it, their focus was reconstructing what had happened and to analyzing it theoretically, mathematically, and practically. Experts call this forensic hydrology. The calculations showed a maximum water flow of about 120 m³/s (+ /- 50 m³/s) at the outlet – an extremely high value. "The value exceeds the magnitude for a 'normal' flood by a factor of 500," says Boessenkool. The enormous volume was established by means of various, sometimes admittedly inaccurate data: the water level visible at the houses and reported by the people, the line of floating debris, i.e. the geometry of the flow cross-section, and assumptions regarding the average flow velocity. The speed of the water proved to be an uncertain factor, so the young researchers used video recordings. As there had been no recordings of the event itself, they looked at footage from other parts of the area – and finally made an estimate. By counting video frames, they measured how much time objects floating in the water required to travel a certain distance, for example along a house. "The speed could not be transferred 1:1 to the wider valley section, but we were able to determine a range of 70-170 m³/s," says Boessenkool. In a field survey four days after the flash flood, they carried out comparative measurements. The result: a flow rate of 0.18 m³/s. A completely different number, about three orders of magnate below the estimated maximum flow rate! The overall calculation, however, made clear that the value range determined for the event itself was quite plausible. The researchers came to a flow rate of 107 m³/s – proceeding from a maximum of a 30-minute rain intensity of 40 mm and a runoff coefficient of 80%.

THE PROJECT

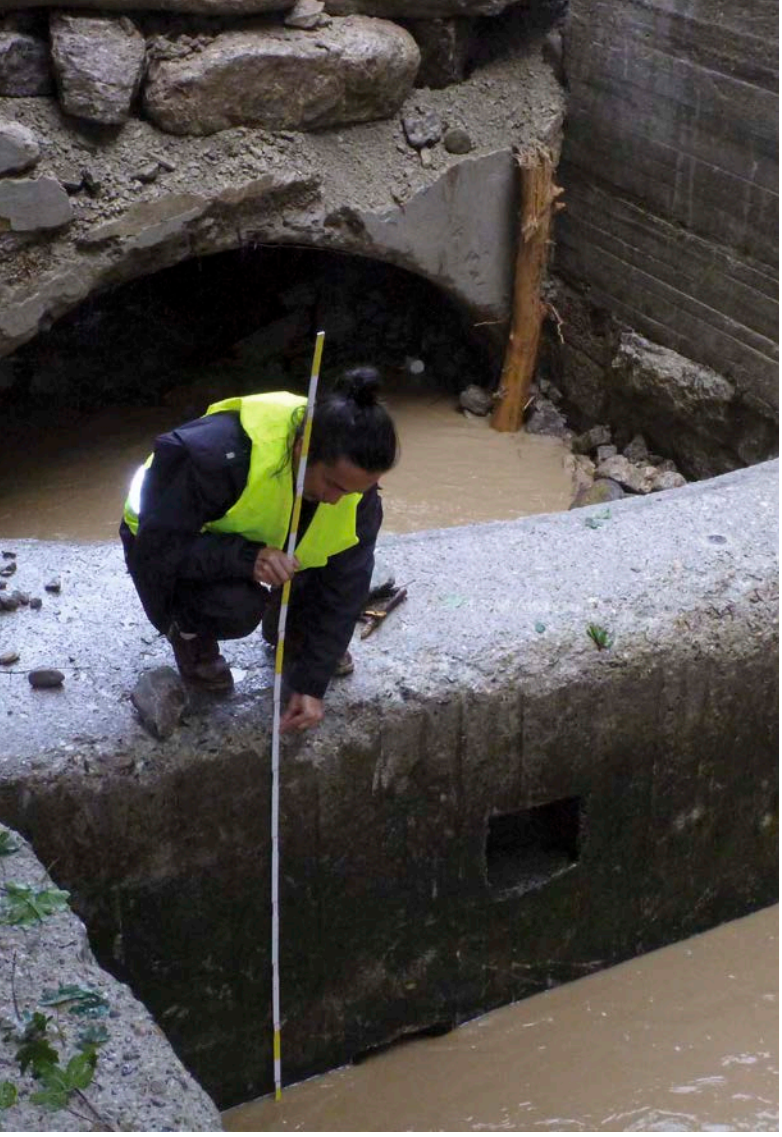
The Flash Flood in Braunsbach. Review and Description of the Event

Project leaders: Prof. Axel Bronstert, Prof. Annegret Thieken (University of Potsdam); a project of the task force "Flash Floods" des DFG Research Training Group "Natural Hazards and Risks in a Changing World" ("NatRiskChange") of the University of Potsdam and the partner institutions GFZ, PIK, and FU Berlin

The Research Training Group **"Natural Hazards and Risks in a Changing World" (NatRiskChance – RTG 2043)** was established by the German Research Association (DFG) at the University of Potsdam in 2015. Partner institutions are Freie Universität Berlin, Helmholtz-Centre Potsdam – GFZ German Research Centre for Geosciences and the Potsdam Institute for Climate Impact Research (PIK). 12 PhDs students and one postdoc research observed and potential natural hazards and risks. They are supervised by 19 researchers from the University of Potsdam and the partner institutions. Their projects focus on geomorphology, seismology, meteorology, mathematics, and hydrology. The structured graduate program includes so-called task force assignments when the students gather and analyze information and data about a current event.

Only a few hours after the flash flood, the Orlacher Bach regained its “standard level”.

Photo: Agarwal, Ankit



The disaster had a complex history

An unusual amount of precipitation led to this natural disaster. This started mainly due to the macro weather situation "low-pressure area over Central Europe", which had caused similar heavy floods in the past. The Braunsbach flash flood in particular was also caused by the high-pressure system "Sören" over Scandinavia blocking the low and by the fact that the air mass came to Central Europe from the south and southeast rather than the west. The surface low system "Elvira" then triggered the thunder cells in Baden-Württemberg and Bavaria, which formed into a squall line. Analyses of the Department of Hydrology and Climatology at the University of Potsdam based on rain radar data from the German Metrological Service showed that between 6:45pm and 8:00pm, approximately 100-140 mm of rain per square meter fell during that peak time. This occurs, on average, less than once in a century.

Also unusual were the soil erosion, the landslides in the area, and the sediment movements in the stream path due to the resulting discharge. "Boulders one meter in diameter rushed through the village," says Prof. Axel Bronstert, who heads the Research Training Group. "Such stones move only once every 1000 years on average." His doctoral students carefully examined section after section of the valley. In the first section alone, they mapped 30 large landslides. The earth movements led to the accumulation of loose sediment, which took the path downwards – as large quantities of trees and plant material, pebbles, and rocks did later. The documentation shows that the landslides brought more than 8000 m³ of material in-

Photos: Agarwal, Ankit (left); Rözer, Victor (top left); Boessenkool, Berry (bottom)

to the waters. The Orlacher Bach, normally 2 m wide and 20 cm deep, had become a torrent. Instead of just 1 m², it suddenly had a cross-section of it to 54 m2. The young researchers also documented the damages it left behind in the village itself. For this, they used the open-source software "KoBoToolbox", which was specifically developed for recording data in emergency situations and crisis areas. They also used IR cameras to document both the respective peak water level and the destruction on the building structure. The outcome was sobering: extremely extensive damage. The center of Braunsbach has been especially affected, and its reconstruction is likely to take a long time.

The disaster was caused by a cascade of various factors, the researchers stress. "Such extreme events have a complex history," emphasizes Bronstert. In addition to the water level, the high flow rate and the large amount of bedload material played a decisive role in causing the damage. "It was not only the heavy rainfall that led to the massive destruction but also the combination of other unfavorable conditions – like the existing relief and the soil conditions," he adds. It is impossible to responsibly judge to what extent humans are at fault. "If such water masses fall, human beings play a comparatively small role," says Bronstert. That the very narrow stream in the village is culverted, i.e. covered with a few hundred meters of slabs did worsen the flooding situation in the center but not fundamentally.

The geoecologist is similarly realistic when it comes to the effects of land use. Some media wrote that the catchment's corn fields were also responsible for the flooding and its repercussions. "Intense rainfall on corn cultures that are in their early stage of development led to silting up (clogging) of coarse and fine pores of the surface," explains Bronstert. "This significantly reduces the infiltration capacity of the soil surface; this results in increased surface runoff." Earlier investigations by his research group have shown that silted soil can have a noticeable effect on local flood formation during extremely intensive precipitation. The results refer, however, to frequent to medium-frequent heavy rain. "We know that the retention capacity of soil is a clear function of the rainfall," says Bronstert. "This retention can play an important role in comparatively low intensity rainfall but is almost irrelevant for very intense rainfall." In his opinion, landscape is being overestimated in extreme events like this. "Perhaps 20% less water would have drained off, but even this would have been enough for such extensive destruction."

Axel Bronstert assumes that such an extremely rare natural phenomenon could have happened in the region before, indicated by alluvial fans the researchers found at the lower stretch of the stream. They indicate unusual flood and sediment transport events over several thousands of years.

THE RESEARCHERS

Prof. Axel Bronstert studied civil engineering/water management and earned his doctorate in hydrology and water management in 1993. Since 2000, Bronstert has been Professor of Hydrology and Climatology at the University of Potsdam.

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Prof. Annegret Thieken studied geo-ecology at the Technical University of Braunschweig; in 2001, she did her PhD in geo-ecology at the University of Halle and her habilitation on flood risk management in 2009. Since 2011, Thieken has been Professor of Geography and Natural Risk Research at the University of Potsdam.

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More precise warnings about location, time, and strength of such events should be possible

Bronstert demands improved forecasts for extreme local precipitation and ensuing flash flooding and to do what the US and Australia do. It is necessary to record and predict the possible developments of thunder cells in time scales of hours to enable more accurate warnings about the location, time, and strength of such events. Short-term forecasts of this kind are, however, likely to also be difficult in the future because the thunderstorm system is a partly stochastic one with many random components. The error rate of precise predictions for small areas, therefore, is high. "And that's a problem. After several false warnings, no one will listen anymore," worries the NatRiskChange spokesperson. When the Braunsbach people have recovered, he and his students want to visit the village again: to present their research report at a town hall meeting and to inform themselves about the current situation.

PETRA GÖRLICH
TRANSLATION: SUSANNE VOIGT

Photos: Roese, Thomas (top); Thieken, Prof. Dr. Annegret (bottom)

View of the Baspa Valley in the Himalayas.

Big Boulders

Prof. Bodo Bookhagen Goes to the Mountains to Research

Photo: Bodo Bookhagen

THE RESEARCHER

Prof. Bodo Bookhagen studied geology, geophysics, and computer science at the University of Potsdam. Since 2014, he has been Professor of Geological Remote Sensing at the University of Potsdam.

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Bodo Bookhagen's family roots are in Tyrol; he has known this landscape since childhood. So it comes as no surprise that he has developed a special relationship to the mountains. Over the years, they even became part of his profession. Bookhagen initially wanted to be a doctor but was drawn to earth sciences and studied geophysics and geology. He is now Professor of Geological Remote Sensing at the University of Potsdam and studies earth surface processes in the Himalayas and the Andes.

