

german research

Magazine of the Deutsche Forschungsgemeinschaft

1/2014



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Cover: Corbis/Zakir Hossain Chowdhury

Garments workers demonstrating for compensation and service benefits in Dhaka, Bangladesh – with a current population of more than 13 million, one of the fastest growing megacities in the world.



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Peter Funke

The Digital Transformation

Big data, digitisation, open access – research libraries are facing some major challenges, which must be taken into account in DFG infrastructure programmes. The introduction of specialised information services is a further step in this direction.

When someone predicts the impending demise of an institution, it tends to outlive expectations. A few decades ago, the imminent disappearance of libraries was predicted, yet now, at the beginning of the 21st century, we are seeing the opposite: new libraries are being built, including some architecturally stunning examples, and old institutions are enjoying fresh interest and growing visitor numbers. In the 1990s it seemed that university computer centres would increasingly take over the job of academic libraries. But through a smart and flexible strategy, libraries have managed to adapt their traditional infrastructures to a fast-changing digital world and not only maintain their position in the research system, but actually expand it – thanks in part to the support of the DFG.

The remarkable transformation of our libraries in recent decades is due primarily to new technologies delivering ever higher quality digitisation of all kinds of knowledge resources. In spite of all the doomsayers, books have a long life ahead of them yet – even if they are no longer only read in printed form. Maintaining access to literature remains a core task of our libraries, be it in the reading room or on the computer screen. But they must also ensure that they provide new forms of media to organise and give access to information.

This is no small undertaking. When a library service runs smoothly, all is well. Yet many users are often unaware of the technical, organisational and above all financial challenges associated with keep-

ing it that way. The everyday use of the internet and search engine hit lists are continually increasing user expectations of having access to comprehensive, up-to-date digital information almost instantaneously. However, it is all too easy to forget that this content – unless provided on an open-access basis – can only be acquired with significant financial outlay on the part of libraries, whose budgets, paradoxically, continue to fall.

It is important to the DFG to ensure the continued availability of literature and other sources of specialised information for the purposes of research. Ever since it was founded, the DFG has maintained a funding programme dedicated to the establishment and development of information infrastructures that go beyond the standard basic functions of a library and benefit researchers throughout Germany.

A key element of this funding was a plan for special subject collections, established back in 1949. This was a response to the fact that, unlike France or Great Britain, for instance, federal Germany had no national library. An acquisition system was gradually established in which a large number of libraries shared the task of acquiring a comprehensive stock of research literature from abroad and making it available for loan all over the country. After the catastrophe of the Second World War, this effective supply system played an important part in enabling German researchers to reintegrate relatively quickly in the international research community.



The system of special subject collections continued largely unchanged for a number of decades, although with regular modifications, and the question eventually arose of whether the original mandate of acquiring as much foreign literature as possible across all subjects still met the needs of users in the digital age. A comprehensive evaluation carried out in 2010–2011, which included a large-scale user survey, prompted a fundamental reorganisation of this funding instrument in 2012.

The new name of the programme, Specialised Information Services, reflects the new objectives. The system is designed to allow researchers based in Germany, irrespective of where they work, fast and direct access to specialised literature and research-specific information that is not available at every institution

in the same scope and in the same quantity. By concentrating on specialist publications and on offering information focussed on specific disciplines, the system aims to supplement the local information infrastructure at universities and research institutions by providing services for peak demand.

In this way, the DFG aims to develop a lasting information infrastructure which serves the specific interests and requirements of these disciplines and thus provides an essential component for first-class achievements in basic research. In terms of acquisitions, this means concentrating on specialised material which is not already available elsewhere but is of high relevance to research. If digital media are to be consistently integrated, new licence models must be developed to allow content to be shared between research institutions for entire disciplines. Other key funding areas will include the digitisation and provision of research data and the retrodigitisation of research-relevant printed material.

The gradual introduction of the new funding programme, which began in 2013 and will be completed in 2015, is no easy task, and will not become any easier. There will be initial questions and challenges that will need to be discussed and addressed through close cooperation between all the parties involved. The new specialised information services can only be optimally implemented through dialogue with users.

At the same time, libraries, as both repositories of knowledge and information exchanges, must rise to this additional challenge in order to secure their essential and prominent position in the research system. To do this, in addition to the support of the new DFG funding programme they will need adequate public funding in order to fulfil their basic mandate.

What is certain is that this investment will pay for itself, because excellent research always depends on an excellent information infrastructure.

Professor Dr. Peter Funke

is Vice President of the DFG and Director of the Institute of Ancient History / Institute of Epigraphy at the University of Münster.

Impulses

Research in Brazil

In late January, the São Paulo Research Foundation FAPESP organised a two-day symposium on the theme Excellence in Higher Education. The DFG was invited to give a presentation on “Research and the Graduate Schools”. The purpose of the symposium was to discuss the quality and quality enhancement of Brazilian research and university education, including a comparative international perspective. Dr. Dietrich Halm, director of the DFG Office Latin America in São Paulo, and Professor Colin Grant from the University of Bath were invited to report on current programmes to increase academic excellence from the perspective of a European research funding provider and a European university respectively.



Illustration: DFG/Jörg Schneider

German-Turkish Year of Science, Education and Innovation 2014: DFG President Professor Peter Strohschneider and the President of Turkish partner organisation Tübitak, Professor Yücel Altunbasak, sign a new memorandum of understanding. The signing took place as part of the official launch of the German-Turkish Year of Science, Education and Innovation on 23 January in Berlin by Professor Johanna Wanka, Federal Minister of Education and Research (standing, left), and Fikri Isik (right), Minister of Science, Industry and Technology of the Republic of Turkey. Over 500 representatives of German and Turkish research organisations, research institutions, universities and businesses attended the launch. The year-long event will also celebrate 30 years of German-Turkish relations in science.

Expanding Relations

DFG President visits Polish partner organisation

DFG President Professor Peter Strohschneider has underlined the strong relationship between the research communities



Foto: NCN/Michal Niewiana

in Germany and Poland on a trip to Warsaw and Krakow. Between 17 and 19 February 2014, four delegates from the DFG visited the Foundation for Polish Science (FNP) in Warsaw followed by the German Historical Institute and the Polish Academy of Sciences (PAN). The Polish Minister of Science and University Education, Professor Lena Kolarska-Bobińska (centre in group photo) was also present at the formal signing of the memorandum of understanding between the DFG and the National Science Centre (NCN) at the historic Wawel in Krakow. The agreement lays the foundations for the joint funding of humanities and social sciences projects by the DFG and the NCN.

Transatlantic Cooperation

DFG President travels to the United States and Mexico

The end of April saw DFG President Professor Peter Strohschneider travel to America. The agenda included wide-ranging talks on current developments in science policy in Germany, the USA and Mexico, the conclusion of agreements on greater joint research funding and a change of personnel. The five-day trip to Mexico City, New York and Washington underlined the significance that the DFG attaches to international cooperation in science and research. At the conclusion of his visit, the DFG President noted that the USA remains a particularly important partner: “The links between our research systems are extraordinarily close and much more than just a matter of business; they are informed by friendship, shared concerns and fruitful dialogue.”

Strohschneider’s visit to the USA was marked by his first meeting with France Córdova, the new Director

of the National Science Foundation (NSF). They signed an agreement in Washington DC under which the DFG and the NSF will jointly fund structured programmes for early career researchers in future. Other items on the agenda included a meeting with Peter Ammon, the German ambassador to the USA, talks with representatives of the US government and of research organisations, a lecture at a conference on “Harmonizing Global Research” and preparatory discussions about the annual meeting of the Global Research Council, to be held at the end of May in Beijing.

In New York, the DFG President visited the Social Science Research Council (SSRC) with which he agreed greater in-depth collaboration. Together with the New School for Social Research and the SSRC, the DFG is planning a conference on inequality in the US and Germany.

DFG President Peter Strohschneider (second from the right) with Eva-Maria Streier, the former New York Office director, and Annette Doll-Sellen, the new director (centre left and right), German Consul General Busso von Alvensleben (second from the left), Max Vögler, DFG Washington Office (far left), and Jörg Schneider, head of the DFG International Affairs Division (far right).



The first stop on the trip was Mexico City. Professor Strohschneider and the General Director of the National Mexican Council for Research and Technology, Professor Enrique Cabrero Mendoza, signed a cooperation agreement which will allow coordinated funding programmes to be financed with contributions from both countries. At the Colegio de México, Strohschneider was shown the work carried out by the first International Research Training Group with a Latin American country: “Between Spaces. Movements, Actors and Representations of Globalization.”

During the visit, there was a change of personnel at the DFG’s Office in New York. At a ceremony in the German House, Strohschneider bade farewell to the outgoing head, Dr. Eva-Maria Streier, who was retiring after almost 30 years at the DFG. A journalist with a doctorate in American Studies, she was appointed Director of the DFG Office on the East River in 2011. She had previously worked at the DFG Head Office in Bonn for more than 25 years as Head of Press and Public Relations and as Press Spokesperson. Before an audience of 80 guests, including the German Consul General, Busso von Alvensleben, and representatives from universities, research organisations, embassies, Jewish organisations and the UN, Strohschneider praised “the exceptional contributions and achievements she has made in both positions”.

