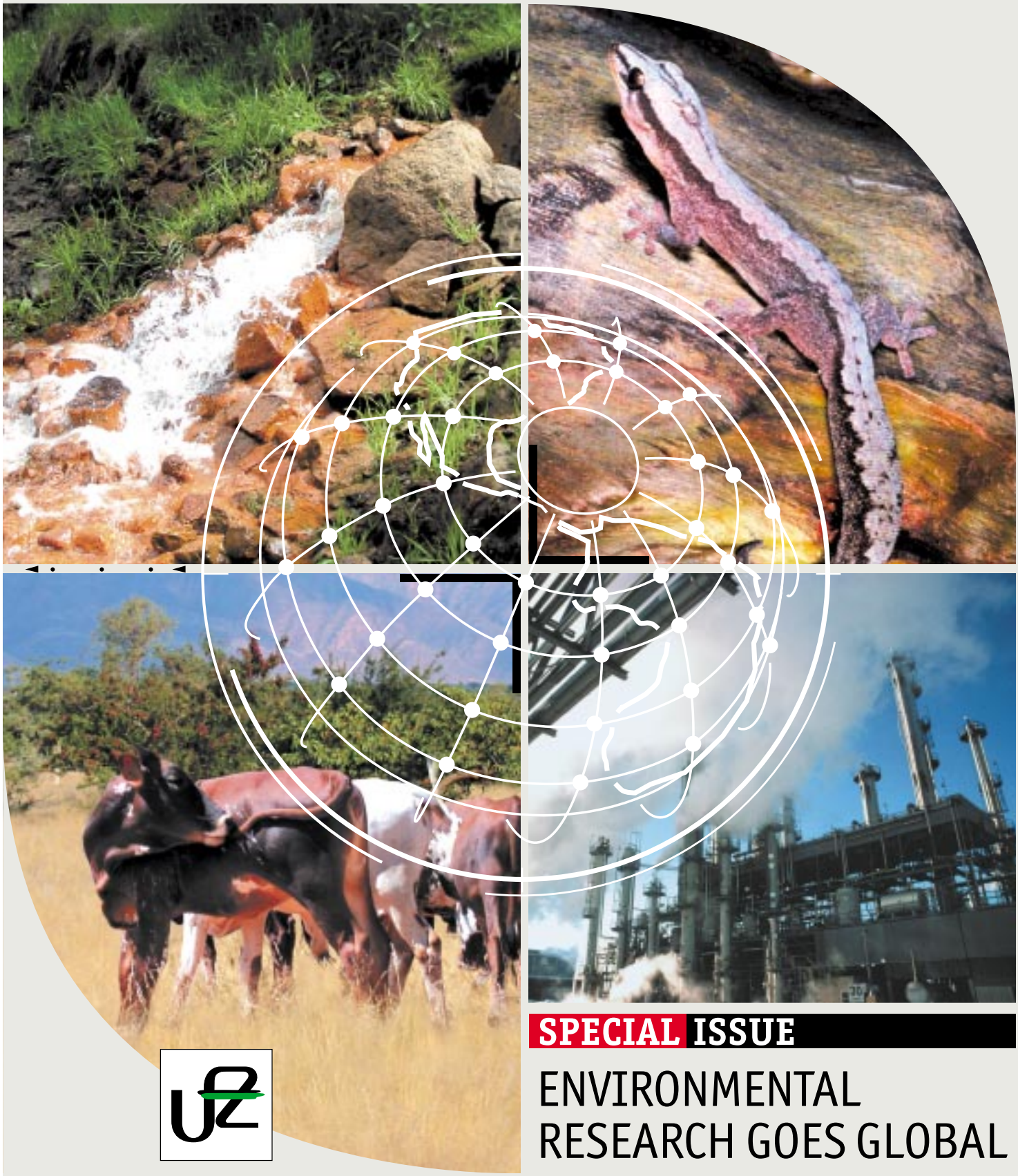
NOVEMBER 2002 [NO. 10]

Lebensräume

The magazine of the UFZ Centre for Environmental Research Leipzig–Halle in the Helmholtz Association



SPECIAL ISSUE

ENVIRONMENTAL RESEARCH GOES GLOBAL

Graphic: WÖHLFAHRT

Environmental Research – vanguard for international co-operation

The significance of internationally networked research is growing continuously. This is not just a logical consequence of European integration, but also a compelling necessity given the increasing challenge stemming from 'globalised' structures. It is therefore no surprise that environmental research is spearheading the development of international co-operation. Environmental problems have never stopped at national frontiers; they are by their very nature international. Those who think in terms of ecosystems and landscapes refuse to be confined by national horizons. This makes environmental research more suitable than any other research field for generating mutual trust between nations and states, paving the way for other forms of contact such as economic co-operation.

This advantage of environmental research needs to be exploited in the face of ever-tougher competition for research support and external funding. And this by no means refers solely to European Union funding under the Sixth Framework Programme for Research and Technological Development now being launched. National funding too, is often linked to international networking. In this respect the UFZ is excellently poised thanks to its diverse international ties and its close involvement in the PEER network of European environmental research centres.

Yet the international dimension of environmental research is also important for completely different reasons. Research performed abroad broadens scientists' horizons in the best sense of the word. Learning about other scientific problems, methods and approaches is one element of this; equally important is the personal gain from experiencing other mentalities, cultures and ways of life. Moreover, visiting scientists are always welcome: not just because their scientific contribution helps solve problems and brings networks to life, but also because new faces provide a welcome addition to everyday (research) life by reporting on activities and views elsewhere and adding a certain something to any working environment.

The articles in this edition spotlight examples of UFZ researchers working all over the world, as well as the fruits of cooperation achieved with visiting foreign scientists at UFZ in Leipzig, Halle and Magdeburg. International scientific exchange is not merely part of the UFZ's duty – it is also an indispensable component of its philosophy. With this in mind, happy reading!

Professor Peter Fritz
Scientific Director of UFZ

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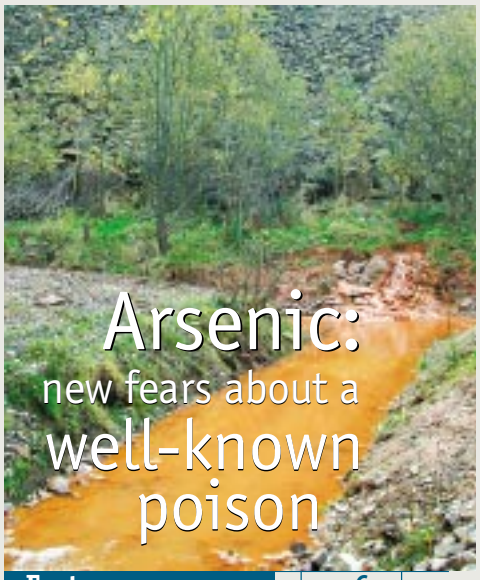

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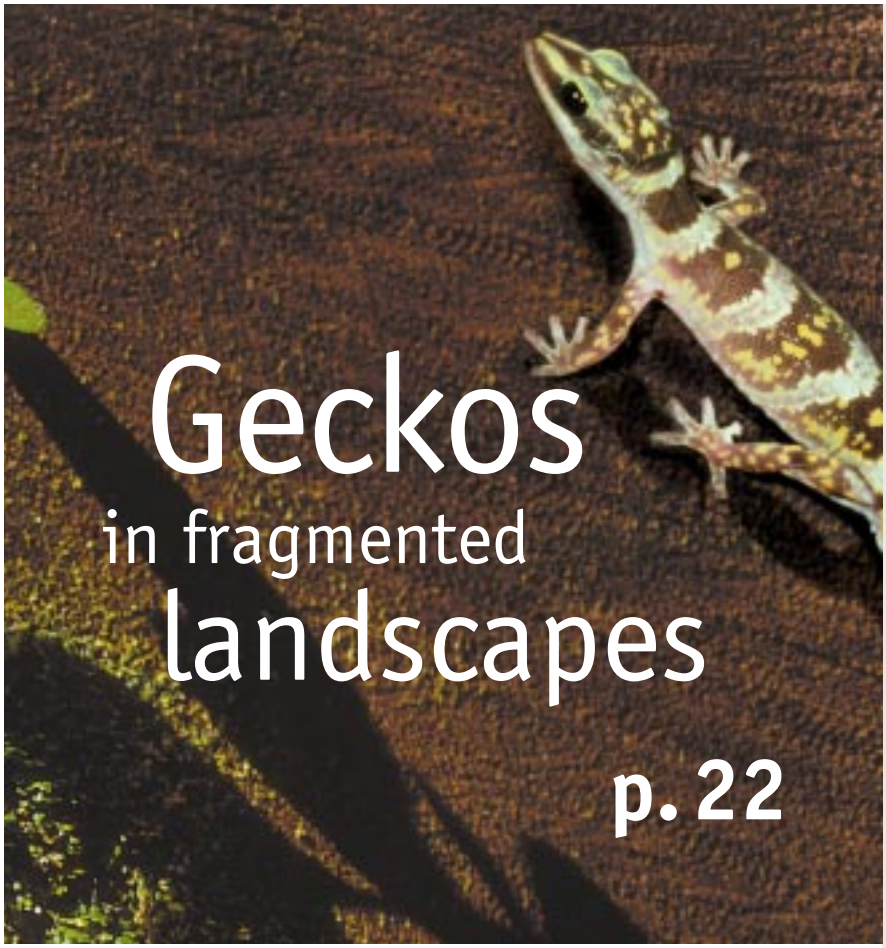

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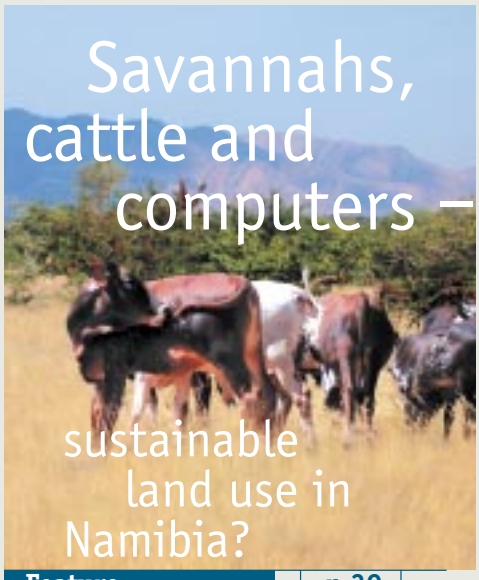

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Farmers and the indigenous population in Namibia are seeking the right balance for sustainable grassland farming in very different ways.