"I have always enjoyed skiing," says Bodo Bookhagen. During his many visits to Tyrol, it struck him that the mountains were changing. Even as a child he wanted to understand how mountains move and glaciers and rockslides work. When he had the opportunity to study geophysics at the newly founded geoscientific institute of the University of Potsdam in 1995, he did not have to think twice. "I did not want to study at one of the universities in Berlin, which I found overfull," he says. Potsdam was a different situation. He already knew the region; his father was born in the Oderbruch, a riverscape on the Oder. He also experienced 1989/1990 in Potsdam – after the opening of the Wall – as motivating, exciting, and full of opportunities for new things. In addition to geosciences, he studied computer science, having worked as a programmer and system administrator at a computer company before his studies. He ended up not finishing his computer science studies but has found much of what he learned extremely helpful. Competently handling satellite data and large datasets is just as essential to his research as mastering a programming language. In his diploma thesis, Bookhagen programmed, for example, a climate model using thousands of data points, which he was only able to complete thanks to his IT knowledge.

Gathering samples on the high plateau of the Central Andes in northwest Argentina.

Photos: Bookhagen, Prof. Dr. (2)

The southern Californian island of Santa Cruz off the coast of Santa Barbara is tectonically very active and exposed to harsh Pacific storms.

From Berkeley to Potsdam

After studying and obtaining his doctorate in Potsdam and Berkeley/USA, Bookhagen researched and worked at the University of California, Santa Barbara and Stanford University. After 15 years in southern California, he returned to Potsdam in 2015, mainly because of the colleagues and the extremely active and internationally recognized working group there. "Their work is really in line with mine, which is motivating." The Golm campus' upswing is obvious as well. The former barracks have since given way to many new buildings. The transport connection has also improved significantly.

As a professor of geological remote sensing, his research takes him from Potsdam to the whole world, especially the Himalayas and the Central Andes. On his expeditions, he always learns a lot about the countries themselves and appreciates the people living there. Contact with the local people has always been positive, because "we explain our plans". To prevent misunderstandings, the geoscientists always bring letters of approval and support. This also facilitates communication with police, for example at the border between Chile and Argentina or India and China (Tibet) – regions where security forces are increasingly present to combat drug trafficking.

Bookhagen and his colleagues are interested in other finds, of course. "During our fieldwork, we gather and date samples, wood or rock to determine the age of glaciers or rockslides." This work is like a time-intensive puzzle, because you have to find the right – significant – samples. A stone found by chance during a walk is of little use.

Bookhagen uses a new method of dating rock finds and other samples developed at the University of California, Berkeley to analyze cosmogenic nuclides. Since only a few laboratories worldwide are able to use this method, Bookhagen has started one at the University of Potsdam. For this analytical method, the geoscientists use highly corrosive hydrofluoric acid to dissolve the rocks, which consist primarily of quartz. They then extract two elements, aluminum and beryllium, which are measured and dated. This enables them to determine the age of rockslides, glaciers, and other landscape formations. Working with hydrofluoric acid requires a lot of dexterity and extensive safety precautions. If this acid comes in contact with skin, it will eat its way through to the bone and burn the mucous membranes and conjunctiva of the eyes.

Photo: Bookhagen, Prof. Dr.

Walking on an old rockslide in the central Andes.

Geological archives offer a glimpse into the past

Looking into the past in order to learn about the future – this captures the research of Bookhagen and his team. Compared to geological time scales, human life is relatively short. Those who live in the mountains or in other regions may experience one flood or rockslide in their lifetimes, if any at all. These events need to be dated to assess the risk of their occurrence. This makes it possible, for example, to determine how frequently floods occur in northwest Argentina.

Even when measuring series are available, they do not usually go back more than 50 or 100 years or cover geologically relevant time intervals – centuries or even millennia. So-called geological archives – objects used to obtain data for the reconstruction of the geological past – fill in these gaps. These include sediments and the structures, minerals, fossils, liquid and gas inclusions contained within them. Analyzing them reveals that, for example, rockslides occur relatively frequently during times of heavy rainfall. Rockslides, which can be several hundred meters high, often dam lakes. They destroy vegetation and infrastructural paths, creating a completely new ecological environment, which sometimes even influences the culture of the people living there. In the Alps, for example, there is a region where the language of two neighboring areas is markedly different despite their spatial proximity. Researchers recently found out that a large rockslide in Roman

Crossing a pass at a height of 5000 meters with a view of Nanda Devi (7800 meters).

Photo: Bookhagen, Prof. Dr.

Top: discussing the route at the foot of Nanda Devi. Bottom: research team, interested local people, and Sherpas approaching the foot of Nanda Devi.

Photo taken with a Lidar to get a surface model of the area of Santa Cruz Island (Southern California), down to the centimeter.

times divided the region – and so the language of its inhabitants diverged.

For some time, Bookhagen has been increasingly interested in remote sensing. Modern computers and satellites have opened up new possibilities. The increasing spatial and temporal resolution of remote sensing data have enabled more accurate images of the earth's surface and atmospheric processes. Higher resolution also means that even more data have to be processed before relevant geoscientific information can be extracted. New remote sensing equipment, such as drones, has enabled the geoscientists to create exact terrain models. "You can calculate how large the rockslide was or how many cubic kilometers of rock moved," the researcher says.

Symbiosis of geology and biology

Bookhagen is currently working with colleagues from various disciplines to lift another large "boulder": the excellence strategy. The University of Potsdam is preparing a cluster application that focuses on the interface of geo-biology, biology, and climate sciences, which involves the interaction of events on the earth's surface, where the influences of geology, biology, and atmosphere converge. "We want to find out how they influence each other," says Bookhagen. "For example, we are looking at how rockslides or the last ice age have impacted biodiversity." The researchers are increasingly aware that looking at the development of the landscape, which once fell under the exclusive purview of geology, requires perspectives from other disciplines, such as biology, to be able to understand the complex picture. Conversely, modern diversity research also needs the geological component. The biologists and geoscientists want to elaborate and use this connection in the excellence strategy. "We have a concept and the necessary infrastructure and have to take advantage of the available competencies," Bookhagen is certain. It will be a project for the entire university. The long-standing cooperation with extramural research partners as well as with the universities in Berlin will play an important role. "This project requires a lot of effort. Without the vision of being much better off in 5-10 years, this would not be possible," Bookhagen underlines. His motivation for this task is also based on his ties with "his" university and the region. The urge to create something new together drives him.

DR. BARBARA ECKARDT
TRANSLATION: SUSANNE VOIGT

Photos: Bookhagen, Prof. Dr. (3)

Having the Lower Hand

Administrative scientists look for structural and organizational hurdles faced by national anti-doping agencies

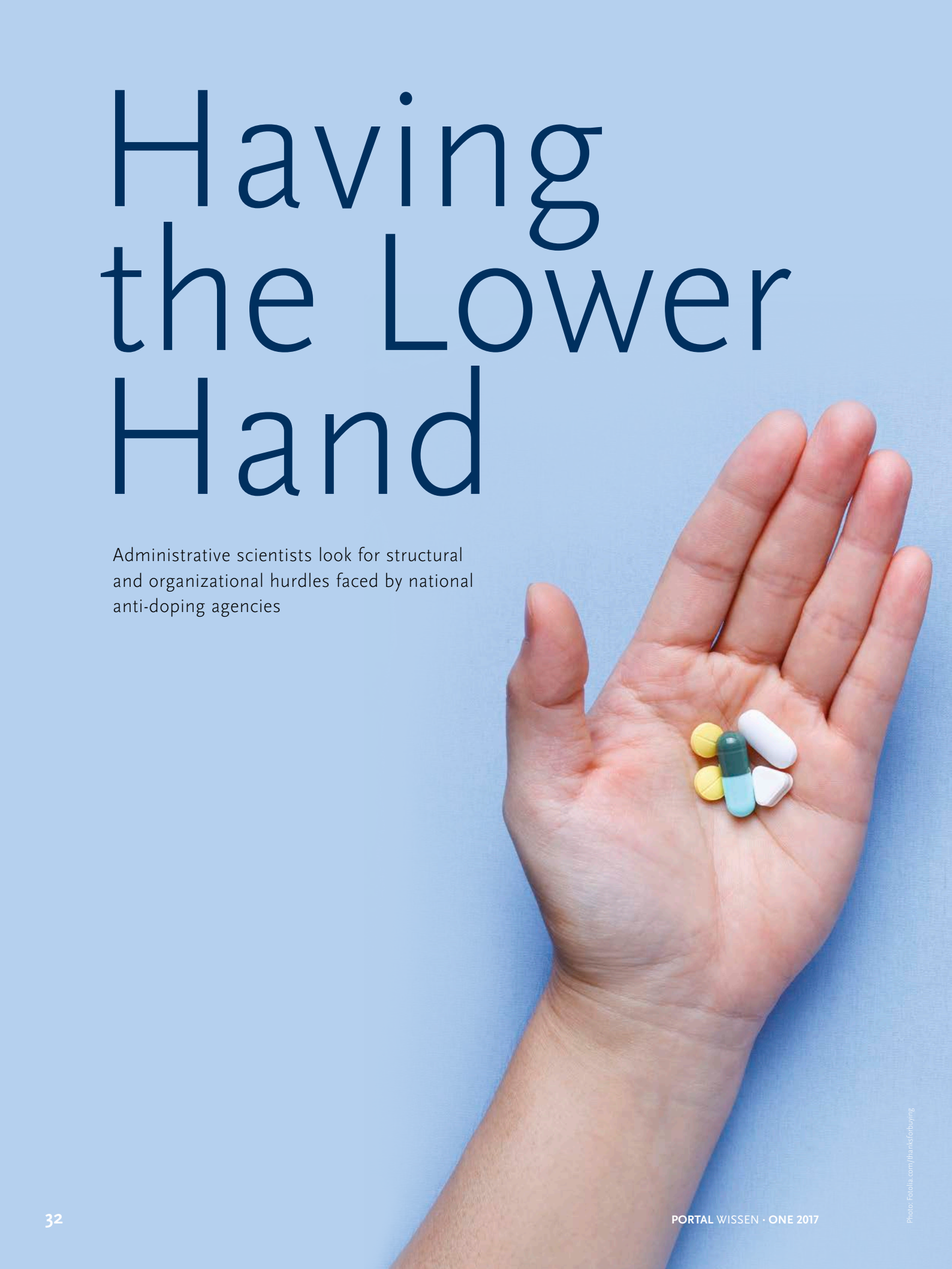


Photo: Fotolia.com/thanksforbuying

THE PROJECT

Organizational structures and performance measurement of National Anti-Doping Organizations – an international comparison

Oversight: Prof. Werner Jann
Duration: 2013-2016
Funding: World Anti-Doping Agency (WADA)