On the same evening, Dr. Annette Doll-Sellen, who had previously worked at the DFG’s International Affairs Division, was introduced as the new Director of the DFG Office in New York. Having presided over KoWi, the European Liaison Office of the German Research Organisations in Brussels, Doll-Sellen has extensive knowledge of research funding by the EU.

Sabine Baumgart and Volker Kreibich

Spaces, Rights and Resources

From city to megacity: Dhaka in Bangladesh is an example of how people living in peripheral settlements strive to secure their survival. But this “informal urbanisation” presents urban planners with enormous challenges.





Opposites meet: The unplanned settlement of Korail is within sight of expensive new building complexes in Dhaka, a city of 13 million inhabitants.

Dhaka, the capital of Bangladesh, is one of the fastest growing megacities in the world. The current population of 13 million is expected to rise to more than 20 million by 2020. The annual population increase of around 400 000 people is the same as the size of an average city in Germany. The dynamic migration of poor people from rural areas is presenting enormous challenges for the city in terms of housing, water and electricity supplies, sewage and waste disposal, the availability of jobs and the provision of health-care and education facilities.

In the metropolitan region of Dhaka, 640 000 households live in 5000 unplanned, densely packed settlements accounting for just 5% of the city's total area – without proper roads, utilities and services and in unsanitary and dangerous conditions. At the same time, as in most megacities around the world, there is a growing demand for luxury housing. The scale of investment is sending land and property prices sky-high. In some districts, prices are comparable to the suburbs of New York – unaffordable for low-income households, including the

lower middle classes. On the outskirts of the city, as well as in the centre, unplanned settlements are emerging for the urban elite. In order to build them, agricultural land is being converted and ecologically important natural spaces, for example for the region's water supply, are being destroyed.

The global urbanisation processes which mean that by 2050, 75% of the world's population will live in cities, are raising questions about the controllability of urbanisation and the complex causes of poverty in megacities. Between 2006 and 2013, these questions

Public space in Dhaka is used for many purposes – to the extent that entire quarters are sometimes inaccessible either on foot or by vehicle.



were discussed in interdisciplinary research teams as part of a DFG-funded Priority Programme, “Megacities – Megachallenge: Informal Dynamics of Global Change”. The key questions facing urban planners are: How does a poor population secure its livelihood in informal settlements? Given the extremely cramped living conditions, how are public spaces used for household organisation and economic production processes? And how is the necessary technical infrastructure brought to these areas without a statutory process of urban planning?

The research shows the high level of pressure on public spaces as a scarce resource among poor urban dwellers. With an average per capita living space of 3 m² (for comparison, the average figure for Germany is about 40 m²), public spaces are used by poor households for cooking, washing and drying clothes, by small-scale businesspeople for storage and sorting, and by itinerant street vendors for setting up their stalls. Access, organisation, timing and financial terms and agreements must be renegotiated on a daily basis. Crucially, public resources are distributed by informal institutions, which are replacing action by the state. This process is strongly influenced not only by individual interests but also by family ties and religious and political affiliation.

The distribution of water is also decided by fragmented negotiation processes. In urban areas without proof of land tenure, basic services are not provided by the authorities. In the informal settlement of Korail, which is home to some



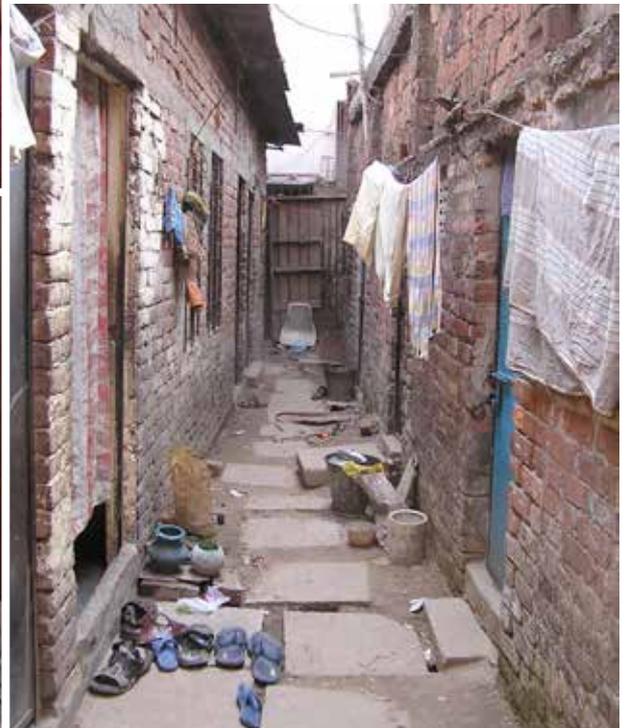
Living in an informal settlement means finding essentials for yourself, including water. Sewage disposal presents a huge problem.

100 000 people, the provision of water is organised by a combination of informal and formal institutions – by tapping water pipes, with contractual arrangements for the onwards distribution of the water to households as the end consumers. The parties involved

are informally organised local collectives and non-governmental organisations on the one hand and private market-regulated suppliers on the other. The result is poor-quality water that comes in small quantities (when it is supplied at all) and at an inflated price. It may



Because living space is so cramped, everyday life often spills out on to the streets, which are becoming narrower and more impassable.





A drainage system is improvised using whatever materials are available.

be up to ten times more expensive than the water from a regular tap in an established, affluent part of the city.

In the inner city, the rising price of land is prompting people to maximise land use by demolishing old multi-storey buildings and putting up new ones, with little regard for the city's historic heritage or buildings worthy of conservation. Public streets, increasingly used by private individuals, are becoming so crowded that for some residents access is practically blocked off. In this situation, land owners come together without consulting the city authorities to restore the necessary width of access roads and secure the profitability of their investments while achieving maximum use of a piece of land.

The dynamic rate of development on the city's outskirts is beyond the planning capabilities of an understaffed city authority corrupted by political influence – in spite of the fact that there are legal requirements to develop a functional settlement structure and protect ecologically valuable natural spaces. The city's peripheral settlements are developing largely without any urban planning, supported by a growing middle class and driven by Bangladeshi investors living abroad.

Land acquisition, parcelling and infrastructure development all take place as the result of non-transparent negotiations by various parties in a process where land owners often receive inadequate recompense and planning require-

ments and infrastructure standards are ignored. The authorities only step in afterwards to connect the unplanned areas to the public water and sewage systems at high additional cost. This ultimately gives unplanned settlements a de facto legal status.

By way of conclusion, it is important to understand that theories and concepts of spatial planning which follow the European or North American idea of a city with the ability to function as a technical, social and political system, and which are designed for common welfare, sustainability and the provision of housing, employment, education and healthcare, do not have adequate answers to these problems. Studying the facets and dynamics of mega-urbanisation requires that we understand important spatial developments and the actions of the actors involved. This research can then be used to help support urban development planning in megacities like Dhaka.



Prof. Dr.-Ing. Sabine Baumgart

teaches Urban and Regional Planning at the Technical University of Dortmund.

Prof. Dr. Volker Kreibisch

was Professor of Geographical Principles and Spatial Planning in Developing Countries at the Technical University of Dortmund until his retirement.

Contact: Technische Universität Dortmund,
Fakultät Raumplanung, August-
Schmidt-Straße 10, 44227
Dortmund, Germany



www.megacities-megachallenge.org

Thomas Hinz, Thomas Wöhler and Markus Freitag

Good Neighbours

How does social integration take place away from disadvantaged areas with social problems? A German-Swiss study is examining how migrants and locals in small and medium-sized towns live together.

The locals in Kreuzlingen, Switzerland, just across the border from Konstanz in Germany, have started calling part of their town “Neukölln” – after a multicultural district of Berlin. This area of town is home to many Germans who

have migrated to Switzerland over the last ten years. They have a reputation for not wanting to integrate and are also seen as competitors on the job market.

It might seem surprising to look at an example where Germans are

the migrants. Yet migration is a well-established phenomenon in both Switzerland and Germany, and Germans emigrate too – many of them to Switzerland. Both countries welcome large numbers of migrants, a situation which is



likely to continue. But what challenges are associated with this trend? How do migrants integrate, not just in disadvantaged districts like Neukölln in Berlin or Marxloh in Duisburg, which are often the focus of media attention, but in small and medium-sized towns, where the majority of migrants in Germany and Switzerland live? A team of sociologists at the universities of Konstanz and Bern, led by sociologist Thomas Hinz and political scientist Markus Freitag, are seeking to answer these very questions.

The project is part of the cluster of excellence “Cultural Foundations of Integration”, which has received DFG funding as part of the Excellence Initiative since 2006. This team of around 200 researchers is studying processes of integration and disintegration across epochs and all social levels, from the requirements of family and community life to political issues on a global level. The group links current issues of public debate to fundamental and empirical research, critically evaluates them, and places them on a theoretical footing.