Arsenic: new fears about a well-known poison

Arsenic is a widespread element in water and soil, and has been known to be a highly poisonous substance since medieval times. In those days it was often used to 'control' the line of succession. Nowadays, millions of people in some regions of Bangladesh, West Bengal, Vietnam, Thailand, Taiwan and Mexico suffer from cancer after drinking water contaminated by arsenic over a long period. Areas in Germany contaminated by relatively high levels of arsenic include parts of the Erzgebirge and Mansfelder Land, as well as most river sediments in those regions. One potentially dangerous source of contamination is the tailings pond at Bielatal in the eastern Erzgebirge, where about 10 million cubic metres of sludge containing arsenic - the residues of tin ore flotation - had been dumped by the time it was closed down in 1991. Leachates emerging from the sedimentation basin contains as much as 3.5 mg/l arsenic and hence poses a danger to both soil and water in the area. Together with cooperation partners, scientists from UFZ are developing efficient analytical techniques and searching for alternative remediation strategies for water, soil and sediment contaminated by arsenic.

The uncontrolled leakage of arsenic from old mines and tailings is an enormous environmental problem not only in the Erzgebirge, but also world-wide wherever the extraction of gold, tin or copper ore also results in mining residues containing arsenic. Redox processes and changing pH conditions can accelerate the output of arsenic from deposited materials via the water pathway, with it being borne by rainwater into groundwater and surface water. To solve the problem of arsenic, bacteria have been strategically deployed at the UFZ using various strategies. One of these is bio-precipitation, in which arsenic and heavy metals are precipitated from water escaping from deposited materials. During this process, bacteria reduce both sulphate and arsenic. As a result, low-soluble arsenic sulphides are formed which remain in the soil or sediment as long as anaerobic conditions are maintained. The reverse process, the microbially induced mobilisation of arsenic and heavy metals from a sediment or soil under anaerobic conditions, is known as bioleaching. Both processes can be used during the course of remediation: precipitation to immobilise the pollutants in a certain place and to stop them escaping, and bioleaching to mobilise pollutants in a controlled fashion and then to collect them. Of special interest are in situ remediation measures in which the redox processes occurring in the waste dump material or sediment are altered such that the dissolution of arsenic is prevented. The crucial factor is the watering and aeration regime used to prevent undesirable weathering processes reversing in the mining material and stopping pollutants from dissolving.

Bacteria have been strategically deployed at UFZ using various strategies to remediate arsenic residues. Bio-precipitation is one, the reverse process of bioleaching another.

As part of a doctoral thesis, systematic investigations are being carried out at UFZ to establish what effects ambient conditions such as pH milieu, redox states and the availability of oxygen have on the mobilisation of arsenic. Measures are then to be concluded from these findings which enable arsenic to be immobilised directly in the source materials.

By contrast, if bioleaching takes place in an uncontrolled fashion or is unintentionally induced, the contamination spreads and the mobilised pollutants can enter the food chain via plants. Together with staff from UFZ's Department of Remediation Research and the Saxon Institute of Applied Biotechnology in Leipzig, the analysts tested what happens if sediment polluted by ore extraction residues comes into contact with oxygen from the air, for example when it is excavated. The leaching-active bacteria of the genus *Thiobacillus* naturally occurring in sediment samples from Lake Süsser See in Mansfelder Land mobilised as much

Photo: B. Daus

Photo: B. Daus

as 80 per cent of the arsenic within three weeks. For this to happen, an energy source which can be used by the bacteria such as oxidisable sulphur compounds must be available in a sufficient quantity. The microbial activity results in sulphuric acid, which reduces the pH of the sediment samples until the copper, manganese and zinc contained are mobilised, too.

Yet arsenic is also mobilised and immobilised in the environment without the need for human involvement. Scientists from the UFZ and the universities of Freiberg, Montreal, Moscow, Cagliari and Helsinki followed the trail of arsenic species and their chemical conversion in water, sediment and soil. They then developed methods of mineral phase separation, pollutant enrichment and solid phase speciation. The tailings pond at Bielatal was used as a test site for most of the questions tackled. Extensive information has been compiled on pollutant leaching over the past seven years, about the mobilisation and immobilisation processes and the

About 10 million cubic metres of sludge containing arsenic hade been dumped in a tailings pond at Bielatal in the eastern Erzgebirge by the time it was closed down in 1991.

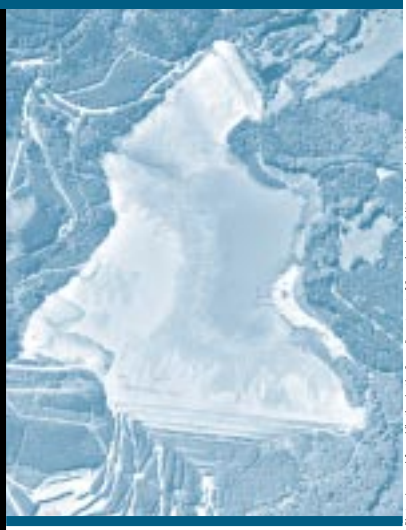


Photo: Approved for publication by the Saxon Department of Surveying (no. 12/02, 24 October 2002)

kinetics of oxidation processes in leachate. The broad range of methods used has proved suitable for describing the processes in detail.

Ever since residues from tin ore processing stopped being flushed into the sedimentation basin, various plant

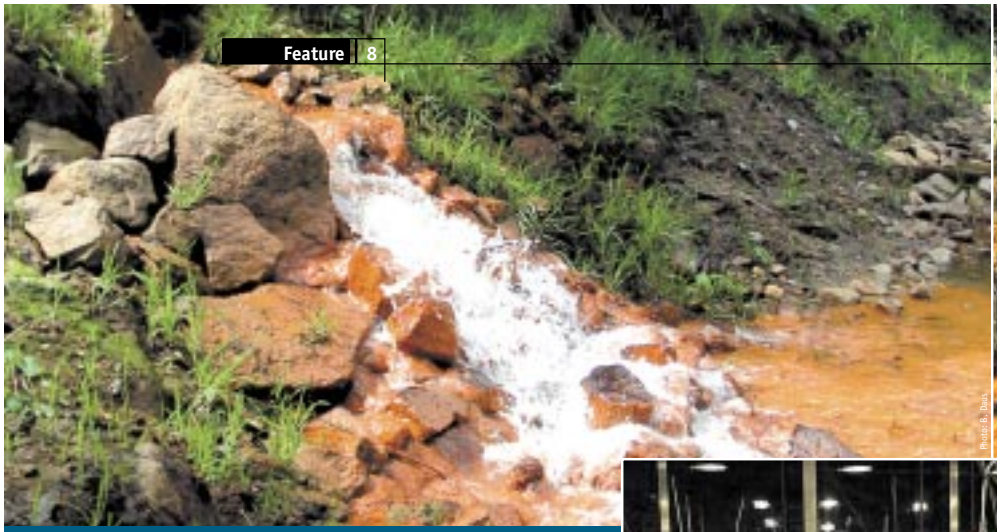


Photo: B. Daus

How can the uptake of arsenic by plants support remediation?

Photo: P. Kuschk

species have taken root there. A doctoral candidate from the University of Leipzig is now investigating how arsenic is taken up, transformed and enriched by such plants. It may be that the cultivation of suitable plant species will in future aid the remediation of arsenic-contaminated substrates. The snag when studying the mechanism of arsenic uptake was to completely extract the arsenic compounds without upsetting the distribution of species existing in the plants. This problem was solved by the introduction of accelerated solvent extraction. The majority of the plant species tested had difficulty coping with the soil containing arsenic and heavy metals. Many plants showed cholorosis, necrosis and stunted growth, or died at an early stage of development. However, wood small-reed (*Calamagrostis epigejos*) and bladder campion (*Silene vulgaris*) thrived. The species which grew poorly or even withered exhibited a high arsenic uptake capacity of 50–90mg/kg, about 50 times higher than in plants on uncontaminated soil. The analytical results show that although higher plants take up inorganic arsenic, their ability to convert it into less toxic organic compounds is very limited.

The behaviour of arsenic compounds in artificial wetlands is now being studied by a Thai PhDstudent working at UFZ´s Department of Remediation Research. She intends to find methods with which water can be purified by fixing arsenic in very complex ecosystems.

In parts of Asia and Central America, the water extracted from deep wells contains high concentrations of arsenic. This is the reason for instances of poisoning as well as cancer of the bladder and the skin suffered by over 30 million people in Bangladesh alone. Simple, low-cost techniques are needed to clean up contaminated drinking water. A scientist from Universidad Autónoma de Puebla in Mexico visiting the UFZ is examining natural sorption materials such as tuff and zeolites in terms of their arsenic-binding capacity. After a period of contact lasting seven days, zeolites were found to reduce the concentration of arsenite and various other arsenic species in a test solution by more than 60 per cent. The almost complete absorption of arsenic took 70 days. Other, above all ferruginous materials were also tested to see whether they can remove arsenic from water. An iron hydroxide granulate patented by UFZ has proved to be very effective in this respect. Even at high initial concentrations of about 1 mg/l, over a long period this level can be reduced below the maximum amount of arsenic permissible in drinking water. Hence the materials mentioned here are all suitable for the in situ remediation of arsenic-contaminated water, including to avoid the pollution of downstream areas.

The environmental and health relevance of arsenic contamination depends not only on its total concentration but also the type of arsenic compounds involved. To determine the various compound forms and oxidation levels of an element in water, soil and plants (speciation analysis), special methods of physicochemical analysis are required. One of these is a combination of conventional chromatographic separation techniques with sensitive spectroscopic detectors which has been developed and used at UFZ. It enables the effect, transfer and conversion of arsenic species to be monitored so that the hazardous potential of the arsenic can be fully assessed. These methods of species analysis have also been used to describe regional arsenic contamination in central Germany.

The initial findings in the analysis of selected samples with high arsenic contamination from the tailings at Bielatal were achieved by coupling ion chromatography with atomic emission spectrometry. For certain materials and pH ranges, ion chromatography needs to be combined with plasma mass spectrometry (ICP-MS) in order to achieve much better sensitivity. Other UFZ experiments have focused on capillary zone electrophoresis and its coupling with an ICP-MS. This technique even enables very small sample volumes of

just a few microlitres of various arsenic species to be identified and determined.