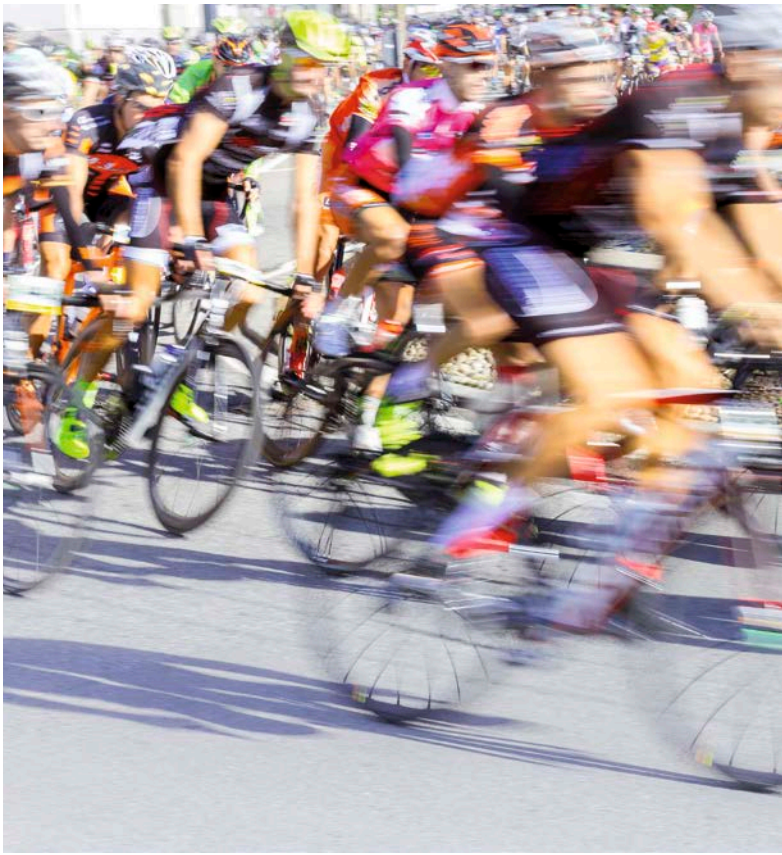
Sports supplements may be the "gateway". When things get really bad, anabolic drugs and downers, blood boosting, or even gene doping can follow. In almost all disciplines, athletes are using banned substances and methods to increase their chances of success. The rates are particularly high in competitive sports. But the greed for fame and money comes at a price: Extreme cases of medical complications have been reported – but this has hardly been a deterrent. In many cases, national anti-doping agencies are powerless; there is little they can do to counter this development. Administrative scientists at the University of Potsdam are researching why this is so and to what extent agencies' effectiveness depends on their organizational structure and the overall circumstances.

A team led by Senior Professor Werner Jann thoroughly examined the organization of the national anti-doping agencies of Germany, Great Britain, Norway, the Netherlands, and Austria. That these five countries were chosen was serendipitous: This "coalition of the willing" formed when some of these agencies wanted to review and improve their own structures – and through personal contact among some of their representatives.

The agencies face similar challenges – and use different prevention strategies

The project was set up as a comparative qualitative case study. The researchers collected important information from 15 guideline-based interviews with senior agency staff members. "No other methods were considered," explains Dr. Markus Seyfried, a member of the working group. "Performance comparisons based on figures alone would have distorted the picture, since the philosophies and conditions of the agencies differ so much. The phenomenon is well known from other organizational reviews. Not every aspect can be "MacGuyvered" and expressed in figures that can be compared.

The study focused on five key factors: resources, regulatory mechanisms, organizational structures, management, and environment. The results show that the agencies have a number of problems in com-



Photos: Fotolia.com/baranq (left); Fotolia.com/Hombach (right); Fotolia.com/Silvano Rebai (bottom)

mon that influence their work. For instance, there is much financial uncertainty due to a lack of long-term budgetary commitment. Temporary contracts result in high staff turnover. Managing test results that differ so much presents another challenge. In some cases, this may not even be their responsibility but rather that of the very associations charged with sanctioning athletes who fail drug tests. For the experts, this is an absurd situation. "It's like putting the fox in charge of the henhouse," says Seyfried.

"We very much hope that our results will help set this straight. The national anti-doping organizations (NADOs) need more skills and clear structures." Their inadequate staffing levels constrain them, making it almost impossible to impact mass sports, where the institutions also see an increased tendency towards doping. Painkillers and performance enhancing drugs, in particular, are on the rise. "In this regard, the national organizations can hardly intervene systematically," Seyfried knows. They are, therefore, attempting to curb the trend through a variety of projects.

The limited resources also affect the everyday work of the organizations: Urine tests are cheaper – and, thus, more common – than blood tests. As a result, certain substances being used by athletes in some disciplines are less likely to be discovered. It's as simple as that: The type of test used in the respective discipline significantly influences the number of athletes who test positive. And this is a very delicate issue, not only in the eyes of the Potsdam researchers. "According to the NADOs' annual reports, only a very small proportion of the tests are positive," Seyfried says. His interviews with agency representatives made it clear to him that different tests – both procedurally and with regard to the disciplines chosen – would probably yield higher "hit rates".

Of course, the researchers also looked at inter-agency differences. For instance, the Netherlands and Great Britain apply two completely different prevention strategies. The Dutch approach is based on rescuing athletes from "bad influences". As part of this "denial culture", athletes are embraced, figuratively speaking. Athletes are given a lot of information about doping and its consequences, and much effort goes into working with the sports associations and strengthening the relationship between coaches, parents, and athletes. This approach is all about caution. "It was quite impressive for me to see how this agency stands up for its athletes," Seyfried remembers. In Britain, the situation is completely different; there, prevention through deterrence is emphasized. Athletes found guilty of doping are "pilloried" – their names are published online and elsewhere. It is hard to tell which approach works better. Experts know that developing guidelines for the "right" approach would be futile. What works in one country may not necessarily work in another.

THE RESEARCHERS

Prof. Werner Jann studied political sciences, mathematics, and economics in Berlin and Edinburgh, Scotland. In 1982, he completed his Ph.D. at the German University of Administrative Sciences in Speyer. Between 1993 and 2015, Werner Jann was Professor for Political Sciences, Administration and Organization at the University of Potsdam, where he has been a Senior Professor since November 2015. His work focuses, among other things, on modernization of the public sector, governmental agencies, ministerial administrations, and political control of administration.

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The black sheep of sports are always one step ahead of the testers

Those who work for a NADO do so "out of conviction," Seyfried stresses. "We have the impression that there is no 9-to-5 mentality." The teams include athletes found guilty of doping in the past, many of whom were recruited because of their intimacy with the subject – and they are usually more committed to their job. But they cannot solve the problem either: The black sheep of sports are always one step ahead of the testers. It takes a lot of time and money to develop detection methods for ever-more substances and tricks. And by the time mechanisms are in place to combat them, the scene has already thought up new ways to deceive the testers. It is like the arcade game Whack-a-Mole. And it's the honest athletes who suffer the most. They are disadvantaged in competitions and

Photos: Fritze, Karla (2)

The **National Anti Doping Agency of Germany (NADA)** is a foundation under civil law. Critics claim that it is not independent, since – in contrast to other countries – it is not funded by the state alone but also by the federal government, sports organizations, and businesses.
In cases of suspected doping, the agency is not permitted to carry out investigations and is unlikely to receive information from the police. Since a new code went into effect in 2015, it has been responsible for testing all in-competition athletes within the German Olympic Sports Federation. In 2015 alone, NADA carried out 12,425 doping tests: 4,590 in-competition and 7,835 during training. Since 2011, the foundation has also been responsible for monitoring drug administration to racehorses.

The **World Anti-Doping Agency (WADA)** – headquartered in Montreal – is the umbrella organization of all national anti-doping organizations. It implements anti-doping measures in sports worldwide. All of its activities are based on the WADA Code (revised in 2015) and the current list of prohibited substances. According to WADA rules, drug violations face a minimum four-year ban.

are one day faced with the question of whether they, too, should use banned substances to keep up with the competition. It's a vicious cycle.

Nevertheless, the team around Werner Jann at the University of Potsdam sees good reason to be optimistic. "Anti-doping agencies are using their funding in a meaningful ways," Seyfried summarizes. "They are very skilled, knowing that they are only able to reach athletes through health education and targeted information." Even though NADOs have a tough job, there are structural elements that may account for the variation in their effectiveness. These include more or less flat hierarchies and the extent to which large networks and informal contacts are used, for instance, to whistleblowers.

Werner Jann and his colleagues have invited representatives from the agencies to a workshop next spring to discuss their research findings. The hope is that they will be able to validate the results and potentially give concrete recommendations. The team has also been drawing up new plans: "It would be good to have a doping index – similar to the Transparency International's corruption index. We hope our findings can contribute to developing this," Seyfried says. A project extension has been applied for at the World Anti-Doping Agency (WADA) and could provide a good basis for developing this index and other initiatives.

PETRA GÖRLICH
TRANSLATION: MONIKA WILKE

Urine tests are cheaper – and, thus, more common – than blood tests.

Photo: Fotolia.com/Gerhard Seybert

"The Lowest Common Denominator is Not Enough"

Moving towards a sustainable society

In our series "Pearls of Science" we regularly introduce researchers from institutions connected with the University of Potsdam in the "pearls – Potsdam Research Network".

Digitization, a transition in energy policy, geopolitical crises – our world is undergoing fundamental changes. Patrizia Nanz – Scientific Director at the Institute for Advanced Sustainability Studies (IASS) and Professor of Transformative Sustainability at the University of Potsdam – researches how this change can be shaped. The goal is a society that is sustainable in many respects – biologically, economically, and politically.

Only together can we succeed, political scientist Patrizia Nanz is convinced. It will take the combined knowledge of various actors for those in the future to be able to sustainably live, be economically active, and consume. The challenges are enormous. Solutions for numerous conflicts and problems need to be developed and hot-topic issues addressed, for instance around the construction of the high-voltage transmission lines that are indispensable for the efficient use of renewable energies but that could be met with disapproval of those impacted or around the phasing-out of fossil fuels and the resulting job losses.

Science does not deliver solutions but rather new findings

Opting for sustainability means having to address many big questions, such as how do we want to live in 10, 20, or 50 years? What economic and life models are sustainable? In this search for answers, science also plays an important role. How science needs to organize itself to be both excellent and relevant is one of the fundamental topics Nanz researches. "Science as such does not deliver solutions but rather new findings," Nanz explains. These findings need to be used to develop solutions. Politics, administration, science, business, and citizens are all in the same boat.

For the sustainability researcher, the new science platform set up by the German government to foster the UN Sustainable Development Goals is a great opportunity. The platform, which she chairs, is part of the German sustainability strategy to reduce greenhouse gas emissions, increase the percentage of renewables in energy consumption, and transport more goods by rail. Going forward, researchers and politicians will be exchanging their views more often and exploring available options.

And this is absolutely necessary. "Problems have become more complex," Nanz points out. Now as before, the task is to find answers to very concrete questions. The first step is to identify "pain points", i.e. those crucial points within the system that offer the greatest leverage in achieving sustainability. A number of distinguished bodies have set out to do just this: the IASS, the research initiative Future Earth, the Sustainable Development Solutions Network, a broadly based steering committee of scientists, as well as various political departments including federal ministries and the German Chancellery.