Sociologists agree that immigration produces both opportunities and risks. The arrival of new, skilled workers, for instance, is an opportunity, given its beneficial effects for the labour market and social systems. And the fact that immigrants are generally younger and – at least in the first generation – have more children than the native population helps reduce the burden on pension systems. In addition, various cultural factors are also frequently perceived as beneficial.

But immigration only presents an opportunity if migrants successfully integrate. Successful integration does not mean complete adaptation on the part of the new arrivals. Migrants rarely feel a complete sense of identification with their new home, experiencing a sense of belonging to both their country of origin and their new country of residence. However, integration fails when social inequali-

ties of a structural nature remain between the newly arrived and indigenous communities: in other words when migrants continue to have a poorer education and lower-paid, less secure jobs.

The integration of migrants has four dimensions: first, structural integration in the education system, job market and property market; second, personal contact with people outside the migrant community, for example inter-ethnic marriage or friendship; third, the acquisition of cultural knowledge, for example language skills; and finally, emotional anchoring in the receiving community.

These four dimensions are closely interconnected. For example, the workplace provides a setting for personal interaction that may result in contacts outside the workplace. Relationships may also provide the “social capital” making it easier to find a new job. Language skills are best acquired through interaction with native speakers. But these contacts can only be made in the first place with a basic knowledge of the language. Emotional identification with a new country also cannot take place in the absence of meaningful contact with the indigenous community. But this in its turn is an important prerequisite for the formation of certain relationships.

Just as important as individual social skills and resources are the characteristics of the migrant group the immigrants belong to. This includes the relative sizes of the migrant and majority communities, the concentration of migrants in a particular area, and the extent of ethnic institutions, e.g. Turkish supermarkets in areas with a large Turkish community.



Multiculturalism as depicted by a graffiti artist in Schleusingen, Germany, in a picture on a bus shelter.

Ultimately, the process of integration largely depends on the extent to which migrants experience discrimination in the education system, on the job market and in the property market.

The research project led by Thomas Hinz and Markus Freitag has been investigating the social integration of migrants since 2010. The work is primarily concerned with neighbourhoods.

Thomas Hinz is particularly interested in social relationships operationalised as personal networks; Markus Freitag in the question of how trust is formed and integration is promoted through clubs and similar groups.

In sport, diversity and integration are common and taken for granted.

Research assistants Thomas Wöhler and Birte Gundelach produced a unique set of data based on a sample of over 900 inhabitants of Konstanz and Kreuzlingen aged between 18 and 90. This data is supplemented by detailed contextual information on the different residential environments. By design, migrants were overrepresented in the sample, accounting for 520 of the 900 people surveyed. This allows for case studies that focus on particular sub-groups, for example the traditional guest worker (Gastarbeiter) communities who arrived in Germany in the 1960s.

The result of this study is a clear picture of the type of neighbourhood in which an individual lives. Is the neighbourhood home to a large migrant community? Are there places to get acquainted with neighbours, for example parks or pubs? What social status do residents of this area have? The unique characteristic of this study is the way in which it combines detailed contextual information with individual data.

Many of the questions asked in the survey focus on the social relationships of migrants and the impact of these relationships on their lives. Examples of questions are: Do immigrants who live in a neighbourhood with lots of opportunities for contact have bigger/better personal social networks? Where do migrants meet people from their new community?





Migration is a much-debated and controversial issue in the media.

Where are friendships and partnerships formed? And what effect do these networks have on other dimensions of integration, such as language skills or identification with the community?

The study is also concerned with the willingness to integrate on the part of migrants, a topic that has attracted controversy in the media. There is currently a lot of evidence to suggest that integration is most likely to fail when immigrants have few opportunities to meet people from the majority community and to acquire their language.

In the light of the study, it appears that alarming scenarios of migrants who are unwilling to integrate are far from reality. In fact, most migrants do gradually integrate: language skills improve over time, the number of social relationships increases, and new community members increasingly identify with their new country. For example, in the area being studied, the majority of migrants

marry across their ethnic group boundaries. Almost half of an individual's friends and acquaintances belong to other ethnic groups. Both these facts suggest that there is a positive framework in place for contacts and relationships between natives and new arrivals.

The study found a connection between the characteristics of the neighbourhood in which someone lives and the degree of integration. However, the correlation is not simply that integration is less likely to succeed in areas with a large migrant population. Rather, all residents have fewer relationships when they live in neighbourhoods with a high proportion of socially disadvantaged people, for example in communities of densely populated tower blocks on the edges of the urban areas in question. The situation is similar at the other end of the social spectrum: people in affluent neighbourhoods experience equally low integration.

And what about the Germans in Kreuzlingen? At present, this migrant group does indeed appear to be poorly integrated in the Swiss community. Like most Gastarbeiter, many plan to return home soon, so they don't believe it is necessary to send their children to Swiss schools or learn Swiss German. But as time goes by, more of them will put down roots in their new community and their children will make Swiss friends. At the same time the indigenous community will get used to the new arrivals and learn to respect them as fellow citizens.



Prof. Dr. Thomas Hinz

is Professor of Empirical Social Research at the University of Konstanz.

Thomas Wöhler

is a research assistant in the cluster of excellence "Cultural Foundations of Integration" at the University of Konstanz.

Contact: Universität Konstanz, Fachbereich Geschichte und Soziologie, Universitätsstraße 10, 78457 Konstanz, Germany

Prof. Dr. Markus Freitag

is Professor at the Institute of Political Science at the University of Bern.

Contact: Institut für Politikwissenschaft, Universität Bern, Lerchenweg 36, 3012 Bern, Switzerland

www.exc16.de
www.uni-konstanz.de/nachbarschaftsprojekt/



Metin Tolan

Germany for the World

“It’s what happens on the pitch that matters,” said Adi Preissler and Otto Rehhagel, former German footballers and coaches, in some oft-quoted words of football wisdom. Statistically, the German national side managed by Jogi Löw is 6.5 times more likely than an “average” team to finally bring home the title again. Here is a scientific approach to a World Cup forecast that uses a few mathematical tricks and computer simulations.



Cup!?



There are still a few weeks to go until the 2014 World Cup in Brazil, but naturally we in Germany are keen to know how our team will fare. So how likely is it that “Jogi’s boys” will lift the trophy on 13 July and bring the coveted title home again after 24 years?

To answer this question, we will assume that a football team is basically like a radioactive source which, instead of emitting radiation, emits goals. This may seem like a strange assumption, but it actually makes perfect sense. The distribution of the number of games in which a certain number of goals k is scored is defined by a Poisson distribution, which also determines ra-

dioactive decomposition. A distribution of this kind always starts with a defined value, passes through a maximum and then drops sharply for high values. The maximum coincides approximately with the average number of goals a . In the Bundesliga the average number of goals per game is 3, so in this case $a = 3$. So for the Poisson distribution: $p_a(k) = a^k \cdot e^{-a} / k!$

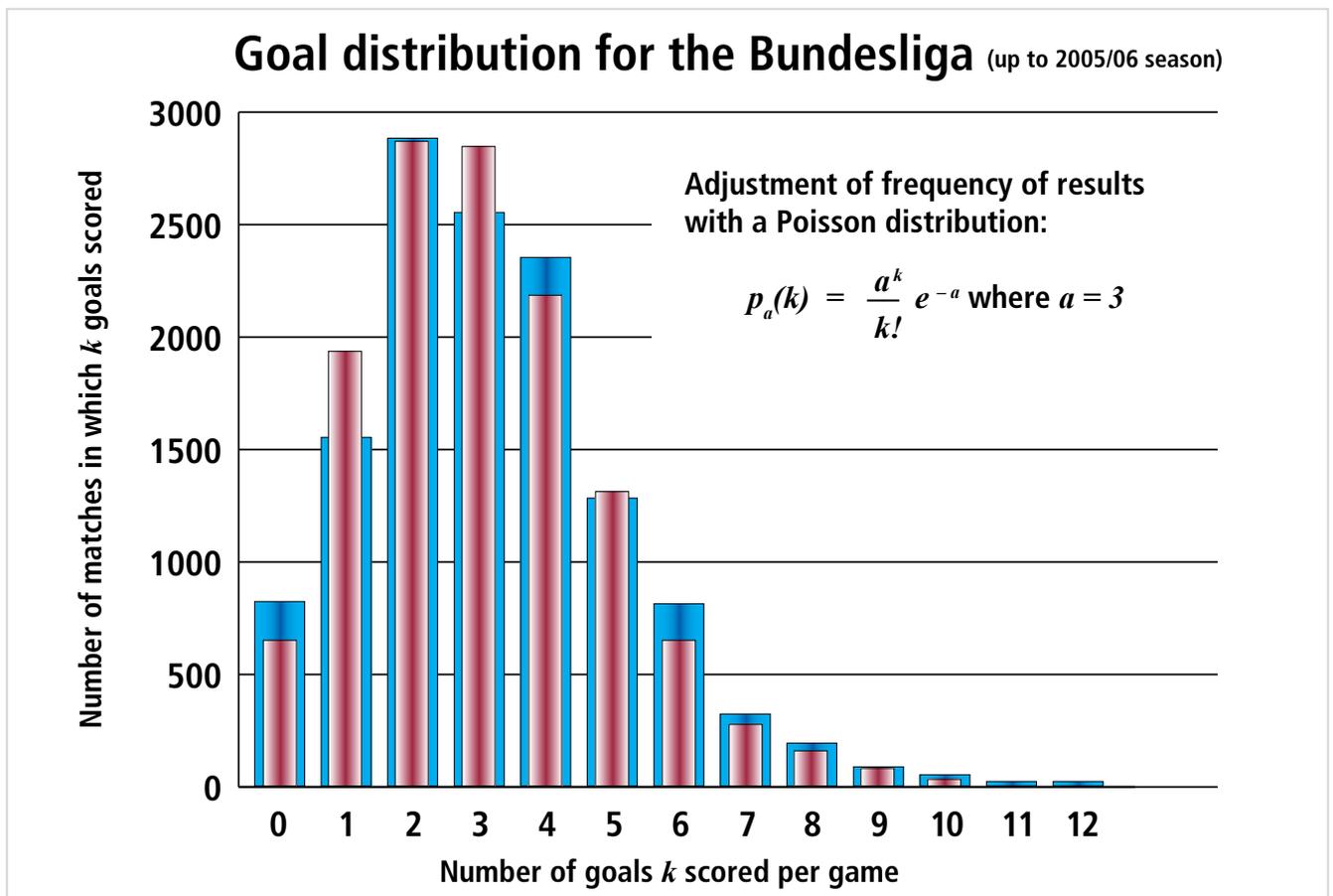
This formula states the probability $p_a(k)$ that a game will end with a total number of goals k if an average of a goals are scored per game. It has often been empirically tested for various professional leagues and national sides, but the same formula also works for an individual team.