However, stabilising arsenic species for the period between sampling and analysis is also important. The conversion processes between the individual species can lead to considerable fortifications within just a few hours. Therefore, the UFZ's Interdisciplinary Department of Industrial and Mining Landscapes and the Department of Analytical Chemistry have jointly developed a technique in which arsenic species in ferruginous water can be stabilised using phosphoric acid. This method has been successfully tested during field trials. All in all, a range of techniques has been developed which enable the detection of certain arsenic species (in some cases for the first time) and which have much better detection limits than some conventional methods for measuring overall arsenic content.

The actual danger emanating from arsenic hinges on its bonding form in solids, which provides information about possible mobilisation. To tackle this issue, sequential leaching techniques have been developed which enable industrial deposits to be assessed. If protective and remediation measures need to be carried out to counter arsenic contamination, it is also important to know the distribution of particle sizes in the sedimentation sludge. Various particle sizes correlate with different concentrations of arsenic, uranium, lead, copper, zinc and nickel in the residues. Together with scientists from the Vernadsky Institute in Moscow, UFZ's analytical chemists have developed more effective techniques for the fractionation of ore sludges. The advantages of the multistage tangential ultrafiltration technique compared to standardised cascade filtration is that it is much less labour-intensive and the membrane pores are far less liable to clog up, meaning that the separation results are much better. Prototypes of the new systems have been built at UFZ and successfully tested at the University of Geneva and the National Institute for Health and the Environment in the Netherlands. Other partners of the project coordinated by UFZ included the Bogadsky Institute in Odessa, the company TREM from St Petersburg, the ISAS Institute for Spectrochemistry in Dortmund and the University of Montpellier. ■

Arsenic – more than just a poison?

Arsenic is a semi-metal in the fifth group of the periodic table and has the atomic number 33. Arsenic is widespread and is the 20th most abundant metal in the earth's crust. Ever since the isolation of arsenic was first reported around 750 years ago, its use has been surrounded by controversy owing to its toxicity. Nowadays we know that the toxic effect of arsenic depends on its type of bonding. The lethal dosage for humans is quoted as 70–180 mg arsenic trioxide, whereas arseno-betaine, which is found in seafood and is hence eaten by humans, is not poisonous. For centuries arsenic has been used as a stimulant and a drug, in some cases with fatal side-effects. On the other hand, arsenic trioxide really does appear to be an effective therapeutic agent against a certain form of leukaemia, and in 2001 an application was submitted for the medication Trisenox to be licensed. Arsphenamine, better known as Salvarsan, was successfully used in the early 20th century to treat syphilis. The physiological effect of arsenic is based on its chemical similarity to phosphorus; it disrupts glycolysis and inhibits cell breathing. This effect is also the principle behind arsenic-based chemical warfare agents like CLARK and Lewisite.

Photo: WOHLFAHRT

Considerable quantities of arsenic are used in many production processes. In 1997, the USA alone imported 30,000 tons of arsenic trioxide, mostly from China. Arsenic is also used as an alloying constituent in the metal industry, as well as in semiconductor and glass production.

Moreover, arsenic is employed as rat poison, insecticide (for example in certain brands of ant killer) and herbicides. Large quantities of arsenic used to be employed as wood preservative (such as chromium copper arsenate) and as a drying agent for cotton.

In Bangladesh and the Indian state of West Bengal, there are regions where well water contains arsenic concentrations as high as 1 mg/l. The WHO estimates that 30–70 million people are at risk of arsenic poisoning in these areas and in 1997 launched an emergency aid programme for water tests and alternative drinking water supply. In Germany, the maximum level of arsenic allowed under the drinking water regulations is 0.01 mg/l.

Uncontaminated sediments and soils typically have arsenic levels of 5–10 mg/kg. Arsenic is released in smelting processes and in the combustion of fossil fuels, and is also enriched in ore mining residues. In areas with a long history of mining such as the Erzgebirge, the Black Forest and the Harz mountains, arsenic contamination is therefore especially high near dumps and slag heaps. According to the German soil protection regulations, industrial soils are allowed to contain up to 140 mg/kg of arsenic. ■

Environmental research in Europe

Interview

with Dr. Christian Patermann, director of environmental research at the European Commission's DG XII: Research

Photo: N. Neuheiser

QUESTION: *Speaking from a European angle, what in your view are currently the weaknesses and what are the strengths of German environmental research?*

DR PATERMANN: The Germans are particularly strong whenever it comes to environmental technologies, especially end-of-pipe technologies, but also integrated systems in areas such as water and soil, and in particular the integration of new techniques like nanotechnology and life sciences. Furthermore, they have always been strong in stratosphere research, in climatic and climatic impact research, and whenever geosciences are involved in environmental research. They are also well prepared for co-operation with eastern Europe. By contrast, however, their collaboration with many non-European countries still appears to me to be somewhat conservative. If you look at the topics that have been dealt with by German-Brazilian, German-Korean or German-Japanese collaboration over the past six or eight years, not much has changed.

It does German research centres credit when they face up to competition, compare themselves to other institutes and of course enter into alliances with them.

Interestingly enough, the weaknesses are encountered whenever biology is involved. For example, as far as biodiversity is concerned, the Germans are relatively weak in Europe. The same can also be said for certain areas of fluvial and lacustrine research whenever it concerns investigating the water itself rather than the use of technology. Germany also lags behind in agricultural research.

The very strong integration of new trends in sustainability research is to be seen in numerous institutions in the UK, France and Scandinavia. Germany, by contrast, doesn't have a single central institute of sustainability research. The little (if you will forgive the expression) done as basic work by the Wuppertal Institute doesn't even begin to compare to programmes such as that at the University of Göteborg, where 300–400 researchers are currently working in the Faculty of Sustainability, or the latest programme of the Natural Environmental Research Council in Britain, where science for a sustainable future is being pursued in an integrated, very concentrated manner. This change of direction and having two or three institutes geared strongly to these new fields is something which can't be seen happening in Germany. I hope, however, that the recent structural changes in the Helmholtz Association creating a comprehensive 'Verbund' Earth and Environment might change this.

And this brings me to another weak point of Germany's international cooperation: the strong reservations German scientists have about collaboration with southern Europe, which have long ceased to be justified. Countries like Greece, Portugal and Spain have invested large amounts in environmental research, especially marine science, and nowadays they partly belong to outstanding networks. Yet little notice of them is taken by German scientists.

In my view, another major weakness is to be seen in Germany's research structure. The Max Planck Society is certainly closely involved in some areas and producing absolutely outstanding results. In the Helmholtz Association, an interesting change of focus is to be seen. But to my mind the Leibniz Association has a lot of catching-up to do, and some of the universities are also beset by large problems of keeping up internationally. This begs the question of whether German research is far too fragmented, including in environmental science. A reasonable, easily controlled division of labour is required, but this comes down to science, the organisation of science and management.

QUESTION: *You mentioned the change of focus at the Helmholtz Association. What strategic goals should it have in mind in a German and a European context?*

DR PATERMANN: I believe that the division of labour should be emphasised much more at the Helmholtz Association. I expect those involved to play to their strengths and for agreement to be reached over what sort of work should be carried out by the individual centres. We also need to take a look at the areas in which they operate. For example, it would seem logical for UFZ to concentrate more on eastern Europe, whereas the research centre in Karlsruhe should look more to western Europe.

Furthermore, without wishing to be dictatorial, I believe there should be much closer coordination with, say, the Max Planck Society and the universities. In this respect, the Helmholtz Association must coordinate matters to make sure the same research is not being carried out by different groups. Sometimes my staff and I have the impression that research is being duplicated without those involved being aware of it.

Ultimately, I also expect the Helmholtz Association to react more swiftly to new trends than before, and to be quicker about providing funding for the research required. And I also expect – because this is something Brussels doesn't do – new directions to be set in basic environmental research.

I regard UFZ to a certain extent as an 'outpost' for links with central and eastern Europe.

QUESTION: *You stressed the necessity of coordination and co-operation. By joining the new PEER network, UFZ has entered into an international alliance. What expectations do you attach to this?*

DR PATERMANN: It does German research centres credit when they face up to competition, compare themselves to other institutes and of course enter into alliances with them. Thank goodness this is now starting to happen. In fact, more attention needs to be paid as a whole to a European agenda. When I look at Belgian, Dutch, Italian or British, Irish or Scandinavian institutions, they seem much more willing to tackle European topics. This is not to say that everything discussed within the European Union's Framework Programmes is actually dealt with by these institutions, but attention must at least be paid to these issues whenever international co-operation is concerned. Of course, some first-class work has also been done in the areas of biodiversity and water research in Germany. But when it comes to competition, we frequently have the impression that others do much more to nurture international cooperation and to compete with foreign players, and are therefore in qualitative terms simply better. This is the result of a whole series of calls for tenders and competitions we have had.

PEER is in my view an interesting model. We have been watching the development of this network with great interest. The institutions involved are very prestigious and we hope that in the long run this will lead to cooperation with a critical mass so that in the end really major projects might be carried out. We believe that PEER will evolve into a central piece of the jigsaw in the European environmental research set-up.

QUESTION: *You mentioned UFZ's good position for future co-operation with the EU candidate countries in central and eastern Europe. What are the topics you and your staff believe to be especially important in this connection and therefore worthy of funding?*

DR PATERMANN: I think that the programme contributions made by UFZ are fine. Simply by virtue of its geographical position, I regard UFZ to a certain extent as an 'outpost' for links with central and eastern Europe. The topics are self-evident: water, soil, air, biodiversity and given the EU's future expansion research in agriculture, rural regions and forestry, etc.

One item is underdeveloped throughout Germany, and this is something I regret very much: ever since the "City of Tomorrow" was made a key action in the Fifth Framework Programme, we have had problems with Germany because there weren't really any contacts there. The research scene in terms of urban studies and also transport studies, both of which are important aspects of sustainability, is strongly fragmented in Germany. But there is much to do for the Helmholtz Association and in particular UFZ in this respect, especially because eastern Europe has so much catching-up to do when it comes to creating a good scientific basis for decisions in these sectors. ■

europa.eu.int/comm/dgs/research/organisation_de.html#DirI

Emissions trading in the EU – new opportunities for ecology

Photos: UFZ

In three years' time, trading with greenhouse gas emissions is expected to begin in the EU. The ball is expected start rolling with between four and five thousand power stations and energy-intensive industrial plants which are responsible for 46pc of the entire emissions of CO_2 within the EU. This will place Europe's climate protection policy on a completely new footing. Scientists from UFZ's Department of Economics, Sociology and Law are analysing and assessing the draft guidelines and advising relevant working parties on a political level.

and economics

(F. Gagelmann)

When the industrialised countries agreed for the first time to limit their greenhouse gas emissions in Kyoto in 1997, they did so on condition that these aims could partly be met by buying surplus emissions certificates from other industrialised states. This marked the birth of international emissions trading – at least on paper. Ideas to include private companies soon followed. National emissions trading among private companies was launched in Denmark in 2001 and in the UK in April 2002. Furthermore, in October 2001 the European Commission published a draft proposal for a Europe-wide trading system due to take effect in 2005. This all puts pressure on Germany to also get to grips with emissions trading. But how exactly should emissions trading be organised? Although the EU proposal responds to many organisational questions, others still remain unanswered. Moreover, some final details will not be decided at EU level at all but will be left up to the member states.