Citizen competencies sought

Once the essential questions have been identified, research can start: "We commission studies, network researchers, summa-

rize results, and introduce them to politicians," Nanz says. Research and policy advice flow into one another, she underlines. "Politicians and researchers sit together on the steering committee." Researchers, politicians, and administrators will meet again later to exchange views. The scientific findings will ultimately be translated into concrete actions – a challenge for everyone. The focus must be on solutions and not on individual interests, which lead only to compromise.

"After all, the lowest common denominator is not enough to achieve sustainability," Nanz says.

At the local and municipal levels, such solutions are already being found, for instance in infrastructural projects. Nanz mentions the example of the construction of high-voltage transmission lines in eastern Bavaria. "A very controversial project," she underlines, in which she was involved in an advisory capacity. It ultimately succeeded because the local citizens actively participated in finding a solution – together with lawyers, mayors, and the commissioned companies. How was it achieved? "You have to talk to the people. Some of my colleagues stayed in those villages for months at a time." This is tedious and time-consuming, she admits, but also necessary if you want the best results. The researcher describes this as "co-creation". She is confident that this works on a large scale as well as a small one.

If you just let the process happen, you may get surprising results. The planned route of the high-voltage transmission lines in eastern Bavaria was ultimately modified. "Environmental planners had not thought of this option, but it turned out to be much less harmful to the environment," Nanz explains. "The citizens know their area best and have a unique knowledge." It is, however, crucial to make sure participants are randomly selected to ensure a representative sample of views and experiences. "Otherwise you get the same group of people all the time: those with time on their hands, who are well educated, mostly male, and over 65."

"Business as usual" cannot continue

Over the next four years, Nanz will – as Scientific Director of IASS – be dealing with future-oriented issues that are particularly pressing to her as a political scientist: "How can we integrate and represent future generations? How can the necessary long-term investments be ensured beyond legislative periods? What forms of participation do we need? How can the objectives of the Paris climate agreement be met?" Together with an interdisciplinary team of psychologists, economists, political scientists, and philosophers, she researches what it takes for a society to be sustainable.

As a mother of two young children who also enjoys new challenges in her private life and lists mountain climbing as a hobby, she knows very well that creating a vision and striving for it requires the courage. Take mobility, for example. "Switching to e-mobility is just switching to a different energy form. This won't suffice," she says. What might a completely new concept for passenger and goods transport look like? And what economic models are sustainable? These are the big issues sustainability research addresses. For Nanz, the IASS is an especially suitable forum to discuss new ways of thinking and new possibilities for shaping the future, in part because scientists of various disciplines are working together. "What we have in common is our interest in sustainability," Nanz underlines. Yet climate and political scientists must find a common language, which poses quite a challenge. "Social scientists have the task of describing the world. This is not enough. Climate researchers know that time is quickly running out."

THE RESEARCHER

Prof. Patrizia Nanz studied philosophy at Hochschule für Philosophie München as well as history and literary studies at Ludwig-Maximilians-Universität München. She is the founder of the European Institute for Public Participation (EIPP). Since April 2016, she has been Scientific Director of IASS.

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Photo: Meyer-Bergfeld, S.

THE IASS

The **Institute for Advanced Sustainability Studies (IASS)** was founded by former Federal Minister for the Environment Klaus Töpfer in Potsdam on 2 February 2009. The Institute fosters science and research on global sustainability, supports young researchers, and facilitates information and dialogue exchange between research, politics, business, society, and culture. Its goal is a more just and peaceful world, in which the understanding of and steering of earth, social, and economic systems facilitate sustainable development for all and in which societies can sustainably address the challenges of the Anthropocene.

Nanz sees societal divisions as one of the most striking problems of our time. "Everybody speaks only with people like themselves; nobody has any idea whatsoever what's going on in the hearts and minds of the others." In real life, lawyers rarely know the problems facing geriatric nurses or single mothers the fears of managers. But this is exactly what is needed to overcome societal divisions. To achieve this, the researcher has developed the concept of "future councils". "A future council is a societally representative body of 12-15 citizens that would deal with self-chosen topics over a longer period of time," Nanz explains, topics that will affect coming generations and for which the course must be set now – such as the permanent storage of nuclear waste or demographic change. The members of this future council would be randomly selected and would work together towards solutions without sacrificing their individual perspectives. Politicians and administrators, municipalities, and federal state governments have already expressed interest in the concept. "This shows that they are looking for a new operating system," Nanz says.

Sustainability must not fade into the background

The tasks on the horizon are enormous, yet the current social climate is not very conducive to addressing them, the scientist knows: "These are difficult times." We lack an intact political community that forms the basis of democracy. Populists are filling the resulting gap with seemingly simple answers and winning over the masses. "As neoliberalism has been the focus since 2000 and as politics tends to foreground economic issues, I believe that more and more people will start reflecting on questions of identity," Nanz says. The scientist sees the danger that important future issues could be forgotten, with sustainability fading into the background. "We have to be prepared for this."

Researchers Patrizia Nanz and Claus Leggewie recently published "Die Konsultative. Mehr Demokratie durch Bürgerbeteiligung" ("The Consultative: More Democracy through Citizen Participation") with Verlag Klaus Wagenbach, in which they present their concept of future councils.

HEIKE KAMPE
TRANSLATION:
MONIKA WILKE

The **pearls - Potsdam Research Network** connects the University of Potsdam and 21 extra-mural research institutions in the science region of Potsdam/Berlin. Cooperation focuses on joint research projects, promoting young researchers and joint research marketing for the Potsdam region

pearls
Potsdam Research Network

www.pearlsofscience.de

Photo: Schulten, R.

Photo: Fritze, Karla

In the cardiac catheter laboratory of the Klinikum Ernst von Bergmann.

Palpitation

Stress in the cardiac catheter lab – and what can be done

THE PROJECT

Stress Management in the Cardiac Catheter Lab: The Study "Palpitation"

Participants: Prof. Pia-Maria Wippert (University of Potsdam); Dr. Klaus Bonaventura (Cardiology and Angiology Clinic, Klinikum Ernst von Bergmann Potsdam)
Duration: 2016-2018
http://www.uni-potsdam.de/sport-gesundheitssoziologie/forschung/stress-und-settings/herzklopfen.html

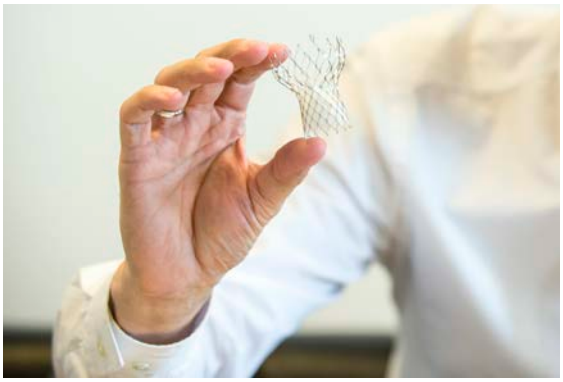
Working on the "beating heart" with a conscious patient or performing exams and interventions without opening the thorax are possible thanks to technical developments in cardiology. While the work in the cardiac catheter laboratory of the Klinikum Ernst von Bergmann (EvB) in Potsdam has become professional routine, stress still exists: for patients, the treating physicians, and employees alike – stress that can impact the quality of medical care as well as patients' condition and rehabilitation. A joint project of the EvB and researchers at the University of Potsdam will help to calm this "heart palpitation".

An ambulance – lights flashing – races through Potsdam with a patient suffering from an acute myocardial infarction. She is immediately admitted to the cardiac catheter lab (CCL) at the Clinical Center. An analysis of her heart shows a life-threatening vascular constriction. The vessel must be widened immediately with a ballon catheter and a stent, if necessary. Moments later, the artery is again sufficiently supplied with blood. The quick, resolute, and professional actions of the doctors and medical staff at the CCL saved the patient's life. Only 21 minutes passed from admission to the end of the treatment, but each passing minute was nerve-racking. Emergency cases allow for no margin of error; delays can have fatal consequences. "In a heart attack, every second counts in minimizing the damage," says Dr. Klaus Bonaventura, Medical Director of the Cardiology and Angiology Clinic. "Such situations are psychologically extremely stressful – not only for the patients but for everyone involved in the treatment. This is especially true for the few cases in which we lose a patient."

Interventions in the cardiac catheter lab have become almost routine – and have enormous diagnostic and therapeutic potential

Not all cases treated at the CCL are so dramatic, of course. Diseases of the coronary arteries, myocardium, the cardiac valves, or blood vessels throughout the body regularly arrive "on the (examination) table". The spectrum of cardiology has grown enormously over the years, Bonaventura explains, along with treatment options. "I started as a cardiologist in 1993. Nothing is as it once was. What was forbidden is now recommended." This applies to research methods as well as to medication and interventions.

"In most cases, patients arrive (or are referred to us by practitioners) complaining of chest discomfort, dyspnea, tightness, or pressure in the chest," Bonaven-



Photos: Fritze, Karla (3)

Dr. med Bonaventura explains the "tools" of a cardiologist.

Prof. Pia-Maria Wippert.

Photo: Fritze, Karla

tura explains. Immediately after they are admitted, an ECG, an ultrasound, and stress tests are done to determine whether the coronary arteries should be examined more closely – possibly even treated – with the help of a cardiac catheter. "Cardiovascular diseases are by far the most common cause of death," says the cardiologist. "Thanks to technical developments, we are now able to help many patients in the CCL, and the intervention has become almost routine – with enormous diagnostic and therapeutic potential."

A cardiac catheter examination is an X-ray examination in the broadest sense: A contrast medium is injected, and the attending physician then inserts a catheter through an artery in the hand or leg and guides it to the heart. X-rays make visible both the vessels (and potentially dangerous constrictions) as well as the examination instrument, so that it can be guided with millimeter precision. The catheter is usually only 1.5-1.8 millimeters thick but is able to take on the necessary instruments such as a stent or a balloon should treatment become necessary. While balloon catheters can be "inflated" in heavily clogged blood vessels to, for example, loosen cholesterol deposits, stents are used to permanently expand constricted sections and keep them open. "We now have a wide range of instruments at our disposal," says Bonaventura, "balloon catheters, which can break even stubborn incrustations at high pressures of 8-10 or even 18 bar thanks to the specific material properties, or stents coated with various drugs that allow for long-term drug treatment."

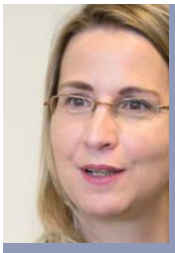
What is remarkable is that patients are conscious throughout the procedure. There is no anesthesia; only the spot where the catheter is inserted is anesthetized. "It is important for us to involve the patients in the process," Bonaventura explains. "The attending physicians introduce themselves, explain each step of the examination, and immediately evaluate the results, also to determine any further procedures."