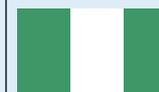
In this case, the probability $p_a(k)$ is the probability of a team scoring k goals during a match if they score an average of a goals per match. e is Euler’s number, 2.7182818... and $k!$ (pronounced k factorial) is an abbreviation: $k! = 1 \cdot 2 \cdot \dots \cdot (k-1) \cdot k$.

The chart below shows the number of Bundesliga matches (up to the 2005/06 season) as a function of the total number of goals k scored in one game.

The blue bars show that in 2550 matches in the Bundesliga, $k = 3$ goals were scored. This means all matches that ended with a score of 3:0, 2:1, 1:2 or 0:3. There are also goalless matches with a final score of 0:0. The blue bar for $k = 0$ indi-

The number of Bundesliga matches as a function k of goals scored in one game. The blue bars show the goal distribution and the red bars were generated by the Poisson formula. The similarity in the results is striking.



Group A	Group B	Group C	Group D	Group E	Group F	Group G	Group H
 Brazil A1 (2,8)	 Spain B1 (1,8)	 Colombia C1 (1,7)	 Uruguay D1 (1,6)	 Switzerland E1 (1,7)	 Argentina F1 (2,1)	 Germany G1 (3,6)	 Belgium H1 (1,8)
 Croatia A2 (1,2)	 Netherlands B2 (3,4)	 Greece C2 (1,2)	 Costa Rica D2 (1,3)	 Ecuador E2 (1,3)	 Bosnia & Herz. F2 (3,0)	 Portugal G2 (2,0)	 Algeria H2 (2,1)
 Mexico A3 (0,7)	 Chile B3 (1,8)	 Ivory Coast C3 (2,4)	 England D3 (3,1)	 France E3 (1,9)	 Iran F3 (1,0)	 Ghana G3 (3,1)	 Russia H3 (2,0)
 Cameroon A4 (1,1)	 Australia B4 (1,5)	 Japan C4 (2,0)	 Italy D4 (1,9)	 Honduras E4 (1,3)	 Nigeria F4 (1,4)	 USA G4 (1,5)	 South Korea H4 (1,6)

Source: Tolan / Graphic: Herling

Statistically calculating the current performance of individual teams: in the last qualifying round, Germany (G 1) scored the highest number of goals per game with an average of 3.6. Mexico (A 3) scored the lowest with 0.7.

cates that around 820 games ended without a goal. As we can see, most matches end with 2 goals, because final scores of 2:0, 0:2 and 1:1 occur relatively frequently. The blue bar for 4 goals is also still high, so matches ending in 4 goals are still quite frequent, but the bars for higher numbers of goals ($k > 4$) very quickly become smaller.

The red bars in the chart illustrate how these figures can also be calculated theoretically. They were calculated using the Poisson formula for an average number of goals $a = 3$. We can see that this formula matches very closely the

distribution curve of the number of matches with k goals. Obviously, the correlation is not perfect: there are more goalless draws in the Bundesliga than would be predicted by the Poisson curve, and there are more one-goal outcomes (final score of 1:0 or 0:1) in theory than there are in reality. But the Poisson curve does predict with surprising accuracy the number of games that end in a particular number of goals. In other words, a football team really does score according to the same pattern that determines the decomposition of a radioactive atomic nucleus. Who would have thought it?

Now we have everything we need to make our World Cup forecast. We know that the probability of each team scoring corresponds to the Poisson distribution. To work out this probability, we simply need to establish an average number of goals a for each squad. To do this we can take the average number of goals scored by each team in the last World Cup qualifying round as an indicator of playing ability. This is the best indication of a team's current performance. The averages a for each team are shown inside the yellow circles in the table above. Germany scored the highest num-

Country	Probability of winning the World Cup
Germany	20.33%
Netherlands	18.61%
England	11.67%
Bosnia & Herzegovina	11.34%
Ghana	10.96%
Brazil	9.04%
Ivory Coast	3.42%
AVERAGE TEAM	3.12%
Argentina	2.28%
Algeria	1.54%
Japan	1.39%
Italy	1.14%
Russia	1.13%
France	1.10%
Portugal	0.99%
Chile	0.81%
Spain	0.65%
Switzerland	0.64%
Belgium	0.64%
Colombia	0.52%
South Korea	0.34%
Uruguay	0.30%
Australia	0.26%
Nigeria	0.19%
USA	0.15%
Honduras	0.12%
Costa Rica	0.11%
Ecuador	0.11%
Croatia	0.09%
Cameroon	0.07%
Greece	0.06%
Iran	0.02%
Mexico	0.00%

ber of goals per qualifying match, an impressive 3.6, followed by the Netherlands with 3.4 and Ghana with 3.1 goals per game. Because the host country Brazil did not have to play any qualifying matches, we have taken the average number of goals from the Confederations Cup, which took place in Brazil last year. In this competition the Seleção, the Brazilian national side, notched up 2.8 goals per match.

Now we can start with our simulation. Using a random number generator and the Poisson distribution, we work out the number of goals a team is likely to score and then do the same for their opponents. This allows individual matches to be “played out” on the computer. When we have done this for all the group matches, we end up with a set of tables showing the final 16. We play out this round using the same method, and we can

even simulate extra time and penalty shoot-outs. We then simulate the quarter-finals, the semi-finals and the final to produce our World Cup winning team.

However, this result alone doesn’t mean much because random chance has played such a big role in the outcome. Using different random numbers might produce a different winner for our (virtual) title. To balance out this effect, we must play our simulated World Cup tournament around 100 000 times. If Germany emerge as the winners 15 000 times, this means our boys have a 15% chance of lifting the title. In this way we can calculate the probability of each team taking home the trophy. The table on the left shows the results of a simulation carried out using a programme written by Dr. Robert Fendt at TU Dortmund.

Left: If we believe the mathematical predictions, Germany has a 20.33% chance of winning the 2014 World Cup in Brazil. Below: The predictions are based on an “intelligent” simulation programme.

```
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```

```
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```
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```

```
<team id="2" name="Kroatien"
```

```
strength="1.20" defense="1.0" />
```

```
<team id="3" name="Mexiko"
```

```
strength="0.70" defense="1.0" />
```

```
<team id="4" name="Kamerun"
```

```
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```

```
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```
<group id="2" name="B">
```

```
<team id="5" name="Spanien"
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```
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```

```
<team id="6" name="Niederlande"
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```
strength="3.40" defense="1.0" />
```

```
<team id="7" name="Chile"
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```
strength="1.81" defense="1.0" />
```

```
<team id="8" name="Argentin"
```

```
strength="1.50" defense="1.0" />
```

```
</group>
```

```
<group
```





Illustration: René Stark/Wikimedia Commons

Flying the flag: Fans at the Olympiapark in Munich at the opening match of the 2006 World Cup, Germany vs. Costa Rica.

As we can see, Germany has a 20.33% chance of winning the World Cup! We should note that this table is only concerned with the winner. It does not mean that the Netherlands will be second and England will be third, only that the Netherlands has the second highest chance of winning the title and England the third highest – the table tells us nothing about the second- and third-placed teams. And most people are uninterested in who finishes second and third anyway, because as the saying goes, ‘second is the first loser!’. But we can also see that the prospects for some teams are bleak: while hosts Brazil have a 9.04% chance of taking home the trophy, Spain only have a 0.65% chance of emerging as world champions and Mexico might as well stay at home.