So what exactly does the EU's draft stipulate, and what is still up in the air? One aspect clearly stated is that emissions trading will initially only concentrate on a few key sectors such as power generation, iron and steel, cement and other building materials, paper and cellulose, and refineries, all of which will be obliged to participate right from the start. Individual companies, sectors or countries not be allowed to opt out of the scheme. Furthermore, absolute quantities of emissions are to be traded – in contrast for example to the targets in the voluntary agreements with German industry, which are usually defined as relative emissions, i.e. emissions per production quantity.

Both these decisions would, assuming they are actually taken, accommodate a functioning, liquid, EU-wide market for emissions rights. However, both are also politically very controversial since they may actually exacerbate the degree of interference which emissions trading will mean for industry. A recent compromise proposal by the Danish EU Presidency suggests a temporary (2005–2007) opt-out possibility for selected branches provided that they achieve the same emission reductions as they would have done under emissions trading, and that this can be clearly proven. Also, the option to include additional sources is suggested. It is not clear whether these propositions will be accepted by the majority of the EU member states.

Some other central issues are also likely to remain open even once the new legislation has been formally adopted at EU level. These include above all the question of how emissions rights should be initially shared out. Should they be auctioned off or allocated free of charge? And if the latter approach is chosen, what formula should be used to share them out? How should new emissions sources entering the market be treated? One reason why these aspects are so important is that the initial allocation will partly decide what companies can sell certificates and who will have to buy them. In other words, it all comes down to hard cash.

As far as these weighty issues are concerned, the European Commission has simply decided that as of 2005 free allocation is to take place. Exactly how emissions rights are to be distributed is up to each member state to decide; achieving greater uniformity appears to have run into political difficulty. Therefore, the EU has simply issued certain guidelines designed to prevent excessive distortions of competition among the member states. The national allocation plans of the member states must be based on these guidelines. Furthermore, they must also be approved by all the other member states and the European Commission. A harmonised solution is also to be sought for allocation starting in 2008, although whether this will be based on free allocation or auctioning has still not yet been decided.

Another factor not yet settled is the extent to which emissions rights or credits from non-EU countries – including developing countries – can be taken into account in internal emissions trading in the EU. The criteria to be applied in this respect (if any) have not yet been decided either.

At the end of 2002 or in the first half of 2003, the guidelines are to be finally decided at EU level. The allocation plans are then to be nationally decided by 2004 and accepted throughout the European Union. A study of the best way of organising an emissions trading scheme should therefore concentrate on these still unsettled questions, so that the findings can be included in the allocation plans for 2005 and 2008.

One of the key questions is the expected impact of such different design options on innovation – e.g., cost reductions and market penetration for renewable energies, the possible widespread adoption of fuel cells in industry, or just 'simple' increases in efficiency in power generation and consumption.

These questions are being investigated within a doctoral project funded by Energy Foundation Schleswig-Holstein at UFZ's Department of Economics, Sociology and Law. In addition to theoretical foundations, i.e. the application of approaches of innovation research to emissions trading, attention is to be focused on an empirical analysis of the experience of existing emissions trading systems.

Not only the British and Danish systems are important in this respect, but also corporate internal trading systems such as that used by BP, as well as pilot projects and simulations. A key role is also played by the US emissions trading schemes in existence for a number of years such as the Acid Rain Program, RECLAIM and OTC, which are designed to reduce 'classical' air pollutants such as SO_2 and NO_X.

One of the key questions is the expected impact of such different design options of emissions trading on innovation.

This doctoral thesis will partly benefit from the fact that Professor Hansjürgens, the department head, is acting as adviser to an emissions trading working party in Saxony-Anhalt comprising representatives of industry and the regional government. In addition, experience from two pilot projects involving UFZ in Hessen and Schleswig-Holstein will also be useful. This cooperation enables UFZ's researchers to continuously monitor the practical proposals currently being discussed.

In these committees it is apparent just how sceptically some sections of industry regard emissions trading, as well as how many misconceptions still exist. In Saxony-Anhalt in particular, many companies could actually profit from emissions trading because the region – like the other states in eastern Germany – possesses a very advanced and hence low-energy industrial park. This requires, however, that this energy efficiency be positively taken into account when the certificates are allocated.

Photo: WOHLFAHRT

In Saxony-Anhalt in particular, many companies could actually profit from emissions trading because the region – like the other states in eastern Germany – possesses a very advanced and hence low-energy industrial park.

There is much arguing in favour of emissions trading being agreed at EU level. For one thing, the majority of the member states advocate it. Although the German government is in favour of emissions trading, at the moment it is in a minority by backing a voluntary pilot phase. Moreover, it is questionable whether the alternative put forward by industry – namely continuing the current voluntary agreements – really would be able to meet reduction aims in the coming decades. There are enough reasons to assume that more stringent targets will come given the ecological problems looming. Emissions trading is one of the cheapest instruments industry can use to tackle this issue. Therefore, the strategy of not criticising emissions trading as such but instead campaigning for favourable initial allocation appears recommendable.

Photos: S. Farcher

URGE:
a European research project into urban green spaces

Since 80pc of Europeans live in and around towns and cities, improving the urban quality of life in Europe is a central aim of the European Union's Fifth Framework Programme (key action: "The City of Tomorrow and Cultural Heritage"). Green and other open spaces play a vital role in enhancing living conditions and can alleviate many typical urban problems. Future urban development needs creative, innovative approaches to the integrated planning of green spaces in order to achieve a balance between built-up land and open areas.

The partners in the European project URGE ("Development of Urban Green Spaces to Improve the Quality of Life in Cities and Urban Regions") believe that improving the urban green structure makes an essential contribution to sustainable urban development. A set of ecological, sociological and economic criteria which takes account of planning needs is being compiled for urban green spaces. These criteria will then be used in conjunction with the characteristics of the towns and cities investigated to produce a handbook of recommendations for planning green spaces. The handbook will outline general, transferable methods and measures to sustainably develop and manage green spaces in towns and cities yet without neglecting regional and structural peculiarities.

Photo: L. Luther

The URGE project is being tackled by an international, interdisciplinary project team coordinated by UFZ's Interdisciplinary Department of Urban Landscapes. The involvement of local authorities from Leipzig, Birmingham, Budapest and Genoa as planning bodies and practical partners in the project team ensures that research takes into account the actual needs and problems in planning urban green spaces, and that the findings can be immediately implemented. Twelve other European cities are also taking part as reference locations.

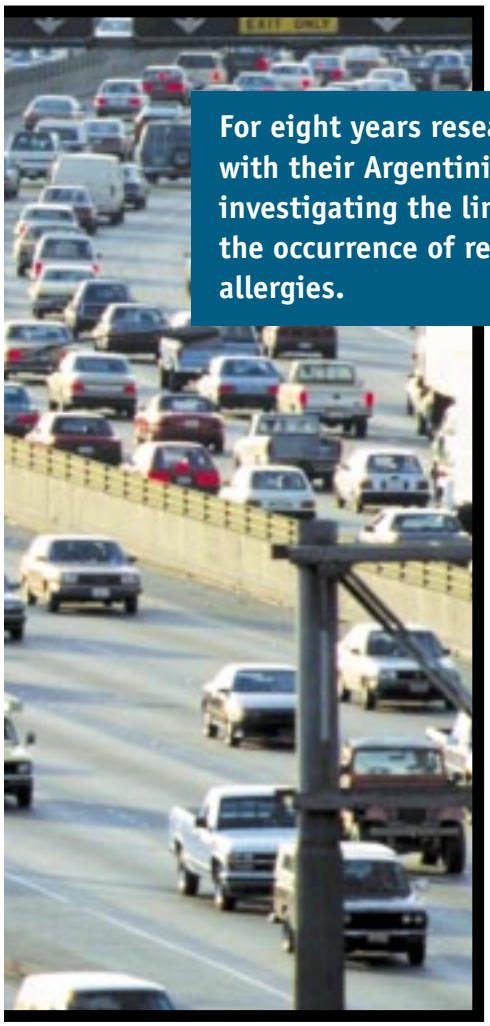
In October 2002 interim project findings were presented at a public symposium in Leipzig. Their translation into practice will enhance existing green spaces and also help to optimise planning strategies for green spaces in European towns and cities.

www.urge-project.org/

Photo: WOHLFAHRT

Air pollution in conurbations – an international issue

The World Health Organisation estimates that every year air pollution is responsible for between 100,000 and 400,000 deaths. According to the UN, diseases of the respiratory tract caused by airborne particles alone cost some $100 billion. Scientists at UFZ's Department of Human Exposure Research and Epidemiology take part in international comparative studies to investigate the link between air quality and the occurrence of respiratory diseases and allergies. Now they are working together with eight other European institutions to develop an air quality forecasting system.



For eight years researchers from UFZ together with their Argentinian colleagues have been investigating the link between air quality and the occurrence of respiratory diseases and allergies.

Diseases of the respiratory tract and allergies are on the increase all over the world. One of the reasons for this is pollution caused by transport and industry. In order to weight the various factors involved, comparatively homogeneous populations at differently polluted locations need to be examined. During a large comparative study, UFZ researchers and their Argentinian colleagues tracked down the causes of respiratory diseases among the inhabitants of Leipzig and the Argentinian city of Mendoza (cf. LEBENSRÄUME 4/1999). The climate, the pollutant composition in the air and the related situation regarding bronchitis, asthma and allergies were found to vary greatly not only between the two cities, but also inside them. This enabled the scientists to identify links between the spread and impact of air pollutants and the main risk factors involved.