The examination, possible treatment, and potential risks (despite the routine nature of the procedures) are explained at least 24 hours before the intervention. This is prescribed by law. This may be the first time the person has had to deal with their illness, even if they have had problems for years, Bonaventura says. Most patients do not want to know about the rare-but-possible complications. "This is where the mental cinema starts: While it is 'everyday business' and a routine examination for us, patients naturally see the risks – however small they may be – in connection with themselves. It is important for us, however, that they make informed decisions."

Better information before a cardiac catheter examination should reduce stress

Because the CCL team is well aware of the psychological stress that patients feel after learning about the examination, it is always trying to improve how patients are informed, for example through the project "Palpi-

Live transmission during a cardiac catheter examination.



THE RESEARCHERS

Prof. Pia-Maria Wippert has been Professor of Sports and Health Sociology at the University of Potsdam since 2010. She specializes in risk stratification of stress associated diseases and intervention development.

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Priv.-Doz. Dr. med. Klaus Bonaventura studied Human Medicine at Saarland University in Homburg/Saar. He is the medical director and head of the Cardiology and Angiology Clinic of the Klinikum Ernst von Bergmann.

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tation", for which Bonaventura has teamed up with the health associate Prof. Dr. Pia-Maria Wippert from the University of Potsdam. "It is now known that life-threatening situations – including cardiac interventions – create stress, which negatively impacts the healing and regeneration processes," says Wippert. "The more stress,

Photos: Fritze, Karla (4)

Balloon catheter.

the more likely complications are," Bonaventura adds. "Both the need for painkillers and the average duration of the hospital stay increase." Improving how patients are informed before a cardiac catheter examination so that their fears are quelled could reduce stress.

"Palpitation" also focuses on the mental stress of the treating physicians and medical staff at the CCL, Wippert points out. "The work is very demanding: The CCL teams have to work very precisely within a very short time – under very stressful conditions, for example in life-threatening situations for patients." The project is meant to help them as well, Bonaventura adds. "Stress can affect the quality of medical care. We want to identify counteractive measures by analyzing the working environment and processes."

The researchers of the University of Potsdam are first trying to determine which specific factors induce stress in patients and attending physicians. For this, guided interviews are conducted with volunteers from both groups that will be analyzed and then form the basis for an information and intervention program. A pre-intervention educational film will be created for patients. After watching it, they can ask specific, individual questions so that they are optimally prepared for the procedure. "For the physicians and employees, we want to develop guidelines – a number of concrete tools – to help them deal with stress," Wippert explains. "They should learn to not take it home with them, to relax and unwind."

The researchers plan to validate the complex interventions in a third step. Chemically analyzed hair samples will determine the chronic stress level of the physicians before, during, and after taking part in the program. "This should tell us whether stress can be permanently reduced," says Wippert.

The goals are ambitious. "In the field of cardiology, there are many technical innovations, but we want to improve the overall conditions," says Bonaventura, adding, "There are about 600 facilities in Germany performing about 750,000 cardiac catheter examinations each year. Our results could help many others."

MATTHIAS ZIMMERMANN
TRANSLATION: SUSANNE VOIGT

Photos: Fritze, Karla (2)

Cosmopolitanisms in the Plural

Research Training Group "Minor Cosmopolitanisms" explores global forms of coexistence

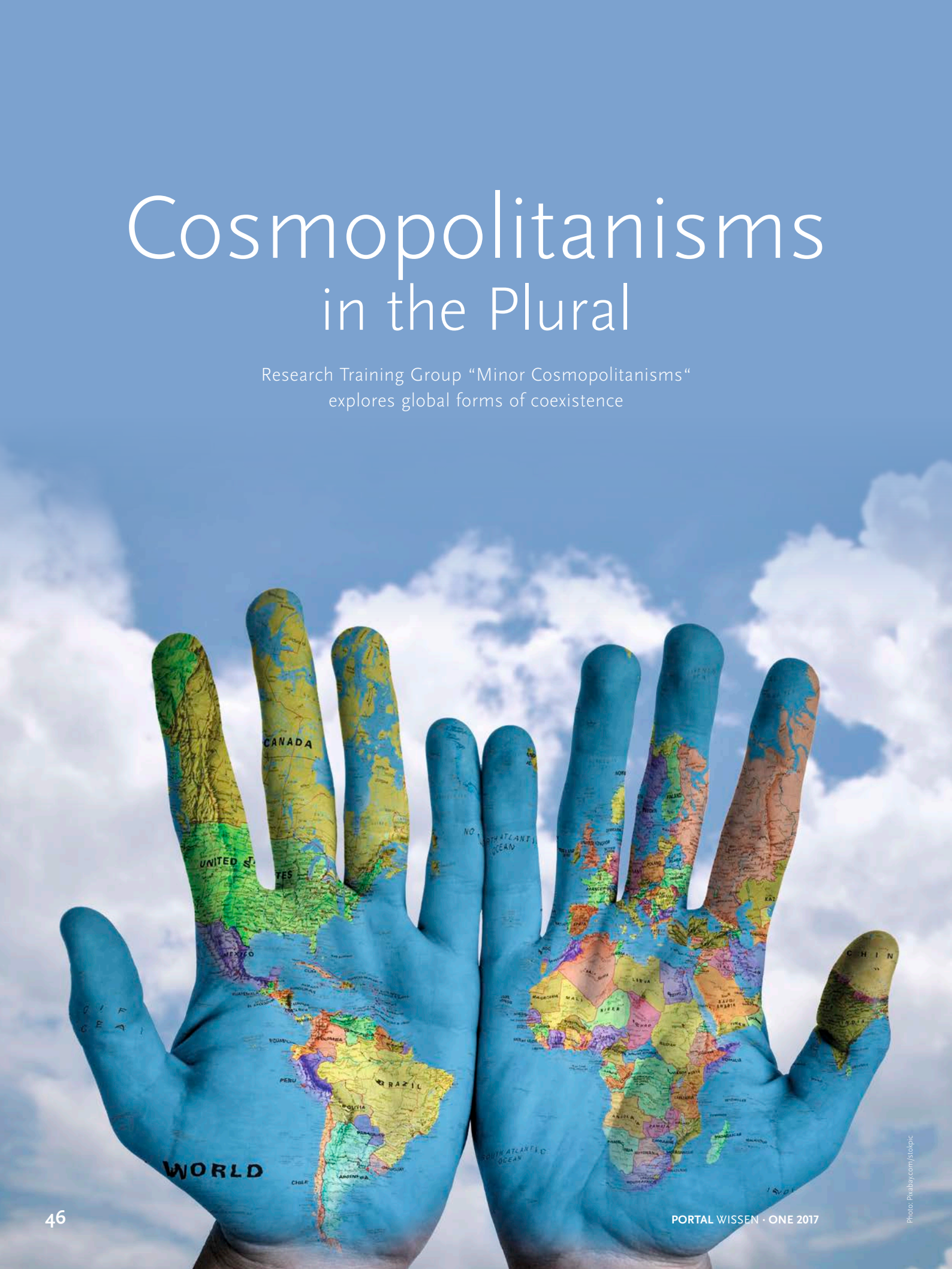

Photo: Pixabay.com/stokpic

The Enlightenment took place in 18th-century Europe – or did it? Prof. Lars Eckstein and Prof. Dirk Wiemann, Anglicists at the University of Potsdam, argue that some phenomena of the Enlightenment also occurred at other times and elsewhere in the world, for example in 5th-century-BCE Greece, in India at about the same time, and in the 17th century in an area south of the Sahara in present-day Mali. The newly established Research Training Group (RTG) "Minor Cosmopolitanisms" at the University of Potsdam looks at such historical and present-day forms of knowledge production within but primarily outside Europe. "We want to explore the ideas and knowledge of transcultural life that have emerged in all parts of the world," say the two spokespeople.

But what are these "minor cosmopolitanisms" that the researchers want to investigate? "The concept of cosmopolitanism has been around for a very long time. It can be traced back to the Stoics in ancient Greece," Eckstein explains. The word is derived from the Greek words *kósmos* ("world" or "order") and *pólis* ("place" or "politics"). In the 4th century BCE, Diogenes of Sinope was presumably the first to declare himself a cosmopolitan; and in doing so, he sought to show his obligation not merely to his city-state but to all of humankind. "Women, non-Greeks, so-called 'barbarians', and slaves were not part of the Polis at that time," says Wiemann.

Enlightenment formulated the idea of cosmopolitanism

During the Enlightenment, the idea of cosmopolitanism became a distinctive aspect of modernity. "Cosmopolitanism", however, also involves a shift and narrowing, "because with the 'citizen', a particular person is placed at the center of world history – the white, male subject with private ownership," says Eckstein. This concept also influenced the US Constitution in 1787, which excluded women, indigenous peoples, and Africans. Nevertheless, philosophers explicitly formulated cosmopolitanism – which was supposed to be applicable to all people – in the singular. "The Northwest-European context of the bourgeois revolution was projected onto the whole world," Wiemann says. Other local Enlightenment concepts and visions for global coexistence were marginalized or were only able to be formulated based on the prevailing bourgeois model of cosmopolitanism. The Research Training Group wants to re-examine and relate global forms of cosmopolitanism. "The RTG asks about coexistence in the world in times of globalization," Wiemann explains, because the promise of the Enlightenment has yet to be fulfilled. "The idea of equality of all human

THE PROJECT

Since October 2016, the DFG-funded international **Research Training Group "Minor Cosmopolitanisms"** has been researching at the University of Potsdam. One postdoctoral and 12 doctoral fellows from Brazil, China, Kenya, Mexico, South Africa, Bulgaria, Switzerland, France, Germany, and the Netherlands explore global cultural and everyday practices. The project involves eight partner universities on four continents – in Asia, Africa, Oceania, and the Americas. It will not only hold summer and winter schools, but young researchers also spend two semesters doing on-site research. Some of them will even be able to obtain degrees from both the University of Potsdam and one of the partner universities. The Research Training group will be receiving 3.9 million euros in funding over the next four and a half years from the German Research Association (DFG). The international project includes Macquarie University (Sydney), the UNSW (Sydney), Delhi University, the EFLU (Hyderabad), Pretoria University, the University of Cape Town, York University (Toronto), and Duke University. The spokespeople, Prof. Lars Eckstein and Prof. Dirk Wiemann, applied for the research training group together with Prof. Anja Schwarz, Prof. Nicole Waller (British Studies and American Studies), Prof. Iwan-Michelangelo D'Aprile (German Studies), Prof. Sina Rauschenbach (Jewish Studies), Prof. Regina Römhild (European Ethnology, HU Berlin) and Prof. Sérgio Costa (Sociology, FU Berlin).

www.uni-potsdam.de/minorcosmopolitanisms

Photo: Fotolia.com/Rawpixel.com

Still frame from the documentary "The Island of All Together" (2015) about refugees on Lesbos.

beings has not been realized," says the Anglicist. Enlightenment ideology itself contained the problem. Enlightenment philosophy was directly connected with European imperialism and colonialism, whose racism remains potent today. "It categorized people as objects of knowledge into ethnic groups." German philosopher Immanuel Kant proclaimed cosmopolitanism as a vision of peaceful coexistence on Earth, yet he also advocated in his anthropological writing for hierarchizing people based on ethnic criteria. "We want to address such contradictions and reflect on them from various locations in the world," explains Eckstein. "We work within the matrix of cosmopolitanism but pluralize it from within."