But what does that figure of 20.33 actually mean? Isn't it rather

low? Well, yes, because it means that the odds of another team returning victorious from Brazil are around 80%. But we should remember that the probability of an “average team” winning a fictitious world championship in which all the teams are equally good would only be $1/32 = 0.03125 = 3.12\%$. So Germany have a 6.5 times higher chance of winning the World Cup than an “average” team would have. Seen in this way, it isn't so bad, especially as no other team has a higher figure.

Only seven teams are better than the average, while 25 are below it. This is a consequence of the Poisson formula, in which the average number of goals has an exponential effect, so small differences in this number can have a relatively large impact. We should also remember that this model is only concerned with the ability of a team to score goals, not to prevent the other team

from scoring. It does not take into account the performance of the defenders, and the Italians would probably have a lot of criticism for our model. So the model could certainly be improved and refined – perhaps you would like to have a go yourself!

All in all, we Germans can relax and look forward to the start of the World Cup on 12 June. No team has a better chance of bringing home the trophy than ours. But we should still keep our fingers crossed for “Schweini” and his teammates, because with an uncertainty of around 80%, there could still be plenty of surprises and excitement in store!



Prof. Dr. Metin Tolan

holds the Chair of Experimental Physics I at TU Dortmund.

Contact: TU Dortmund, Fakultät Physik, Otto-Hahn-Straße 4, 44227 Dortmund, Germany

The author won the 2013 Communicator Award presented by the DFG and the Donors' Association for the Promotion of Sciences and Humanities in Germany.



Metin Tolan: Manchmal gewinnt der Bessere. Die Physik des Fußballspiels, Piper Verlag, 3rd edition December 2013, ISBN 978-3-492-26492-1, 9,99 Euro.

The World Cup simulation programme can be downloaded from: <http://e1.physik.tu-dortmund.de/wm-2014.zip>



The Fuel of Intimacy

In the media, it's often described as the "cuddle hormone" or the "orgasm hormone". But oxytocin is also attracting a lot of attention among scientists. Biopsychologist Markus Heinrichs talks about the unique qualities and secrets of this hormone – and its possible use in psychotherapy for people with severe social disorders.



Illustration: Paulwip/pixelio.de

The cuddle hormone, the orgasm hormone, the trust hormone – it's been given many names in the tabloids. But the hype isn't just in the media – scientists are equally excited about this hormone, which goes by the unwieldy name of oxytocin. This neurohormone is credited with creating trust, intimacy and empathy and reducing inner stress, fear and anxiety. Is this the hormone that can do everything? Numerous researchers and clinical groups all over the world are studying the "oxytocin system" in animals and humans and its effects on the body and mind.

Freiburg-based biopsychologist and psychotherapist Professor Markus Heinrichs is an internationally respected pioneer of oxytocin research, and his expert knowledge

is very much in demand. So what is fact and what is mere speculation when it comes to the "social hormone" and what therapeutic potential does it offer?

OXYTOCIN

Oxytocin (from the Greek for "quick birth") is a neuropeptide produced in the hypothalamus, which acts as a hormone on numerous organs and as a neurotransmitter between nerve cells. Since the 1950s, scientists have

known that it can be used to induce labour and stimulate milk release in the mother. Experiments since the early 2000s have shown that oxytocin strengthens social-emotional perception and bonding between humans, reduces stress and anxiety, and is secreted during sexual activity.

We posed these and other questions during an interview with Heinrichs at his institute in Freiburg, where he combines basic research in the laboratory with therapeutic work in his psychotherapeutic clinic for stress-related illnesses.

german research: Professor Heinrichs, you've been studying oxytocin for almost 20 years – do you ever have dreams or nightmares about it?

Markus Heinrichs: Not yet, far from it, neither in a positive nor a negative way.

How did you first hear about oxytocin?

In an article in the mid-1990s on the subject of prairie voles and their pair bonding behaviour. The article was about a group of American researchers who had discovered a link between pair bonding and the availability of oxytocin in the animals' brains. If there was a lack of the hormone, these monogamous animals were no longer able to maintain a pair bond. My admittedly overconfident question was whether the hormone could have a similar importance in humans. At the time, people just smiled at the idea.

Why was that?

Oxytocin was known in obstetrics as the hormone administered to women in the delivery room to induce labour or as a nasal spray to improve lactation. It was the obstetric hormone.

How did you start your experimental work?

With a group of lactating mothers and a group of non-lactating mothers. We knew that the suckling baby "activated" the secretion of oxytocin in the mother, and we wondered if the oxytocin protected the mother against stress. This was very clearly confirmed. We carried

out a second experiment with men, who were given oxytocin as a nasal spray in place of breastfeeding. The effect was observable there too. These two initial studies in humans encouraged us to investigate further.

What brought about the breakthrough?

At the University of Zurich, I came into contact with the economist Ernst Fehr. In a joint experiment, we were able to demonstrate that a high level of oxytocin in the brain significantly increases a person's willingness to take the social risk of investing trust and that the hormone is crucial to social approach behaviour. We were able to publish our findings in *Nature*, which certainly helped to raise the profile of this area of research in my field.

To sum up the story so far – what definite facts do we know thanks to research?

In terms of behaviour the hormone can do at least two things, which is what makes it so interesting. It can help the individual to control fear, stress and alarm systems when a person wants to build or allow social intimacy. At the same time – and this is important – it stimulates the reward areas of the brain, making social intimacy more pleasurable. This combination of factors makes oxytocin a very important hormone in social terms. It has to do with sex, love and trust too, but the buzzword "cuddle hormone" falls far short of the reality.

Do humans have an "oxytocin system"?

Yes, absolutely. First there is the hormone, and then there are the receptors and their sensitivity. This is an area where our knowl-

edge is still very limited. Recent studies with Marco Prinz, a neuropathologist in Freiburg, showed that the highest density of receptors in humans is in the brain's reward area and the amygdala in the limbic system – interestingly, that's exactly where the monogamous prairie voles have the most receptors too.

PERSONAL PROFILE

Professor Dr. Markus Heinrichs has held the Chair of Biological and Differential Psychology at the University of Freiburg since 2009. Born in 1968, he studied psychology in Würzburg and Bonn. He received his doctorate in 2000 from the University of Trier and subsequently worked as a postdoctoral researcher and associate professor at the Department of Psychology at the Uni-



versity of Zurich, where he held a research professorship funded by the Swiss National Science Foundation between 2007 and 2009. He has investigated the role of oxytocin in social interaction and innovative clinical applications for social disorders in a number of DFG-funded projects.

www.psychologie.uni-freiburg.de/Members/heinrichs/

You are involved in three DFG projects investigating the interaction between oxytocin and social cognition ...

We are asking the question of how social thinking works. We aren't just looking at hormone availability, but trying to understand the genetic aspect of receptor sensitivity. It's a pharmacogenetic approach that presents a few methodological challenges in the lab.

Everything has its dark side. Does that apply to oxytocin too?

Faces and emotions: The eye movements of a volunteer are recorded in the psychology lab with an eye tracker.



At the doses used in our experiments, where volunteers were given oxytocin in a nasal spray, there were no undesirable side-effects. But oxytocin is not "good" per se. Hormones have a relevance and importance in evolutionary biology, including behaviour. Oxytocin plays a role in the mother-child relationship, pair bonding and group bonding.

And what about therapeutic use? What kind of people could benefit from administered oxytocin?

Primarily, people with severe social disorders. People with autism, a condition for which there is currently no curative treatment. Also people with social anxiety disorders, which are much more difficult to treat than other anxiety disorders, and patients with certain personality disorders such as borderline personality disorder. Here and at other research institutes around the world, scientists are working hard to test oxytocin as a means of treatment.

Test? You can already buy "liquid trust" online.

I would warn people to steer well clear of such things, particularly as you never know what exactly is in them. All of the clinical studies are still ongoing, so as yet there is no clinical evidence of effectiveness. But for me, one thing is certain: a hormone spray by itself will not change an individual's behaviour. Treatment is only successful if the patient learns new behaviours and new cognitions, perhaps having new social experiences after years of avoidance. This can only happen under therapeutical supervision, and is especially effective in a group setting.

Are you in favour of psychotherapy in combination with oxytocin?

We are currently testing this possibility in large-scale clinical studies. Oxytocin may give an individual the extra boost they need to risk new social experiences. The challenge to researchers is to identify those people who could benefit the most. If we could predict genetic sensitivity to administered oxytocin with a simple saliva sample, this would be a huge step towards personalised psychobiological therapy.

In other words, there's a long way to go yet!

In three or four years' time we might be able to give a clear, evidence-based answer. But before that there is still a lot of basic and clinical research to be done.

What do psychiatrists think of your results?

Gratifyingly, they're very interested, open-minded and willing to discuss our approaches. Here in Freiburg we have some excellent partnerships with the University Psychiatric Hospital, which enables us to carry out clinical trials in a hospital setting.

One last question: our society has been described as a stressed, 'exhausted' society. Could oxytocin be a solution?