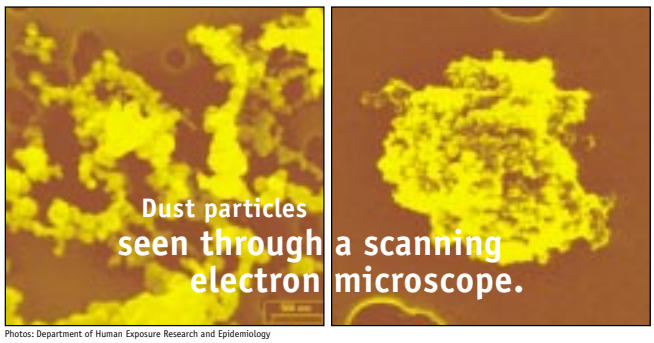
In 1999, UFZ's Department of Human Exposure Research and Epidemiology commenced a new bilateral project with the Institute of Environmental Research at the University of La Plata in Argentina. The project focuses on airborne fine dust particles and the health problems they cause at differently polluted sites in the industrial region of La Plata (dominated by the petrochemical industry), the urban region of La Plata (affected by high transport), and the urban region of Leipzig (transport and domestic heating), as well as unpolluted control regions in the surroundings of La Plata and Leipzig. The dust particles are filtered out of the air, classified in terms of particle size, and the pollutants adsorbed on them are then analysed.

In both cities, the very smallest particles with a diameter of less than 1.5µm accounted for over 60pc of the mass of airborne particles. Hence airborne dust in cities mainly comprises particles which can even penetrate the alveoli in the human lungs, thereby exacerbating the risk of respiratory diseases, asthma and allergies. Moreover, chemical analyses showed that 80pc of airborne PAHs (polycyclic aromatic hydrocarbons), many of them carcinogenic, are absorbed on these particles with a diameter below 1.5µm. In the industrial region of La Plata, the proportion of carcinogenic components in the air is much higher than in the inner cities of La Plata and Leipzig.

To find out how mutagenic these fine dust particles actually are (i.e. the extent to which they can induce genetic mutation), the scientists used the AMES test. Deliberately modified bacterial strains are exposed to extracts from the dust particles. Substances which have a mutagenic effect change the growth characteristics of these bacteria and hence indicate the extracts' mutagenic potential. The toxicity of the dust extracts was examined using test organisms – the unicellular animal *Tetrahymena pyriformis*. The most toxic and also mutagenic effects in the test systems used were in turn triggered by the dust fractions with a particle size below 1.5µm. The mutagenic potential in the City of La Plata was found to be five times higher than in Leipzig. The collections and analyses of dust particles of various sizes performed in this project hence underline the especially high-risk potential of tiny particles able to penetrate the alveoli and other parts of the lungs.

The most toxic and also mutagenic effects in the test systems used were triggered by the dust fractions with a particle size below 1.5µm.

To ensure comprehensive risk assessment, VOCs (volatile organic compounds) in the air are also studied. Near La Plata refinery, twice as many aromatic compounds such as benzene, toluene and xylene were found in the air than in the urban part of La Plata, where the outdoor air is still four times more polluted than in Leipzig. However, the situation is reversed when comparing indoor air in apartments in Leipzig and La Plata. In fact the indoor VOC concentrations in Leipzig are ten times higher than outdoors. This is due to the effects of renovation and decoration, emissions from furniture, and different ventilating habits. Epidemiological studies show that children living in the areas concerned are subject to an additional health risk.



Dust particles seen through a scanning electron microscope.

Photos: Department of Human Exposure Research and Epidemiology

The development of software tools for an automatic forecasting system for air quality is the object of the EU project APPETISE started in 1998.

Photo: UFZ

Yet it is not just dust particles which can impair human health. High concentrations of tropospheric ozone, nitrogen oxide and sulphur dioxide all have serious health impacts and are therefore covered by the European Commission's air quality guidelines. An automatic forecasting system for air quality would enable risk groups among the population to prepare themselves for situations in which the normal levels are exceeded. The software tools necessary are now being developed by the EU project APPETISE, which started in 1998. Nine institutes (including UFZ) from five countries are involved in this programme and are conducting case studies in the cities of Catania, Norwich and Cambridge, Helsinki, Prague and Berlin. The partners have varying backgrounds which are all being incorporated into the project, including expertise in recording and modelling air pollution data, health effects, and public air pollution warning systems. Contact has already been made with the possible end-users of the planned forecasting system.

The difficulties about predicting air quality are that pollutant concentrations do not behave linearly, that we still do not know enough about many transformation and transport processes, and that the air pollution situation interacts in a highly complex manner with meteorological and transport data. Through APPETISE the groups of researchers have obtained access to techniques and experience which go far beyond their national possibilities – just like the pool of real and modelled data made available to all the participants. For example, some 30 million sets of data have now been compiled, consisting of hourly data on transport, air quality and meteorology from 20 European cities gathered over a period of 26 years.

In addition to working on the forecasting system itself, UFZ's contribution to APPETISE comprises studies on how ground-level ozone affects human health. Within a kindergarten study in Leipzig complaints such as sneezing, colds, coughing and sore throats have been recorded for 277 probands. By using statistical methods and taking into account the influence of the weather and mutual infection, the interpretation of the diaries verified the correlation between higher ozone concentrations and an increase in respiratory complaints.

Researchers are also focusing on a phenomenon called premature mortality which is observed during periods of higher ozone. If the death rate returned to normal once an ozone episode was over, the victims of air pollution would have to be regarded as additional fatalities. In actual fact, however, following ozone episodes the death rate falls below the average, and this can only be explained by the additional stress accelerating the demise of those already severely weakened or suffering from chronic disease by a few days or weeks.

Within APPETISE, the quality of 16 existing models has now been tested to predict ozone pollution in ten different European regions. In the next step, the scientists from the various research institutes will be combining the most suitable modelling approaches and developing them further. The final product is expected to help save considerable costs in air pollution monitoring, be easy to use, and be made accessible to many users. Interest in the APPETISE forecasting system is already high since the stringent EU guidelines introduced in July 2001 stipulate more extensive pollutant documentation and lower limits than, say, the German Pollution Control Act. ■

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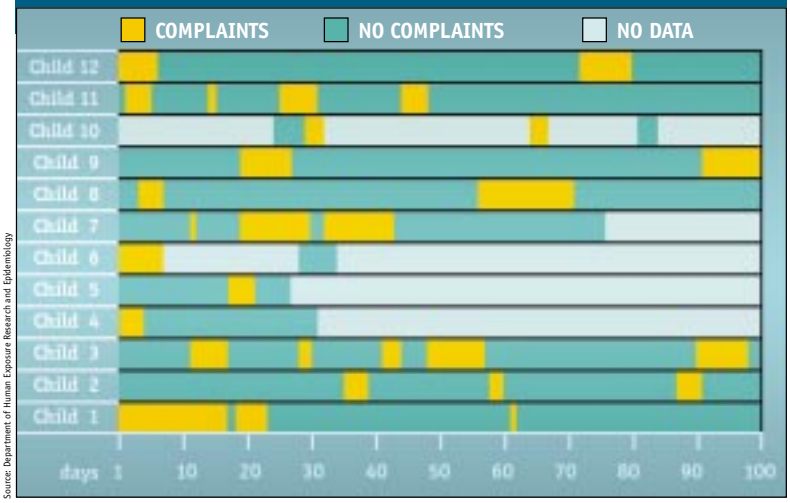

Source: Department of Human Exposure Research and Epidemiology

www.ufz.de/spb/expo/APPETISE.html
www.uea.ac.uk/env/appetise/

Environmental research in the social sciences – co-operation between Argentina and Germany

Interview

with Dr S. Kabisch of UFZ's Department of Economics, Sociology and Law, and the visiting Argentinian scientists Dr M.C. Trifiró, Universidad Nacional de Cuyo, Mendoza, and Dr G. Velasquez, Universidad Nacional del Centro, Tandil

Photo: A. Kunzelmann

QUESTION: *How did the co-operation begin between the three of you?*

DR TRIFIRÓ: In 1995, Dr Kabisch was visiting research centres in Mendoza. While she was there, she learned of the socio-geographic and demographic work being conducted at the Universidad Nacional de Cuyo. We met a year later when she returned to Mendoza, and we quickly found we had many ideas in common, so we began working together. In Mendoza we wanted to create a socioeconomic and demographic atlas for the Gran Mendoza region as a necessary instrument for urban planning and as a way of making our scientific findings broadly available. Hence the aims were similar to those attached to the UFZ's social atlas of Leipzig. The UFZ gave us conceptual assistance and helped us get to grips with the geographic information system, too. We also jointly discussed the maps' structure, such as what indicators and categories to use – a process which involved close collaboration with Dr Kindler from the Department of Applied Landscape Ecology.

We have now been working together successfully for seven years. We have presented various research findings at a number of international conferences, such as at Louvain-la-Neuve in Belgium in 1999, and at La Coruna in Spain in 2002. Our presentation came in for special praise at the Belgian conference with our collaboration being emphasised as a prime example of mutual learning and fruitful co-operation.

Our collaboration has been emphasised as a prime example of mutual learning and fruitful co-operation.

DR KABISCH: Our original intention was to make sure the ideas and concepts we had developed in Leipzig could be transferred to other regions in the world, and also to seek exchange with partners abroad. The Institut Geografica de Universidad Nacional de Cuyo in Mendoza was eminently suitable for this purpose. The very complex problems of a city like Mendoza – not just the very different living conditions ranging from expensive city-centre districts to areas of poverty on the outskirts, but also the environmental conditions of a sub-arid area with limited water resources and green spaces as well as the permanent risk of earthquakes – mean an integrated approach needs to be taken. And here we encountered 'open ears' on the part of our Argentinian colleagues.

What prompted the investigations in Mendoza was the need for better planning instruments which took account of not only aspects of urban planning but also social and environmental concerns. Thus it was that the Atlas Socioeconomico de los Departamentos del Gran Mendoza was completed in 1999 as the only one of its kind documenting an Argentinian city.

The advantage of such investigations in Argentina is that unlike in Germany a census is carried out every ten years, and so statistical data are continuously collected. This enables a watchful eye to be kept on the development of looming problems, so that suitable ways of responding can be recommended before it is to late. These data provide a very good basis for urgently necessary demographic and social investigations into the quality of life in Argentinian towns and cities, as well as the resulting decisions which need to be taken in the way of social and urban planning.