Culture of remembrance in the Republic of Suriname.

THE RESEARCHERS

Prof. Dirk Wiemann studied English, German, and Political Science at the Carl von Ossietzky University of Oldenburg. Since 2008, he has been Professor for English Literature at the University of Potsdam.

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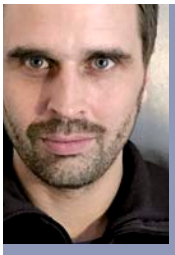

Prof. Lars Eckstein studied English, German, and Sports in Tübingen and the US. Since 2009, he has been Professor for Anglophone Literatures and Cultures outside of Great Britain and the US at the University of Potsdam.

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Knowledge is a crucial aspect in this context. "In classical Enlightenment, there was only one form of education," says Wiemann. "Everything else was magic or superstition." The researchers, therefore, want to investigate alternative forms of knowledge that have evolved worldwide and developed visions and laws of global coexistence. "We understand films, literature, theater, exhibitions, protest movements, and the like as forms of knowledge production," Eckstein adds. "We are, therefore, well prepared to take on this task as literary and cultural scholars."

From refugee films to a sound archive

Global "methods of demonstration and representation" examined by the group's young researchers include, for example, films made by refugees with their mobile phones on their way to Europe. How do they experience the flight and the European border regime? What kind of pictures do they use for their cinematic self-documentation? Doctoral student Anouk Madörin addresses these questions in her highly topical research project.

Irene Hilden's work deals with the sound archive of Humboldt Universität, which contains sound re-

Photos: www.theislandofalltogether.com (top left); Wikipedia.org/Mark Ahsmann (top right)

cordings of imprisoned colonial soldiers from a WWI prison camp near Berlin. "Among them were Tartars who had to fight for the Russian Empire, North and West Africans who fought for the French, and Indian soldiers who had gone to war for the British Empire," explains Eckstein. Language and human sciences researchers from Germany forced the prisoners to speak a text in their language onto wax cylinders. The prisoners were also measured anthropomorphically, and plaster casts of their heads were made for anthropological "racial research". "The legacy of such a sound archive is politically extremely difficult."

Yann Le Gall explores how African states and communities deal with colonial-era bones that have since been returned from Europe to South Africa, Namibia, Zimbabwe or Tanzania. Are they buried there? Are they displayed in a museum? Do they serve a political purpose? "It is important in such projects that the fellows not only go overseas and do two semesters of research at our partner universities but that their work is supervised there as well," say the spokespeople. "We closely cooperate with our colleagues in South Africa, India, Australia, the US, and Canada as well as Humboldt Universität and Freie Universität in Berlin." The two researchers believe that the diverse and often controversial research projects also require experimental research methods. They want to give their doctoral students the freedom to bring diversity into the research group.

The research program organizes two annual summer schools at the partner universities. Three years from now, a closing conference at the Haus der Kulturen der Welt in Berlin will combine the researchers' findings. In the final year of funding, the colleagues will also have the opportunity to organize *outreach* projects and to stage performances, exhibitions, readings, or plays. "We want to reach not only scholars," explains Wiemann. "Our goal is to take a plurality of knowledge beyond the university and into the public."

JANA SCHOLZ
TRANSLATION: SUSANNE VOIGT


Sound archive of Humboldt-Universität.


Photos: Kirby, Tim/BBC NV

Better Therapies with Mathematics

Graduate program PharMetrX
trains young scientists in pharmacometrics

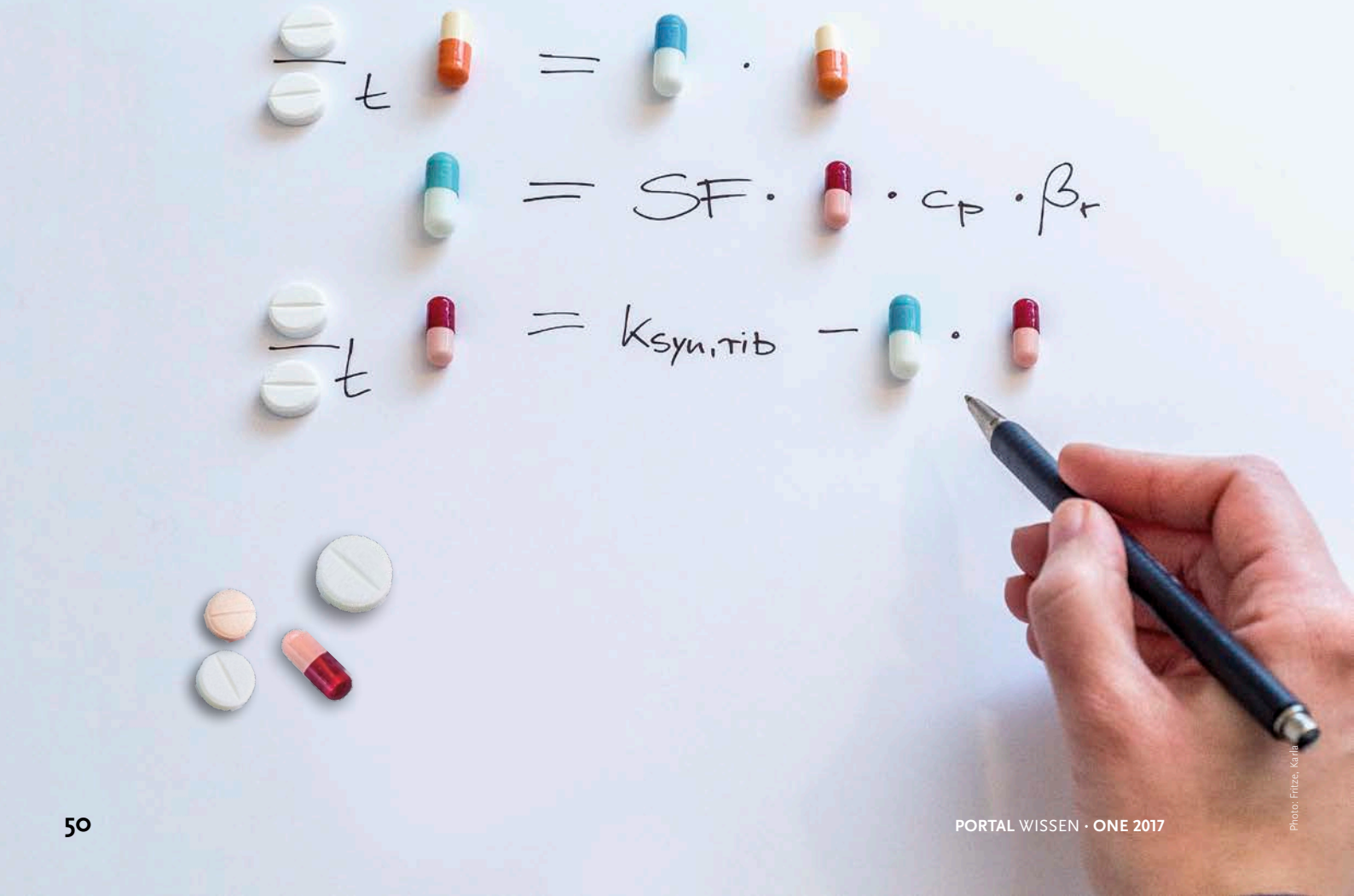


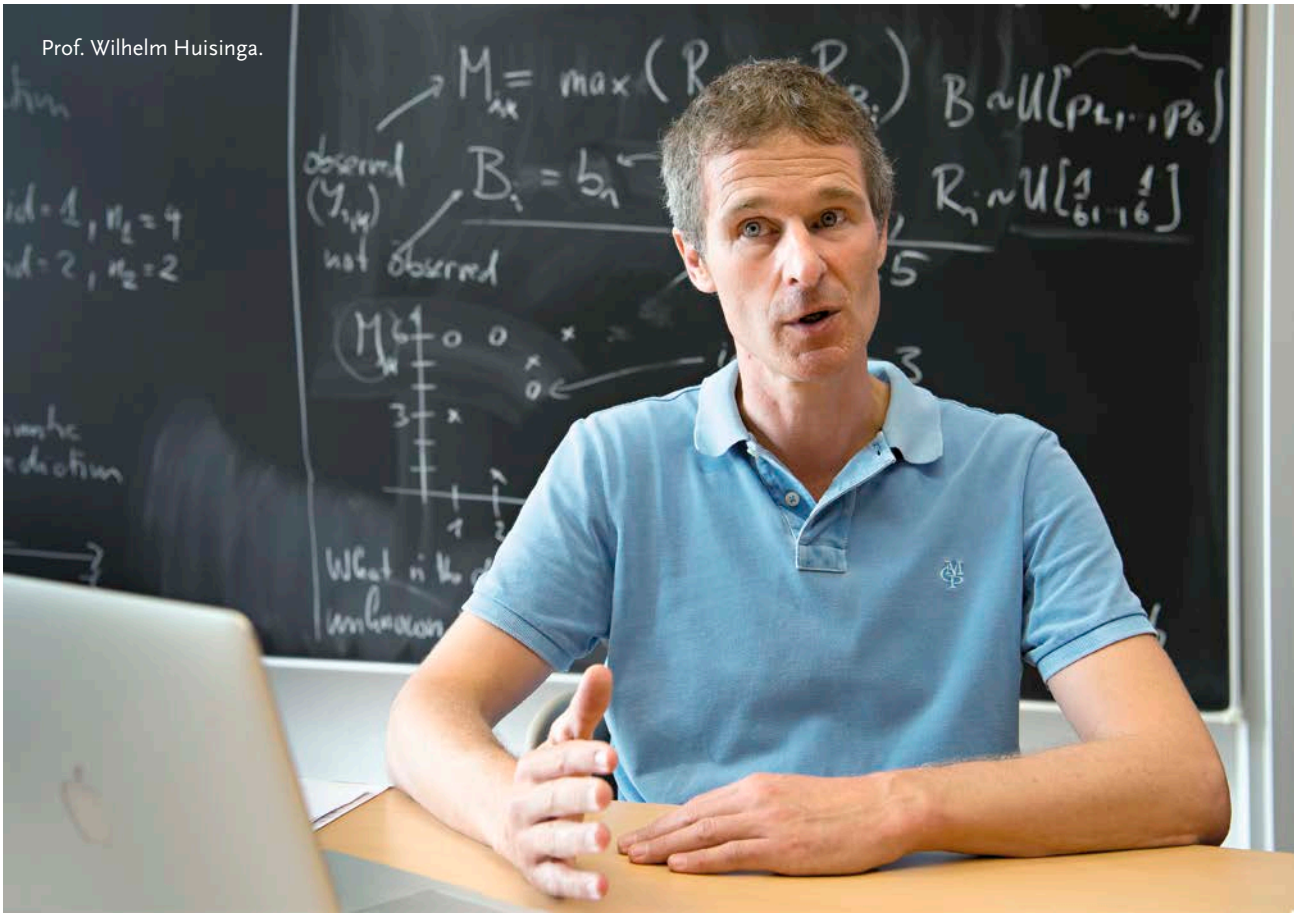
Photo: Fitze, Karla

Pharmaceutical research is changing: In addition to classical clinical trials, mathematical models are increasingly being used to extract new knowledge from complex datasets in order to streamline planning for pharmacological experiments and clinical trials. This demands interdisciplinary expertise: researchers need to understand both mathematics and pharmacology. The graduate program "PharMetrX" teaches young scientists crucial research methods and procedures.