It's not a lifestyle drug, if that's what you mean. Oxytocin may be a new pharmacological option for a specific group of patients with certain social disorders, but only in combination with the right psychotherapy. Accurately identifying this group and providing optimum care is a huge challenge, one which will keep us busy for some years yet.

Thanks for talking to us, Professor Heinrichs.

Interview by **Dr. Rembert Unterstell**,
Publishing Executive Editor of *german research*.

Albrecht Beutelspacher

Open Secret

The science of encryption is entering new territory. The RSA algorithm opened the door to public key cryptography, but fundamental mathematical problems remain to be solved before we can use it for applications such as electronic payment.

For over 2000 years people have used cryptography to transmit secret information in a secure way. Until the mid-1970s, the only known way of doing this was to use what is known as symmetric cryptography. The basic idea was as follows. The sender and the recipient of a confidential message agree on a shared secret, the “key”, on which the security of their communication depends. The sender uses the key to encrypt the message and the recipient uses the same key to decrypt it. An eavesdropper will have a hard time decoding the secret message without any knowledge of the key.

In the absence of any alternative, methods of this type had become the standard, and people had become used to the associated main difficulty: before you could exchange confidential messages, you first had to exchange the secret key. This is particularly awkward if several parties all want to communicate with one another using the same system.

In 1976 there was a sensation when Whitfield Diffie and Martin Hellman came up with a completely different approach. Their vision was to devise a way of sending a confidential message without the need for a shared secret. The recipient would still need a secret key to decrypt the message, otherwise he would be no better off than a potential eavesdropper. So

the message would be encrypted without any special secret and decrypted with a unique, private secret.

For a practical example of how this works, and an indication that the vision could become reality, we need look no further than the postal service. To send someone a secret message we place the letter in an envelope and find the mailbox with the recipient’s name on it. Posting the letter in the mailbox is the equivalent of using the public key. No one now has access to the letter except the legitimate

recipient, who can open the box with their own private key.

Let’s return to our story. Two years later, in 1978, Ron Rivest, Adi Shamir and Len Adleman published the algorithm that would be named after them: RSA, the algorithm that would make public key cryptography a reality. The mathematical method on which the RSA algorithm and almost all other public key algorithms are based is called modular exponentiation.

The function $f(x) = gx$ for any base g is one of the most widely

Encryption without a shared secret key: The public postal service already uses the same basic principle with great success.



investigated and best understood functions in mathematics. However, we generally only consider the scenario where all the occurring numbers are real numbers.

We can also make it much simpler by only using natural numbers: 0, 1, 2, 3 and so on. To be more accurate, we only use the natural numbers below a fixed number n , i.e. 0, 1, 2, ..., $n-1$. We can still use these numbers to add, subtract and multiply, by first calculating as we would with the natural numbers and then dividing the result by n and only considering the remainder.

If $n = 10$, we would calculate 3×8 by first calculating $3 \times 8 = 24$ and then taking as the result the remainder left when we divide 24 by 10. The result is 4. This is called modular arithmetic.

This function is easy to calculate, but very difficult to invert: if

we know that $f(x) = xe$, it is extremely difficult to work out the value of x . It can be done, but only if we know a secret number called d . Then we simply raise the result to the power of d and get x . This makes this “modular power function” ideal for public key cryptography.

In the RSA algorithm, we represent the message as a natural number m and apply the modular power function to it using the recipient’s public exponent e . Anyone can do this as it does not require any secret information. However, only the legitimate recipient can decrypt it using his or her private key d to exponentiate the secret message.

If I want to receive a message, I choose two large prime numbers, p and q , and multiply them to make $n = pq$. I then choose two natu-

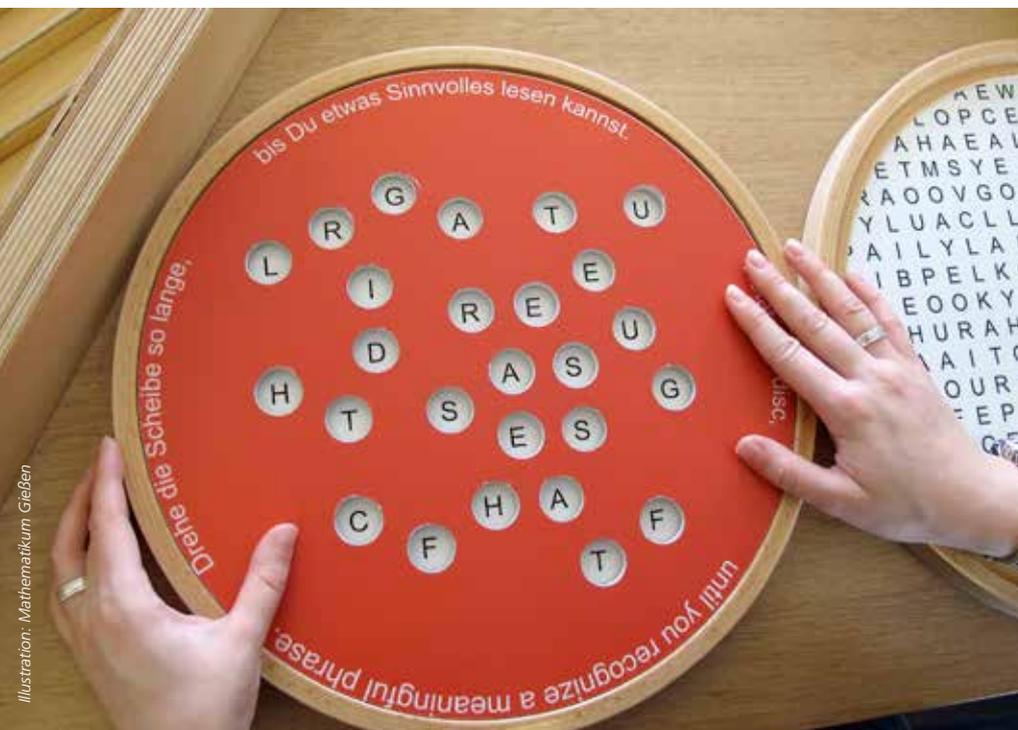
ral numbers, e and d , which have the property that their product ed is of the form 1 plus a multiple of $(p-1)(q-1)$. The numbers e and n are made public (the public key), while d is the private key known only to its owner. The prime numbers p and q must also be kept secret. The message is encrypted by raising the number m (representing the message) to the power e and taking the result modulo n : $c = me \pmod n$. I can decrypt it using my private key d : $m = c^d \pmod n$. A relatively elementary law discovered by the great mathematician Leonhard Euler (1707–1783) guarantees that the process of decryption does indeed produce the original message m .

The invention of public key cryptography was the trigger for developments in research and application previously thought impossible. In addition to the decisive benefit of key management, the application potential lies primarily in the fact that public key cryptography allows the use of a “digital signature”.

To sign a message we choose two large prime numbers, p and q (just as we did to decrypt a message), which must be kept secret, and multiply them to make n . We also choose the numbers e and d and follow the procedure outlined above. The numbers e and n are the public key and d is the private key.

A message represented by the number m is signed by raising m to the power d , and taking the result modulo n : $\text{sig} = m^d \pmod n$. The signature is verified using the public key by checking that $\text{sig}^e \pmod n$ is the same as m . The advantage of using a signature is that only the holder of the secret key can

A Caesar cipher disc encrypts and decrypts a message letter by letter.



Resembling a typewriter, the Enigma cipher machine was used by the German military in the Second World War.

public key methods because every new public key algorithm so far has significantly changed our understanding of what a public key algorithm is.

A second challenge is what we call the factoring of numbers. The security of the RSA algorithm is closely linked to factoring: if an eavesdropper could break down the known number n into its prime factors p and q , he would have broken the system – in other words, he could work out the private key. For this reason it is crucial to understand how difficult it actually is to factor large numbers.

Finally, a large area of research in its own right is the development of so-called communication protocols. This term refers to complex applications that solve problems such as secure electronic payment or electronic voting. Electronic payment, or payment with “electronic coins”, would be particularly useful for Internet transactions. An electronic coin is a number with a monetary value. For this to work, a number of conditions must be met.

For instance, only authorised bodies must be able to produce “money numbers”. In particular, there must be no way for anyone apart from these institutions to generate money numbers either systematically or by chance. These numbers must be very large (about 200 decimal places). Also, anyone must be able to verify that a given number is in fact a money number. A digital signature is the

ideal way of achieving these two properties.

Real money systems offer a high level of anonymity, and electronic money systems would be expected to do the same. In other words, even the issuer must not be able to reconstruct the journey of an electronic coin. This property is achieved by means of a “blind signature”. There is another problem that will have to be solved which is specifically associated with electronic coins. Because an electronic coin is only a number, or rather a bit string (a sequence of zeros and ones), it can easily be copied. So we need a way of preventing a coin from being cashed multiple times. This could be done by removing the coin’s anonymity if it is cashed a second time.

Electronic payment is an important current area of research, but before it can be put to everyday use, a whole series of problems remains to be solved. In particular, the systems require much greater performance capabilities.