QUESTION: *Let's go back to the socioeconomic atlas for the Mendoza district. What sort of information does it contain and who finds it useful?*

DR TRIFIRÓ: The atlas describes the various socioeconomic and demographic conditions in the Gran Mendoza conurbation, which has a population of about one million. Our goal was to use specific criteria such as population growth, child mortality, running water and sewer connection to identify problem areas and to recommend solutions to the local authorities. When it came to translating our findings into practice, the snag was that Gran Mendoza is divided into six different independent districts each run by their own local authorities. Co-operation with the university is generally much worse than it is between UFZ, the University of Leipzig and the local authorities in Leipzig. The usage of our findings by private investors is also restricted because unlike the technical disciplines, the social sciences have little contact with the business community.

Source: Universidad Nacional de Cuyo, Mendoza

QUESTION: *How important are the quality of life and the environment against the background of the current crisis affecting Argentina?*

DR KABISCH: They reflect the current political and socioeconomic situation in Argentina, where the balance of power is subject to rapid change and those in charge primarily pursue their own interests and ignore the quality of life of the general public and environmental problems. And this explains the poor relations between the administrative side and universities.

DR TRIFIRÓ: The universities are short of funds to buy books. Often they don't even have the paper or printer ribbons necessary to produce publications. Academics don't know when they will be paid. There's no travel funding; moreover the sheer distances make co-operation between universities very difficult – for example Mendoza and Tandil are over 1,000 km apart. Attending conferences in the USA or Europe is only possible if the costs are paid privately or by host institutions like UFZ.

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For us German scientists, investigating how the inhabitants in the Mendoza conurbation deal with these problems – a situation which is unknown to us in German towns – is a new challenge.

The conditions at UFZ are simply incomparable with those at a university because our teaching duties leave us less time for research. In Argentina the teaching burden has grown in recent years. We share our offices with seven or eight colleagues, and often there are only a few computers. Our actual research work has to be done at home. And the worst thing is that we can't even publish our findings. But our enthusiasm keeps us persevering and doing our work. And we also regard the crisis as an opportunity to do something new.

QUESTION: *How will your co-operation continue?*

DR KABISCH: A social atlas is a dynamic instrument which needs to be improved step by step. In the first step, we created an overview of the entire Gran Mendoza region. Two years ago we concentrated on two particular urban districts of Mendoza in order to analyse the problems suffered by the public in detail. Differences were found between indicators of the quality of life which can be objectively measured and their subjective perception by the population.

Since the problem of suburbanisation is not confined to Mendoza but also exists in German towns and cities, the findings of the Argentinian investigations can be transferred to Germany and are most interesting to us. The city centres are gradually becoming deserted while in the surroundings 'closed neighbourhoods' with their own infrastructure and security personnel are springing up. They are very attractive to well-off sections of the population in terms of their location, infrastructure, microclimate and safety. Land consumption is continuing apace and city-centre urban quality is diminishing.

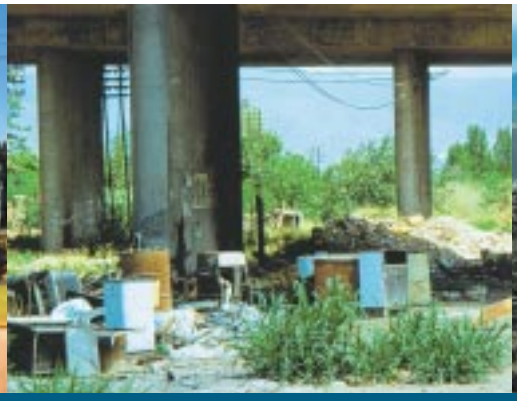
DR VELASQUEZ: One specific phenomenon in Latin America is that in contrast to the major cities, hardly any

study results are available on smaller cities with a population between 100,000 and a million. The swift growth of towns and cities in Argentina means that many conurbations are turning into large cities, with their quality of life rapidly deteriorating. We have found that urban growth is accompanied by social polarisation. Comparatively well-off private housing areas are emerging next door to slums, the Villas Miserias. Visible and invisible mental borders are being created which make for social divides. The aim of our investigations is in the end to compare the objectively determinable indicators with the perceived quality of life among the public, and then to conclude recommendations for town planners. A considerable amount of research needs to be done on the concrete translation of the findings into Argentinian urban development.

QUESTION: *Is the situation in Argentina comparable with that in other countries in Latin America such as Chile?*

Concepción contains international ports and used to be one of the main centres of heavy industry in Latin America. According to our Chilean colleagues, it is also one of the most badly contaminated regions in the world. Therefore, it's not just colleagues from EULA but also regional authorities who are very interested in the atlas project. They regard it as an instrument for regional planning. A corresponding co-operation agreement has already been signed.

Photos: S. Kabisch



The changing land use, with agricultural districts being turned into housing and industrial estates leads to constantly shrinking farmland.

The swift growth of towns and cities in Argentina is accompanied by social polarisation.

DR KABISCH: The changing land use, with agricultural districts being turned into housing and industrial estates, is comparable with the situation in Europe. However, what is especially problematic in Argentina is that many of these new estates are being built on valuable farmland where wine, fruit or vegetables used to be cultivated. In the Gran Mendoza region, where agriculture is already hampered by the semiarid conditions and only possible with costly irrigation, the amount of land used for farming is constantly shrinking, making supply bottlenecks likely. Moreover, many new estates are being built in areas subject to environmental risks such as earthquakes, landslides or flooding. For us German scientists, investigating how the inhabitants in the Mendoza conurbation deal with these problems – a situation which is unknown to us in German towns – is a new challenge.

DR VELASQUEZ: What's different about Argentina is that until a few years ago it had a broad, influential middle class, whereas other countries like Chile and Brazil have always had a deep divide between rich and poor.

DR KABISCH: Through our work in Mendoza, we also came into contact with colleagues from the Universidad Concepción in Chile, where the Instituto EULA coordinates joint European-Latin American projects in various disciplines. EULA and UFZ are currently drawing up an environmental and social atlas for the city of Concepción. Once again it's based on the social atlas developed at UFZ in Leipzig, although the concept behind it has been broadened for Concepción. This city is an ideal candidate because good, extensive environmental data are available for Concepción, and because in Chile, too, the social structure is well documented by a regular census providing demographic information and data.

Co-operation with our Chilean colleagues is also very good. Three of them came to Leipzig just two weeks ago to discuss new ideas and concepts with Dr Velasquez and us. We have thus managed to create a network from which new projects can be initiated.

DR VELASQUEZ: Meeting Dr Trifiró and Dr Kabisch and comparing the problems of other regions with the results of socio-geographical studies in Tandil have given me plenty of new insights. Back in Tandil I'll pass on this knowledge to my colleagues in the Urban Net of Quality of Life – a network of urban ecologists and social scientists in Latin America which was founded at the Universidad del Bío-Bío in Chile in 1994.

DR TRIFIRÓ: We're very keen to maintain international co-operation, even though it's becoming increasingly difficult for us due to the lack of funds. Consequently we really depend on support by institutions such as UFZ. ■

Geckos in fragmented landscapes

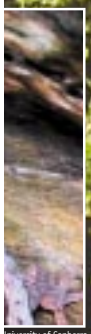
Photo: D. Hunter, U

Photo: M. Hähn

Photo: D. Hunter, University of Canberra

Despite countless research and species protection projects, biodiversity is continuing to decline all over the world. Apart from the direct loss of habitats and the gradual deterioration of habitat quality, the reasons are the isolation and fragmentation of the remaining habitats. Gecko populations in Australia are ideal for studying how landscape structures and habitat deterioration affect the viability of species at different spatial scales.

Photo: B. Gruber



University of Canberra

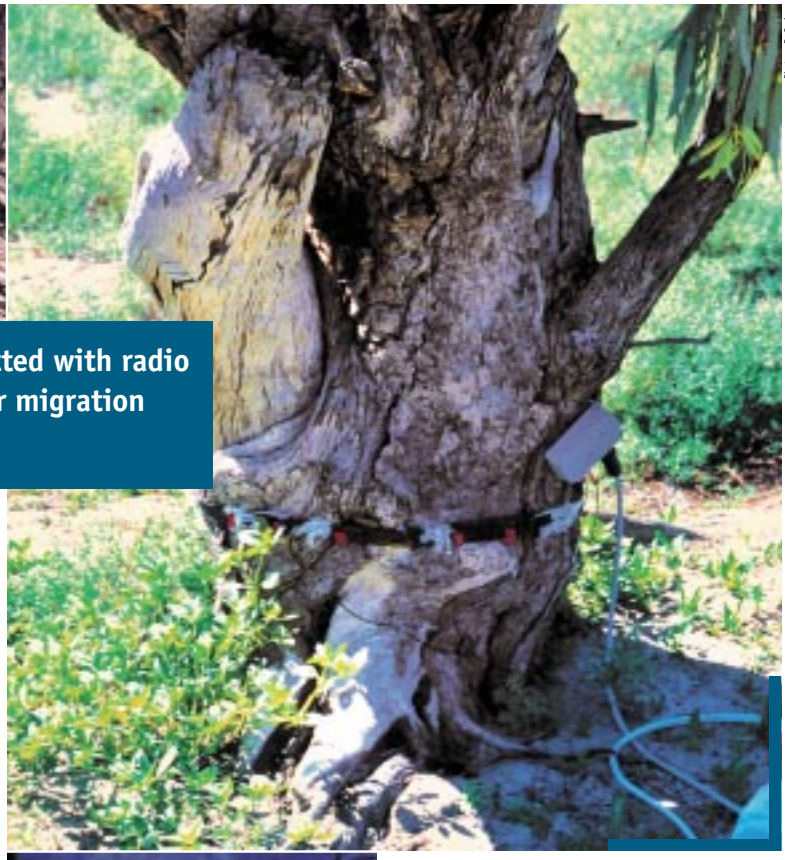
(B. Gruber, M. Höhn, K. Henle)

Landscape fragmentation is almost always the result of human interventions into large habitats. Intensively used landscapes devoted to one single purpose such as farmland, the transport infrastructure, housing and commercial estates, and recreation areas are all spreading at the cost of natural and semi-natural habitat. Suitable habitats for numerous species are often so badly decimated that the probability of local extinction skyrockets.

Whether a species can survive in such fragmented areas mainly depends on the environmental variability and spatial spread of the residual habitat, as well as the species' population parameters and mobility. Different species have different abilities to overcome the barriers caused by fragmentation. A new road, for example, is a minor problem for birds, but a major obstacle for otters. The structurally dependent rate of exchange between residual habitats is hence a crucial parameter when simulation models are used to estimate the degree of risk faced by a population.