A patient arrives at the ER with a fever and difficulty in breathing. Doctors diagnose pneumonia. Rapid action is required, since the mortality rate rises with every hour. The physicians first decide to administer a combination of antibiotics – hoping that one of them is the right one. But what combination covers the broadest spectrum of pathogens? And what dosage should be given to avoid side effects and antibiotic resistance? This is where pharmacometrics comes in, a discipline that uses and develops mathematical and statistical methods to answer how drugs should be developed and used therapeutically. Since 2008, the graduate program "PharMetrX: Pharmacometrics & Computational Disease Modelling" – a joint initiative of Freie Universität Berlin and the University of Potsdam – trains young scientists in this emerging branch of research.

Physiological processes are represented in mathematical equations

One of the young scientists is 30-year-old PhD student Christoph Hethey. He is investigating the effectiveness of various antibiotic combinations and whether their active ingredients interact. To be able to do this, Hethey – a pharmacist – is developing new methods to simulate possible infection scenarios using comprehensive datasets from pharmacological research. They simulate the reactions between bacteria and the various active ingredients. "Mathematics is a language in which you can formulate complex issues and analyze them quantitatively," explains Wilhelm Huisinga, Professor of Mathematical Modelling and Systems Biology at the University of Potsdam. He chairs the program, together with Charlotte Kloft, Professor of Clinical Pharmacy and Biochemistry at Freie Universität Berlin. The active ingredients' path, absorption, distribution in the body, metabolization, and, ultimately, their effect at the target location – all of this can be represented in formulas and equations. The data on which the models are based were obtained from tests in cell cultures, on animals, and from clinical testing on humans, i.e. from all the testing required before a new drug is approved.



Prof. Wilhelm Huisinga.

Photo: Fritze, Karla

Immersion course of the "PharMetrX" graduate program.

PhD student Jane Knöchel is also participating in the program. While pharmacist Christoph Hethey focuses mainly on mathematical methods, Knöchel – a mathematician – is looking to acquire the necessary biological and biochemical knowledge in the program. "Pharmacists have less experience in statistics, whereas mathematicians lack pharmaceutical knowledge," Wilhelm Huisinga summarizes. The graduate research training program complements the necessary methodological skills through immersion courses. In six one-week modules, each of the young researchers learns the joint language of pharmacometrics and how physiological processes can be represented in mathematical models.

THE GRADUATE PROGRAM

PharMetrX (Pharmacometrics & Computational Disease Modelling) was launched in 2008. Young researchers with a background in mathematics, biochemistry, or pharmaceutics are trained in the field of pharmacometrics. The discipline combines mathematical, statistical, and pharmaceutical methods and approaches.

https://www.pharmetrx.de/

Mathematical models must be kept simple

Knöchel's research project also looks at the coagulation cascade. It starts in the human body, for instance, after an injury to stanch the bleeding and follows an exact sequence of protein breakdowns. Various proteins are involved that are structurally changed, activated, and deactivated. For physicians and pharmacists, the complex mechanism is highly interesting, since it also plays a decisive role in strokes and heart attacks. Knöchel studies it through

Photos: Fritze, Karla (2)

the eyes of a mathematician: "The task is to rank the processes according to their significance to the complex mechanism," she explains. The starting point of her research is an existing 50-equation model. Each protein's production and decomposition rates as well as mutual interactions are described mathematically. This model is so complex that it is not suitable for many pharmacometric applications – such as the statistical analysis of clinical data. "There are too many parameters involved, so we have an identifiability problem," Knöchel says. Her doctoral thesis, therefore, focuses on methods of simplifying a model so that it shows all relevant processes of a specific issue and disregards others. "The task is to develop a new mathematical method for model reduction," the researcher outlines. For her, moving from mathematics to pharmacometrics was not too difficult, even though she had to familiarize herself with completely new scientific fields. Being able to contribute to research on both biochemistry and pharmacology was particularly attractive to her. After all, the best theory is not worth the paper it is printed on if it lacks practical relevance. "The concrete application shows how useful mathematics can be," Knöchel says.

Christoph Hethey and Jane Knöchel are two of 53 young scientists who completed – or are about to complete – their doctoral studies under PharMetrX. The program aims to advance pharmacometrics research, establish it at universities, and train young researchers. "PharMetrX bridges pharmacology and mathematics," Huisinga explains. Experts in the field are in high demand, he underlines. The need is such that six research-driven pharmaceutical companies support the PharMetrX program as cooperation partners.

THE RESEARCHERS

Prof. Wilhelm Huisinga studied mathematics in Berlin. Since 2010, he has been Professor of Mathematical Modelling and Systems Biology at the University of Potsdam. Together with Prof. Dr. Charlotte Kloft of Freie Universität Berlin, he directs the PharMetrX graduate program.

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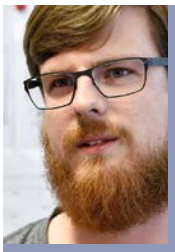

Christoph Hethey studied pharmacology at the University of Münster and has been pursuing a doctorate at the University of Potsdam since 2013.

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Jane Knöchel studied mathematics at Humboldt-Universität zu Berlin and started her PhD at the University of Potsdam in 2014.

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Pharmacometrics helps to plan optimal studies – and could even replace them

While Knöchel focuses on improving pharmacometric methods, the model developed by Christoph Hethey in his doctoral thesis deals with a more concrete topic: Which combination of antibiotics is most appropriate in which scenarios? Researchers determine this experimentally, but "if you use mathematical models instead, experiments can be planned optimally, which saves time and effort," Hethey explains. In his model of 10 differential equations, the modes of action of the various substances are represented at cellular level so that possible interactions and their influence on bacteria population growth can be predicted. This example shows that pharmacometrics is not about depicting existing knowledge mathematically but rather about being able to make predictions. What happens when active ingredients interact in the human body? What if a patient has diminished organ function or certain genetic predispositions that lead to a faster decomposition of the active ingredient? What dosage changes would be necessary? Instead of examining such issues from scratch in complex tests, mathematical modeling provides new insights through which certain hypotheses can be ruled out from the start. So does that mean pharmacometrics can replace traditional experimental studies on active ingredients? "Under certain conditions," mathematician Huisinga answers. For some issues, clinical testing on humans is no longer necessary, since the human-drug interaction has been sufficiently researched for mathematical models to make reliable predictions. This applies, for instance, to the interactions of some drugs, an increasingly important problem. In this field, pharmacometrics is doing pioneering work: "Some drugs on the market are now using mathematical modeling for dosage adjustment, which is noted in the patient information sheet."

HEIKE KAMPE
TRANSLATION: MONIKA WILKE

Porpoise in the Ecomare Nature Museum in the Netherlands.

PORPOISE

The small bottlenose dolphin, brown fish, or mereswine: There are many names for the harbor porpoise in the literature. Like dolphins and other whales, the approximately 1.5- to 2-meter mammals come to the surface of the water to breathe. The common porpoise lives in the shallow coastal waters of the North Atlantic – off the coast of Europe, northwest Africa, and eastern North America. The animals also live in the Black Sea and the coastal waters of the North Asian and North American Pacific and feed on fish, crustaceans, and squid. The porpoise is the only whale species native to the Baltic Sea. The population in the inner Baltic Sea is facing extinction. Many animals suffocate in gillnets; pollutants and noise also endanger their survival.

Photo: Wikipedia.org/Ecomare

The Dolphin's Shy Relative

Genetically analyzing endangered cetaceans in the Baltic Sea

You need some luck to see them. Porpoises are shy and inconspicuous. These two-meter animals flash their dark fins above the water only to immediately dive back down again. Researchers have been observing them in the North Sea and Baltic Sea for decades. Using new molecular-genetic methods, Potsdam researchers are investigating whether these animals form independent populations.

It is only a small piece of frozen tissue: A bright layer of fat beneath dark, leathery skin. What is in the petri dish in the laboratory of the Chair for Evolutionary Biology once belonged to a porpoise, which was found dead on a Baltic Sea beach and now benefits scientific research. Hundreds of these samples from various specimens are stored here at -20°C, sometimes even at -80°C for long-term storage. They are cut and digested by enzymes. The researchers are interested in the genetic information hidden in the tissue, present in the DNA in every individual body cell, because analyzing it offers insight into the animals' relationships. The question of whether Western and Eastern Baltic Sea animals differ from one another and form independent populations is crucial for their protection.

Porpoises in the Dolfinarium Harderwijk.

One of the two populations in the Baltic Sea faces extinction

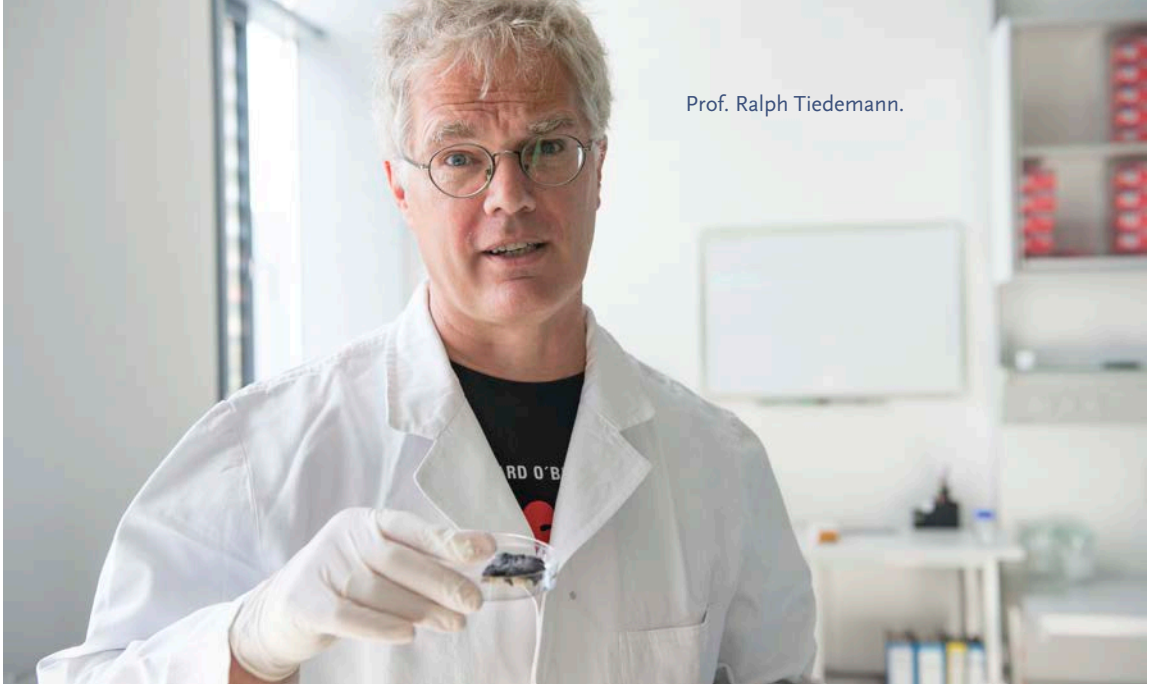
Ralph Tiedemann, Professor of Evolutionary Biology and Systematic Zoology, has been researching porpoises since the early 1990s. "How many of these animals are actually living in German waters?" This question concerns science now as it did back then, the researcher explains. At the German Oceanographic Museum in Stralsund, researchers measured the skulls of some porpoises and were able to identify morphological differences depending on their geographical origin. Some had longer mandibles than others, which Danish studies have corroborated. It was the first indication of two separate populations of porpoises in the Baltic Sea. Using various methods, they tried to record the reclusive animals and determine the populations' location and size. The researchers were also interested in the migration of these mammals.