Prof. Dr. Albrecht Beutelspacher

lectures in geometry and discrete mathematics in Gießen and is the founder and director of the Mathematikum, the world’s first hands-on mathematics museum.

Contact: Justus-Liebig-Universität Gießen,
Mathematisches Institut, Arndtstraße 2,
35392 Gießen, Germany

*A. Beutelspacher, H. Neumann,
T. Schwarzpaul: Kryptografie in
Theorie und Praxis.
ViewegTeubner, 2nd edition 2010*

www.mathematikum.de



generate a signature, which can then be verified by anyone. The new German identity card uses an electronic signature of this type.

All in all, public key cryptography has generated several exciting new areas of research, demonstrating that there are still plenty of unsolved puzzles in mathematics. So what are the most fundamental challenges at the present time? Firstly, we are looking for new public key methods. At present, only a handful of such methods are known. More algorithms are needed for practical reasons – partly because we need new algorithms in case the ones we use at the moment are cracked. From a theoretical point of view we need more examples of

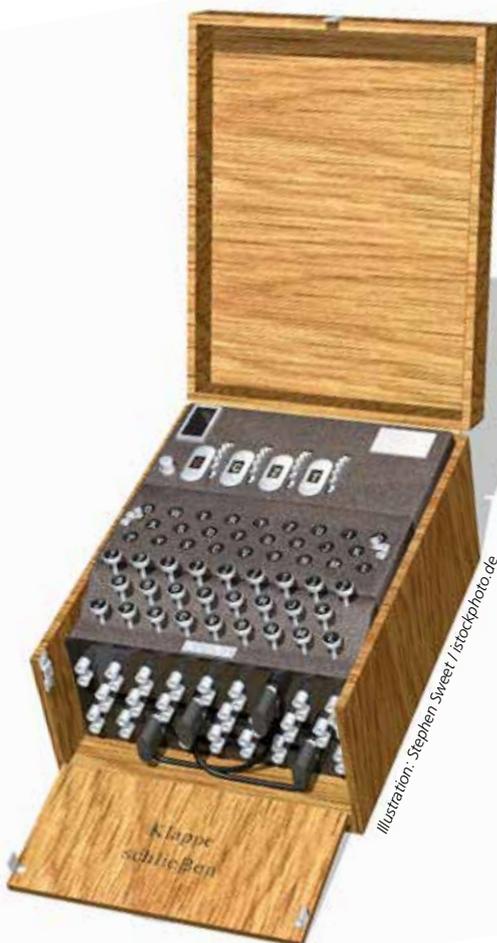


Illustration: Stephen Siveest / iStockphoto.de

Thomas Gottschalk and Christoph Sudfeldt



Illustration: Untertitel

Colourful Diversity

More grassland, more hedgerows, more maize? Land-use scenarios help us to understand how species diversity can be increased in Germany's agricultural landscapes. The necessary data is being gathered by monitoring ten bird species in their natural habitats.

Whatever happened to the skylark's song? Wasn't it only a few years ago that you could admire the lapwing's erratic flight in spring and hear the little owl in the evenings from the nearby orchard? Questions like these, relating to the birds of field and meadow, are often heard – and not without reason. According to an indicator report published by the Federal Statistical

Office in 2012 on sustainable development in Germany, bird populations are under threat, with the number of farmland birds, at least, having noticeably declined.

The reasons for the disappearance of farmland species are as varied as they are complex: the intensity of agricultural use, the abolition of EU-subsidised set-aside land, the increased break-up of grassland

and the growing cultivation of energy crops, particularly maize, are all posited as key causes. But does this mean that modern agriculture no longer offers suitable habitats for animals and plants? And what needs to change in order to achieve sustainable land use in Germany, providing wildlife habitats alongside the production of food and energy crops? Since 2010, these questions

have been studied by the DFG-funded project “Sustainable Land Use and Species Diversity”, based at the Institute of Animal Ecology at the University of Giessen and Rotenburg University of Applied Forest Sciences.

The cooperation partner in the transfer project is the Dachverband Deutscher Avifaunisten e.V. (DDA), an association of Germany’s national and regional ornithological societies. The DDA is coordinating a nationwide bird monitoring programme involving over 5000 ornithologists, most of whom participate on a voluntary basis. As a partner in the transfer project, the DDA is very interested in the results, which will reveal what kind of sustainable land use can contribute to growing bird populations as representative of species diversity.

In the research project, the sustainability of land-use practices is evaluated using the indicator of “species diversity and landscape quality”, drawn from the federal government’s National Sustainability Strategy. This indicator, of special relevance to conservation, is one of 21 key indicators covering economy, society and environment, designed to measure the effectiveness of sustainable actions. The Federal Statistical Office publishes regular reports presenting updated information.

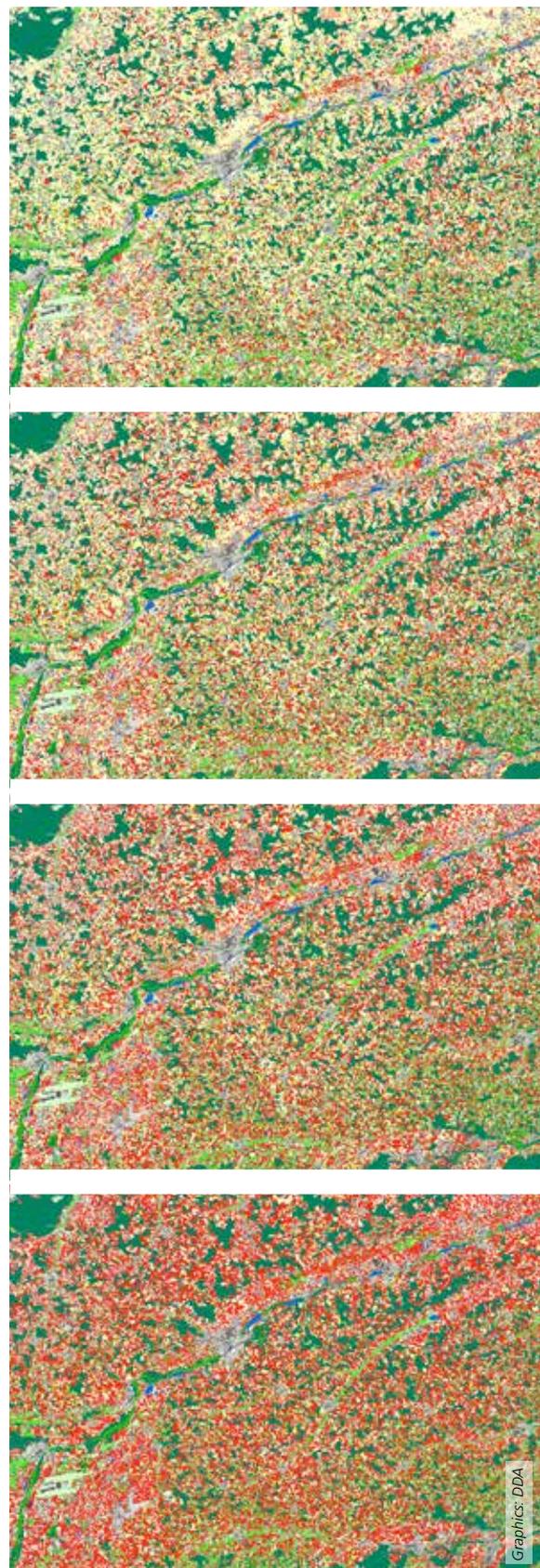
The indicator is calculated by studying trends in the breeding population of 59 bird species, which serve to represent the quality of the landscape as a habitat for many of Germany’s native species. The size of each population is compared with a defined species-specific target. In the case of the lapwing, for example, a panel of experts set a target of

Analysing land-use sustainability in the scenario of increased maize cultivation – here between Freising and Landau in Bavaria. Images 1–4 show a maize cultivation area of 5% (current situation), 10%, 15% and 20% (simulations).

a doubling of the current breeding population to 150 000 pairs – assuming that the development objectives and measures outlined in the federal government’s sustainability strategy are fully implemented by 2015. If a habitat improves for one bird species – and the number of breeding pairs therefore increases – it may be assumed that other animal and plant species will benefit too, and that a more diverse landscape will emerge.

The transfer project uses the results and experience gained in the Collaborative Research Centre “Land-Use Options for Peripheral Regions” based at the University of Gießen (1997–2008) to formulate concrete application-based questions. What regional development objectives must be pursued in Germany to ensure a high degree of species diversity, and therefore achieve national targets for farmland birds, with the minimal outlay in terms of cost and complexity?

The intention is to identify positive examples of sustainable agriculture and nature-friendly landscape development. To do this, the impacts of different land-use patterns on bird populations are computer-simulated. Through the efforts of its volunteers, the DDA has contributed over 300 000 breeding bird records, while the agricultural departments of the state governments have supplied digital maps showing the geographical distribution of field crops.



Using this data, it was possible to create high-resolution habitat models for the indicator species for agricultural landscapes all over Germany. The information is processed by 25 x 25 m cells of 591 million pixels each, with data on land-use, topography and climate. In the next stage, with the help of various calculations, the research team will create different spatial land-use scenarios and assess their

impact on the bird populations in the model.