Unfortunately, the exchange processes between sub-populations remain difficult to quantify despite advanced techniques. Surveys of this type entail a huge amount of work, especially if the species is difficult to keep track of even with modern field ecological techniques or if its mobility is low.

For ten years, UFZ's Interdisciplinary Department of Conservation Biology and Natural Resources has studied the habitat requirements of geckos and the exchange rates between their sub-populations in Australia. One of the aims of this work is to achieve a better understanding of the exchange processes at various spatial levels. Tree-inhabiting geckos, which are typical representatives of organisms with a small activity radius and medium mobility, are especially endangered by isolation. Their overall habitat is a relatively small, clearly defined system of habitat islands with unsuitable areas in between.



Photos: B. Gruber

Geckos were caught and fitted with radio transmitters to follow their migration patterns.

With a population size of 50–100 animals per habitat island and a habitat size of 1–2 hectares, the exchange rate between habitat islands can be documented with sufficient accuracy. Mammals like foxes or otters are less suitable for this question since although their population sizes are much smaller, they have a much larger activity radius, whereas insects like butterflies and hoverflies usually exist in very large populations on either large or very small overall habitats.

In order to obtain information about exchange processes at a small scale, a population of *Gehyra variegata* in Kinchega National Park in New South Wales was selected. Together with colleagues from the University of Canberra, UFZ biologists determined the number of geckos per tree in the study area. It turned out that most geckos live in couples on the same tree, sometimes for a number of years. Some trees only contain individuals which in order to find a mate have to move to other trees. These individuals undergo a high risk of being devoured when they are on the move. This makes the overall gecko habitat ideal for evaluating the impact of fragmentation which in this case means higher mortality when switching between trees. Many *Gehyra* specimens were caught, marked and released in order to keep track of how often they change from one tree to another and to learn about the rules on which this exchange is based. By embedding these migration rules into a computer model, the activities of individual geckos can be simulated. As a starting parameter, the resulting model delivers the number of offspring of a gecko population, the key parameter being the number of encounters between males and unmated females. The species' chances of survival can then be simulated in various landscapes via the number of offspring. The capture-recapture and simulation methods developed are now to be used on other animal species.

Gecko populations in Australia are ideal for studying how landscape structures and habitat deterioration affect the viability of species at different spatial scales.

Assuming this is successful, the result will be a classification system which categorises species by their susceptibility to fragmentation effects.

A second project involving the University of Canberra, the Murdoch University in Perth, and the Australian science organisation CSIRO (Division Sustainable Ecosystems) focused on geckos' chances of survival within a larger region. During the study in the Wheatbelt in western Australia, the main question was whether a habitat generalist is able to deal with fragmentation better than a habitat specialist. The above-mentioned *Gehyra variegata* lives on trees, in undergrowth and in bushes, and sometimes even under rocks. By contrast, *Oedura reticulata* is found exclusively on smooth-barked eucalyptus species. In an area measuring 1,680 sq km, 93pc of the original vegetation has given way to farmland, making it especially suitable for fragmentation studies. All that remains of this previously undivided habitat is now a series of habitat islands varying greatly in size. A research programme carried out by CSIRO's Division of Wildlife and Ecology had already

Photos: N. Höhn

During the study in the Wheatbelt in western Australia, the main question was whether a habitat generalist is able to cope with fragmentation better than a habitat specialist.

studied the serious consequences of this landscape intervention such as changes to the hydrology, the increase in salinity, wind and water erosion, and alterations in the local climate. Numerous plant species in the region have since been classified as rare or endangered, or have even gone extinct. The loss of habitat has led to the disappearance of a third of the original mammal species. Studies of birds also reveal a similarly diminishing trend. Sooner or later even less sensitive groups of species such as reptiles are expected to dwindle, too.

It was against this background that the populations of the above two gecko species were investigated. Whereas in 1991 *G. variegata*, the habitat specialist, still occurred in 97pc of its original area of distribution, the specialist only occupied 72pc of the habitat islands. The more specific habitat requirements of *O. reticulata* appear to have reduced both its survival chances and its ability to disperse.

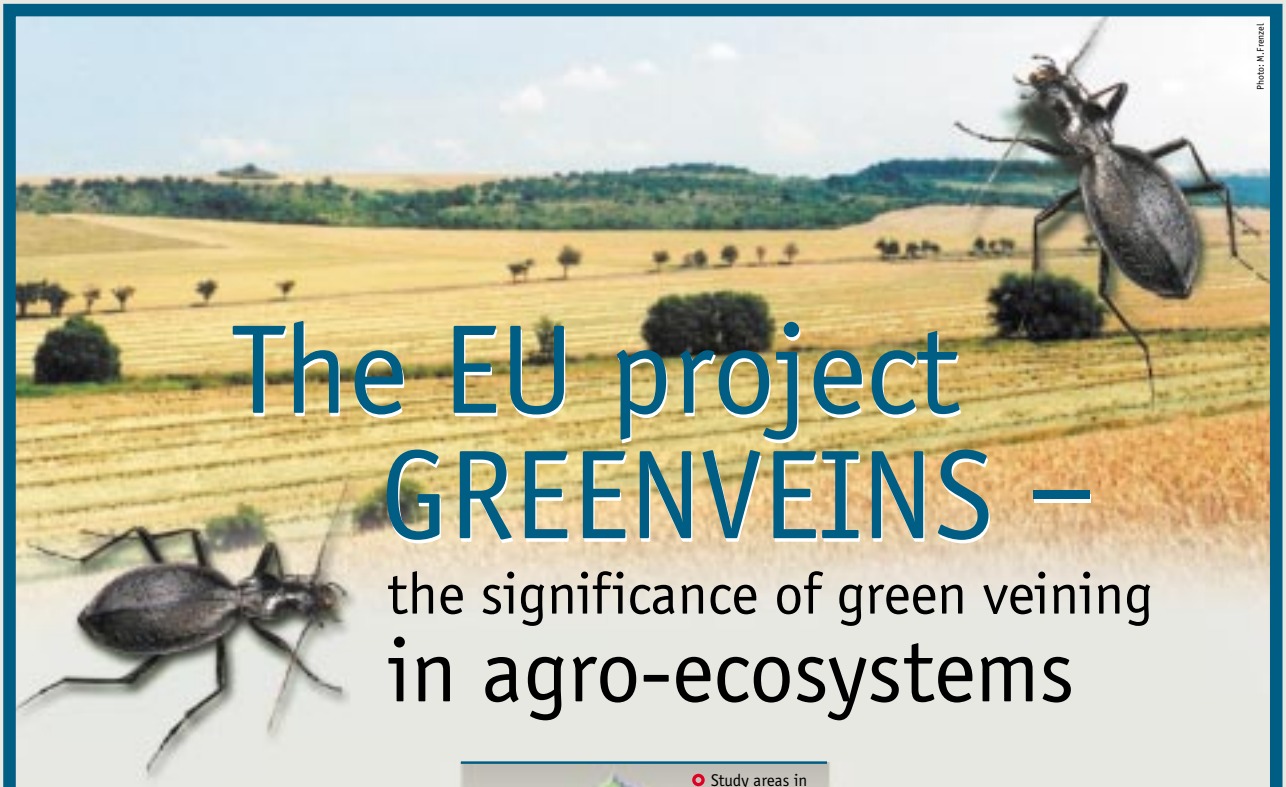
In 1991, 37 areas in the Wheatbelt were intensively investigated for the existence of the two gecko species. Repeating the presence/absence analysis in the year 2001 revealed no changes to the distribution of the 37 *Gehyra* populations, and so the populations in the area investigated seem to be viable. And as back in 1991 some populations only comprised a few individuals, the results imply that individuals can migrate between subpopulations and reoccupy vacated habitats. By contrast, the situation is very different for *Oedura* populations. In three of the 37 areas, the populations had died out and there appeared to be no prospect of resettlement. As a result, the habitat specialist is evidently more susceptible to fragmentation.

Photo: B. Gruber

The project was taken a step further to study tissue samples from animals caught in 1991 and 2001 using genetic methods. Genetic analysis enables the migration rates between habitat islands to be estimated, and can thus provide direct evidence of the habitat specialist's limited mobility. The habitat specialist's populations are also likely to display reduced genetic variability owing to the effects of inbreeding.

One of the future tasks of conservation research will be to establish whether the rules found in the studies presented here are generally valid. It is hoped that the rules initially describing the hazard potential for a particular species can in future be integrated into forecasting systems and protection programmes for as many species as possible and thus help them survive. ■

www.ufz.de/spb/nat/landnutzung.html
www.csiro.au



The EU project GREENVEINS – the significance of green veining in agro-ecosystems

The cultural landscape in central Europe is largely dominated by agricultural usage, which in turn has a direct impact on biodiversity. The term 'biodiversity' covers biological diversity at various levels, starting from landscape structures and the abundance of species down to genetic variability within a single species.

The European Union's project GREENVEINS (Vulnerability of Biodiversity in the Agro-Ecosystems as Influenced by Green Veining and Landuse Intensity) is examining the significance of semi-natural landscape elements such as hedges, woodlands, lakes and streams for biodiversity in the agricultural landscape. Semi-natural landscape elements are 'green veins' which provide habitats for plant and animal species which otherwise could hardly exist in a purely agricultural landscape. The aim of this project is to filter out those parameters which if slightly altered have a major impact on the landscape's biodiversity. UFZ is joined in this project by groups of researchers from France, the Netherlands, Belgium, Switzerland, the Czech Republic and Estonia. The project is being coordinated by the Netherlands-based environmental research institute ALTERRA.

UFZ's Departments of Community Ecology and Applied Landscape Ecology are jointly studying four different areas in Saxony-Anhalt each with a size of 16 sq km. The selected areas differ in terms of the degree of land use intensity and the proportion of semi-natural landscape structures. Whereas Community Ecology is in charge of documenting plants, birds and insects, Applied Landscape Ecology digitises and analyses the landscape data using aerial photographs and habitat maps.

The zoological survey is now mostly complete, although thousands of insects still need to be determined. Initial analyses show that as land use intensity increases, the productivity of insects measured as the number of individuals caught also rises. By contrast, the more intensively the landscape is used, the more the species diversity of insect, plant and bird communities declines. Yet if a large number of different landscape elements are used to create 'green veins' and skilfully networked, diverse plant and animal communities can also thrive in agricultural landscapes.