Under the direction of the German Oceanographic Museum, researchers initiated a study with underwater microphones in 2002, installing 12 hydrophones in the Baltic Sea. The researchers then installed a network of 304 submarine microphones between Rostock and Finland in 2011. The devices captured the porpoises' typical clicks that they use to orientate themselves and hunt under water. There were also sighting campaigns by plane and genetic investigations.

The results confirmed that there are not only different populations in the North Sea and Baltic Sea but also two distinct groups within the Baltic Sea. While the population of the Western Baltic Sea, the so-called Inner Danish waters was about 10,000, there are only about 500 in the central and Eastern Baltic Sea. The latter population causes concern, as it may be in danger of extinction. Most of the porpoises found on the beaches died in fishing nets. The extensively used nets that are made of thin yet extremely tear-resistant nylon

Porpoise tissue in the Potsdam lab.

Photos: Dähne, Dr. Michael/Delfinarium Harderwijk (2nd from the left); Fritze, Karla (right)



Prof. Ralph Tiedemann.

threads become a death trap for the porpoises. They will drown if they get caught in the mesh, because they would no longer be able to come up to the surface for breathing. So far, attempts to keep porpoises away from gillnets using signals have only been partially successful. Noise pollution from ship traffic and the construction of offshore wind power plants may pose additional problems to these cetaceans. Furthermore, they are at the end of the food chain – pollutants accumulate in their bodies.

Tiedemann and his team analyze the complete porpoise genome

If a dead porpoise washes ashore in Mecklenburg-Vorpommern, Michael Dähne and his team get down to business. As a curator for marine mammals at the German Oceanographic Museum, he takes care that the dead animals are first recovered and prepared for scientific studies. “Every year, we have 20-60 dead animals,” says Dähne. Fishermen who find dead whales in their nets sometimes also bring them to the Oceanographic Museum. Each specimen is recorded, given an identification number, and initially frozen. In the subsequent dissection, the researchers of the Oceanographic Museum investigate whether the animal suffered from diseases, whether it had parasites, and its cause of death. A toxicological analysis shows the level of pollution.

The researchers also take numerous tissue samples for further scientific studies. “An animal is almost completely utilized,” says Dähne. Ribs and muscle tissue go to the Belgian University of Liège, where they determine the porpoises’ food web through isotope analysis. Other institutions examine the samples for bacteria and viruses. The porpoise’s skeleton remains in the oceanographic museum and is studied morphologically. The complete dissection of a porpoise takes 2-4 hours. A portion of the skin and muscle samples also goes to Potsdam, to Ralph Tiedemann’s genetic laboratory. The carcass must be as fresh as possible for the molecular-genetic investigations that are carried out here, because only intact hereditary material can be used for genome-scale analyses. Since decomposition begins immediately after death, it is a race against time. Parallel to the studies on individual animals, Tiedemann and his team are currently analyzing the complete porpoise genome. Whether the two groups of porpoises in the Baltic Sea are two separate populations may seem unimportant to the layperson. In fact, the answer could decide whether the group in the central Baltic Sea will survive the coming decades. “If you consider the animals in the entire Baltic Sea to be one population, you could argue that there are still 10,000 animals and a few hundred more do not matter,” Tiedemann explains. "Regarding the animals in the central Baltic Sea as a separate population, however, means that they are in great danger. Then you have to discuss how big the difference between the populations must be to be relevant for nature conservation.”

This is precisely the question asked by the Potsdam researchers, who want to use molecular-genetic

Photos: Fritze, Karla (2)

methods to determine in what ways the two Baltic Sea groups are distinct. It is known that the areas of the two populations overlap, but they seem to stay there at different times. While the large group from the northwestern Baltic Sea is in the Pomeranian Bay between June and September, the small group is mainly in Swedish and Polish waters. The researchers assume that this vulnerable population spreads throughout the Baltic Sea during winter. Whether the two porpoise populations intermix has not yet been able to be ruled out. The Potsdam researchers are investigating this with molecular-genetic methods. Their analyses even allow them to determine the degree of relationship of individual animals.

Michael Dähne emphasizes, "To know where the animals' habitat is and how they migrate seasonally is the most important prerequisite for their protection." This is only possible in cooperation with fishermen. "Methods have to be developed to reduce bycatch." This could be achieved with alternative fishing methods, such as longlines or fish traps.

The occurrence of single mutations – so-called single nucleotide polymorphisms (SNPs) – of 400 animals is being evaluated. "Small but consistent differences" have already become apparent, Tiedemann explains. The paths of the two populations continually cross each other during seasonal migrations, but the animals may not mate with each other and always return to their original areas. This provides new, pressing arguments for the protection of the smaller Baltic Sea population. "The porpoise is the only whale species that reproduces in German waters," Tiedemann emphasizes. His conclusion, however, is disillusioning. "If the population in the central Baltic Sea dies out, there will probably be no more porpoises in the foreseeable future."

HEIKE KAMPE
TRANSLATION: SUSANNE VOIGT

THE RESEARCHERS

Prof. Ralph Tiedemann studied biology, computer science, and Icelandic at the universities of Kiel and Reykjavík. He earned his doctorate with population-genetic studies on eider ducks and wading birds. After working as a visiting scholar at the Free University of Brussels (ULB), he received his habilitation in zoology in 2000. Since 2002, he has been Professor of Evolutionary Biology and Systematic Zoology at the University of Potsdam and researches population differentiation, species-formation processes, and adaptation phenomena in various organisms, e.g. whales, birds, amphibians, fish, and rotifers.

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Dr. Michael Dähne studied applied geography and environmental protection at the University of Rostock. Since 2015, he has been Curator for Marine Mammals at the German Oceanographic Museum in Stralsund and researches the population sizes and distribution patterns of marine mammals in the North and Baltic Sea.

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Photos: Fritze, Karla (top); Dähne, Dr. Michael (middle); Dähne, Dr. Michael/Deutsches Meeresmuseum (bottom)

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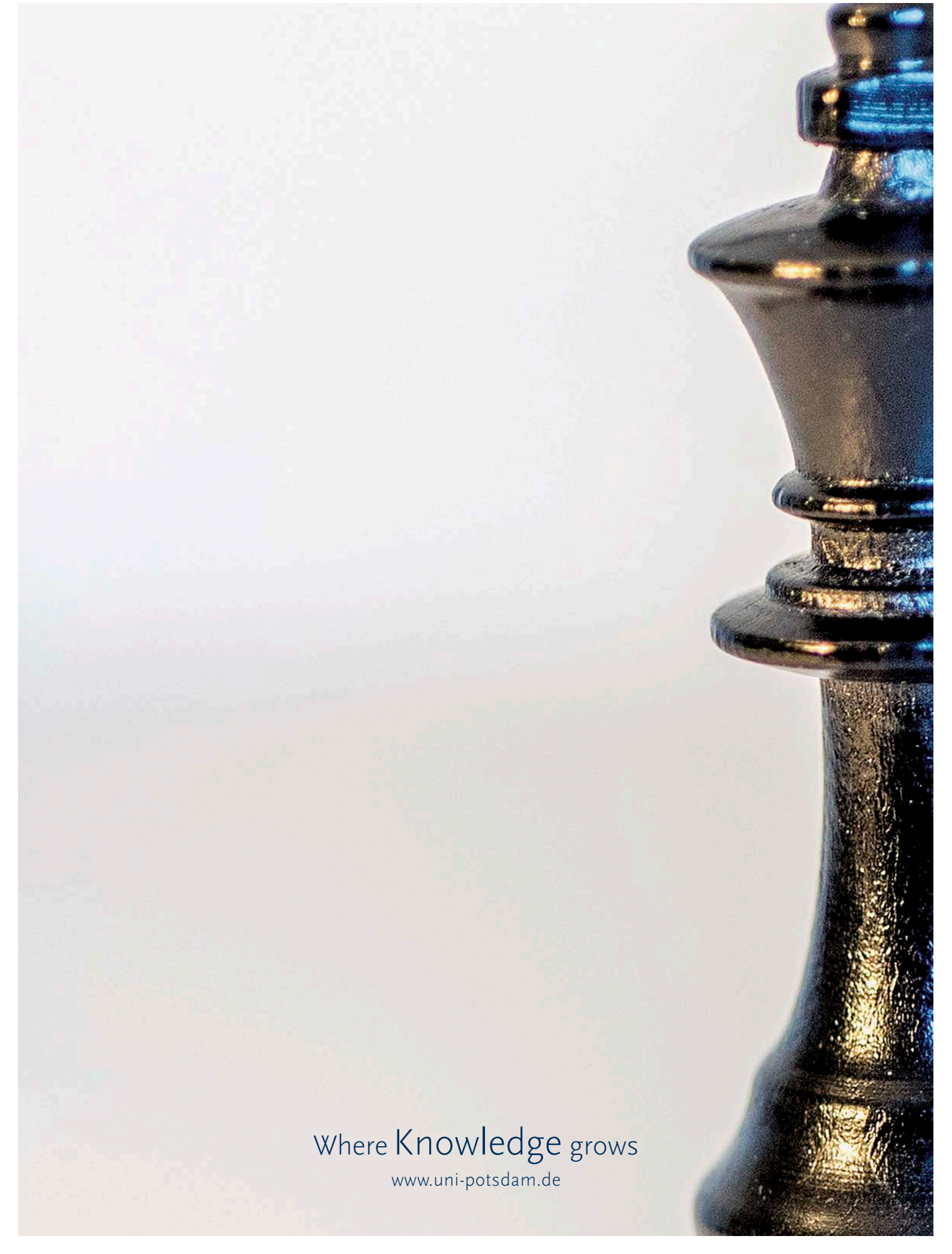

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