By changing parameters that affect species diversity, such as the proportional area of grassland or hedgerows, the researchers can evaluate their impact on species diversity and landscape quality. Achieving sustainable land use in an agricultural landscape means taking regional landscape and land-use factors into account. To take account

of these specific characteristics and differences, the country was divided into focus regions in which different landscape trends were simulated according to the predominant landscape type.

The reason for this approach is that farmland birds show different distributions depending on their habitat preferences. For example, the lapwing is not found in hedgerow landscapes, instead preferring open grassland or fields. Yellowhammers and red-backed shrikes, on the other hand, favour agricultural landscapes with hedges, bushes and trees.

Thanks to habitat models and up-to-date land-use data, it was observed that throughout Germany – with regional differences – the lapwing prefers low-vegetation maize and corn fields as a breeding habitat at the start of the breeding season. Grassland, fallow arable land and nearby water are also important factors in the choice of breeding site. In addition, conservation areas are of great importance. So far, the researchers have investigated the impacts of additional grassland in wetland regions, the expansion of conservation areas and an increase in maize cultivation on the German lapwing population.

The results of the simulations demonstrate that the lapwing prefers maize fields as a breeding habitat over other crops as long as there is sufficient grassland or water nearby. Fields of this type are attractive to lapwings because, unlike other crops, they have little vegetation cover in April when the breeding season begins. In vegetation-free fields, enemies are also easy to spot. Because maize fields offer little food or places to hide for the young at this time, en-



Illustration: Thorsten Klügel

Above: Field observation – a lapwing in Schwalmwiesen, Hesse. Below: Project team member Sophia Franke consolidates research results on the PC.

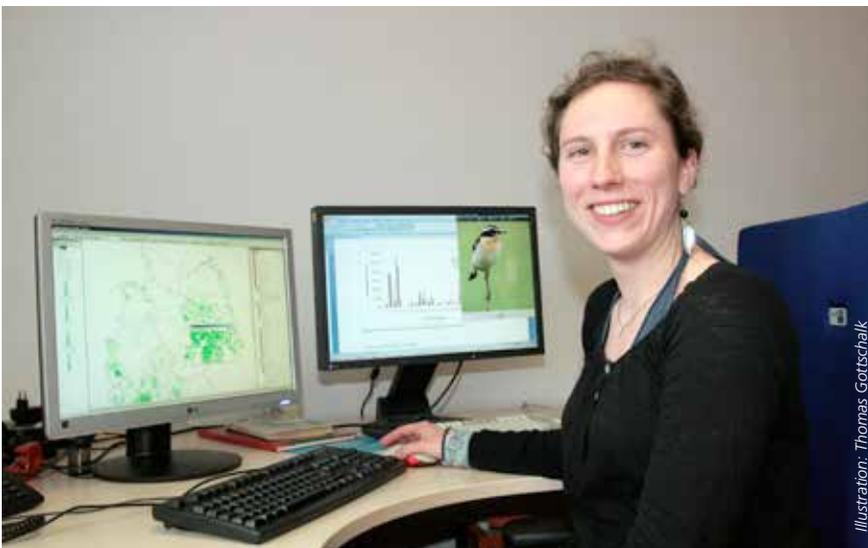
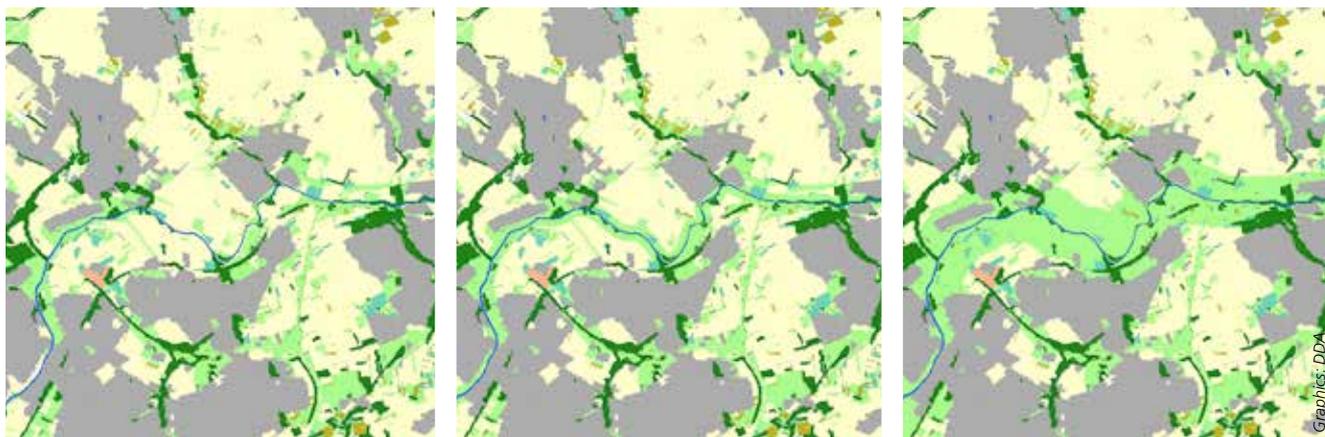


Illustration: Thomas Gottschalk



Simulations of increased grassland area with adjacent water (L to R): the situation today and with buffers of 100 m and 200 m.

ture lapwing families migrate into neighbouring marshes or pastures soon after the eggs have hatched. However, despite the fact that the total area under maize cultivation is increasing significantly, largely due to the use of maize in biogas plants, the national lapwing population is actually in decline. So additional research is needed into the bird's breeding success in the context of different crops and its mortality.

It was also discovered that the replacement of arable fields with intensively farmed grassland within floodplains has a negative impact on the lapwing breeding population. This initially surprising observation is easy to understand when the intensity of grassland exploitation is taken into account. Most grassland areas under agricultural management in Germany near a water source are unsuitable for the species due to intensive use (and large amounts of fertilisers), because on the thickly vegetated ground the ground bird cannot move around or spot enemies. Intensively used areas of grassland bordering wetland have no positive effects for the lapwing.

Conservation areas, on the other hand, do have a positive impact on the national lapwing population. Species-specific management measures such as extensive grazing and the creation of wet areas often provide the ideal breeding conditions for the lapwing.

While the lapwing prefers to breed in maize fields near suitable wet feeding areas, these areas do not present a suitable habitat for most of the other indicator bird species. The red kite, corn bunting and whinchat, for instance, prefer areas with grassland. It became apparent that a further expansion of maize cultivation would not ultimately represent a sustainable form of land use, but would instead lead to a dramatic loss in farmland bird populations.

Although the simulations revealed a few important measures for increasing the populations of the indicator species, the targets for many of these species have not yet been achieved using the models. The research team now intend to carry out further land-use simulations, for example by increasing the area of extensively used pastures or spring grain, always in conjunction

with the question of how the defined targets can be achieved.

The results are of considerable importance to the DDA, both on paper and in practical terms. The landscape simulations provide new data and contextual information on the interactions between landscape variables and landscape configuration, with reference to species diversity and sustainable land use in Germany.



Prof. Dr. Thomas Gottschalk

is Professor of Landscape Ecology and Regional Development at Rottenburg University of Applied Forest Sciences.

Contact: Hochschule Rottenburg, Schadenweilerhof, 72108 Rottenburg, Germany

Dr. Christoph Sudfeldt

is the General Director of Dachverband Deutscher Avifaunisten e.V.

Contact: DDA, An den Speichern, 48157 Münster, Germany

www.hs-rottenburg.net/1103.html
www.dda-web.de/



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Impressum

german research is published by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation);

Publisher: WILEY-VCH Verlag GmbH & Co. KGaA, P.O. Box 10 11 61, D-69541 Weinheim;

For the annual subscription rate please refer to the Wiley Online Library:

<http://olabout.wiley.com/WileyCDA/Section/id-404508.html>

Address of editorial staff: DFG, Press and Public Relations Office, Kennedyallee 40, 53175 Bonn;

postmaster@dfg.de; www.dfg.de

Editor-in-chief: Marco Finetti (responsible for content)

Publishing Executive Editor: Dr. Rembert Unterstell

Copy Editors: Stephanie Henseler, Angela Kügler-Seifert

Translation: SciTech Communications GmbH, Heidelberg; oneword GmbH, Böblingen

Printed by: Bonner Universitäts-Buchdruckerei (BUB);

Printed on Inapa Oxygen silk, coated, 100% recycled, FSC certified paper with a semi-matt surface.



For one evening, Berlin's Gendarmenmarkt was transformed into the fictional town of Springfield. At the DFG's traditional New Year reception in mid-January, President Professor Peter Strohschneider transported guests into the world of the Simpsons and the cult TV series of the same name. What does an unexpected and ominous comet that appears above the Springfield Observatory and then fails to fall to Earth have to do with science and research in general, and basic research in particular? And how far is it from there to the statements relating to science and research in the coalition agreement of the new federal government? The president's speech gave his audience – made up of academics, politicians and other leading figures – plenty to smile about and also plenty to think about.