The next step will investigate whether and how certain habitat qualities such as shape, edge areas and distribution patterns in the landscape affect species and genetic diversity at various landscape scales. ■

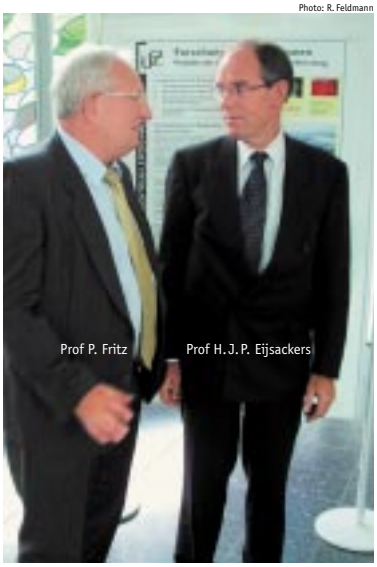
www.halle.ufz.de/bzf/index.php?en=804

PEER – the new network in European environmental research

Interview

with Prof Herman J.P. Eijsackers, research director of ALTERRA, Wageningen (NL), and chairman of the PEER network, and Prof Peter Fritz, the UFZ's scientific director

Photo: R. Feldmann



QUESTION: *How did PEER come to be set up?*

PROF FRITZ: Environmental research has always been international, and therefore internationality has always been important for UFZ. Following the restructuring of the Helmholtz Association of National Research Centres, we also had to see who our strategic partners in Europe were. Another reason to get involved in the establishment of PEER was that the European Union's Sixth Framework Programme called for partnerships to be formed going beyond the previous extent.

PROF EIJSACKERS: As far as we're concerned, it all began with the visit by Prof Fritz and Dr Müller in November 2000. We immediately perceived the great importance of such a network because it provided us with a framework for real co-operation under the EU's Sixth Framework Programme. The reactions at the next meeting organised by SYKE in Finland emphasised just how positive the institutes from non-classical EU states like Finland also were about this type of co-operation. And that's why it all happened so very, very fast: all in all it took just 18 months to reach the point where we are now. This rapid development was only possible because the participants cooperated so well, and also because

We will only have achieved our goal once we have become acknowledged as an important grouping at the level of the EU.

UFZ's directorate with the help of Jan Marco Müller provided so much impetus.

QUESTION: *What synergy effects have been made possible by PEER?*

PROF FRITZ: The synergy effects are visible in almost all the topics dealt with by UFZ, and that can't be emphasised enough. I'm particularly pleased that for example the sociologists and economists within PEER are reaching a critical mass of a few dozen scientists. And they'll be organising their own workshop with over 100 participants on the fringe of the opening conference for the Sixth Framework Programme in Brussels, November 2002.

PROF EIJSACKERS: One of the things about PEER which is useful and helpful for me is that it gives us the opportunity to understand more about each other's cultures. And I have the feeling that these directors' meetings have all been informal in the best sense of the word. We were able just to speak for ourselves and not take up formal positions; we were able to speak openly about the interests of our respective institutes. For me it was very interesting to see that although these different institutes were acting from different national perspectives, they all had the same aims. And then it was quite easy to come to synergistic co-operation. Another thing which I hope will bring further synergy is that all these institutes have highly specialised experts – European or even world experts in a very specific topic. These 'prima donnas' as I call them are treated extremely delicately because they are so very good, but they cannot be used to their full potential by their employers alone. If we could also use these highly esteemed experts on an exchange basis, then we would really have a level of expertise which is more than just one institute can offer.

PROF FRITZ: Another idea for profiting from synergy effects is the joint usage of specialised laboratories. In Heidelberg, for example, the German Cancer Research Centre maintains a laboratory run by French and Germans together. Many things which we do within PEER will really have to be done together because the consistency and reproducibility of data are more likely to be ensured through working in one laboratory than at three or four.

PROF EIJSACKERS: It's not feasible of course for just one institute to maintain one of these very specialised laboratories.

PROF FRITZ: To touch upon a completely different aspect, we have hardly started with European co-operation and are already discussing whether there is interest in for instance working together in Latin America. I regard not only the Europeanisation of science but also joint work by Europeans in South America, Africa and Asia as an important element of our future research activities. Latin America is a key area of research at the UFZ and therefore we are asking our PEER partners about possibilities for working together in these countries.

PROF. EIJSACKERS: If we want to work in such countries, we'll have to be very efficient – in both scientific and financial terms. This means bringing together the expertise, data and knowledge already available in the most efficient way.

PROF. FRITZ: The issue of funding is an essential consideration for projects in, say, Latin America. The EU is opening more and more offices in Argentina and elsewhere which actually have money for projects by Europeans in Latin America. We have to tap these sources, yet we won't be able to do so as Germans, Dutch or Finns, but only as Europeans.

QUESTION: *What new project qualities can arise?*

PROF. EIJSACKERS: If you look at the six pillars we've defined in PEER, it's obvious that these aren't just individual fields of expertise, but that multiple expertise is involved, for instance in landscape ecology, contaminated terrestrial ecosystems, integrated water management, the relationship between global change and land use, the biodiversity issue and policy instruments. If you look at the titles of the pillars it's quite clear that a combination is involved of the natural sciences with the humanities. One example of such an integrated approach is landscape architecture in a technical, elevated sense, which blends design, ecology and control instruments.

QUESTION: *How will PEER achieve the close co-operation intended with policy-makers and stakeholders?*

PROF. FRITZ: At the UFZ we attach great importance to the findings of, say, our biodiversity research or our research into the behaviour of pollutants being integrated into practical work and legislation – and I assume that the same goes for the other PEER partners.

PROF EIJSACKERS: I think that the majority of the activities in all institutes are geared towards national policy. This is true of SYKE, NERI and CEH. We at ALTERRA are independent but still highly dependent on national ministries, just like UFZ and Cemagref. The question is, how can we jump to the higher level of EU integration?

PROF FRITZ: This is where the future partnership of IES at Ispra steps in. After all, the IES is a non-national organisation directly linked to the EU. I would like to underline again what the Europeanisation of activity means. We will only have achieved our goal once we have become acknowledged as an important grouping at the level of the EU and once we have reached the stage at which we can become involved in the drafting of environmental laws.

PROF EIJSACKERS: This aspect, which was already clear to us at the beginning, must now be discussed within the implementation of the Sixth Framework Programme – with EU representatives and with the European Parliament in Strasbourg. We are now in a position to do so in view of the size PEER has reached.

PROF FRITZ: We would like to offer the European Union not only a broad, interdisciplinary spectrum of environmentally relevant research, but also advice, counselling and if necessary task forces that can be deployed for the EU at very short notice to solve acute environmental problems.

PROF EIJSACKERS: We will have to see whether Brussels is willing to have regular contact with the consortium we have become. And I look forward to seeing what happens in late autumn.

QUESTION: *What can be done to support environmental research in southern Europe and in the EU candidate countries?*

PROF FRITZ: The integration of southern and eastern Europe will have to develop over time. Co-operation with eastern Europe currently hinges above all on the financial possibilities. If you don't inject cash yourself, you won't be able to achieve anything; that's the situation in Russia and in many other countries. Furthermore, those of us starting projects outside the PEER countries must also think about how to involve the other partners. This means jointly trying to raise the funding needed to get things done in eastern Europe.

PROF EIJSACKERS: It's surprising that the question only addresses southern Europe and the EU candidate countries. In addition to Poland and the Czech Republic there's a large number of non-EU candidates in eastern Europe. It would be only logical to compare the content of PEER's

Photo: ALTERRA

Photo: A. Künzelmann

six research pillars with the themes relevant to society in these countries. PEER itself will only be able to grow to a limited extent, otherwise it will become unwieldy. The potential partners in our core area are Spain, Portugal and Greece, as well as eastern European states. The second group comprises the fringe of the EU: the north African states and other countries bordering on the Mediterranean. In the third step, we would then come to the global perspective, especially the southern hemisphere.

QUESTION: *Finally, what concrete effects does working in PEER have for ALTERRA and the UFZ?*

PROF EIJSACKERS: Let me tell you about a nice example illustrating the effects membership in PEER has for us. Thanks to our co-operation within the network, here in Wageningen ALTERRA has already come to be regarded by other organisations as a leading institute within European affairs. They watch us organising co-operation and making progress because we are ahead at the moment.

PROF FRITZ: The effect at UFZ is that we automatically think less nationally and more on a European scale. We are determined to contribute to European integration. In future, UFZ will receive its funding on the basis of a programme structure instead of an institutional basis. As these programmes are more or less clearly aligned towards Europe and the world, co-operation within PEER will be indispensable for us. And international co-operation will in turn lead to European ideas being adopted in our national programmes. ■

PEER–Partnership for European Environmental Research

On 10th August 2001 in Helsinki five leading environmental research centres in Europe (since joined by a sixth) decided to found the PEER initiative. The specific aims of PEER are:

- *to develop and promote joint strategies in environmental research;*
- *to establish a strategic framework for the advancement of environmental science in support of European Union and national policies;*
- *to enhance the coherence and complementarity of the research activities carried out by the PEER members;*
- *to create synergies and critical mass, so as to improve the competitiveness of European environmental research;*
- *to promote collaboration within PEER, ensuring gender equality, knowledge and technology transfer, the dissemination of the scientific results and close co-operation with policy-makers and other relevant stakeholders;*
- *to encourage and support the exchange of scientific personnel between PEER members and other institutions in the European Union and beyond;*
- *to create opportunities for the training of young scientists;*
- *to build the capacity to integrate European environmental research databases with a focus on their interpretation and exploitation;*
- *to contribute to an institutional capacity building in environmental research, especially in the candidate countries of the European Union;*
- *to prepare and facilitate proposals for the instruments foreseen in the Framework Research Programmes of the European Union within the agreed focus of PEER;*
- *to develop management capacities for large-scale and long-term European research projects and programmes, ensuring that this is done in an integrated way building on the existing strengths within PEER;*
- *to co-operate in other fields of activity that may arise from this co-operation, for example in joint task forces.*

Presently, PEER has six member organisations employing together more than 4,000 people and having an overall annual budget of 280 million. This accounts for about 40pc of the total budget the EU plans to spend on the 6th RTD Framework. By acting together, the PEER centres intend to exert a greater influence on environmental and research policy in the future. The co-operation was confirmed by a framework agreement signed on 25 June 2002 in Roskilde (Denmark). ■

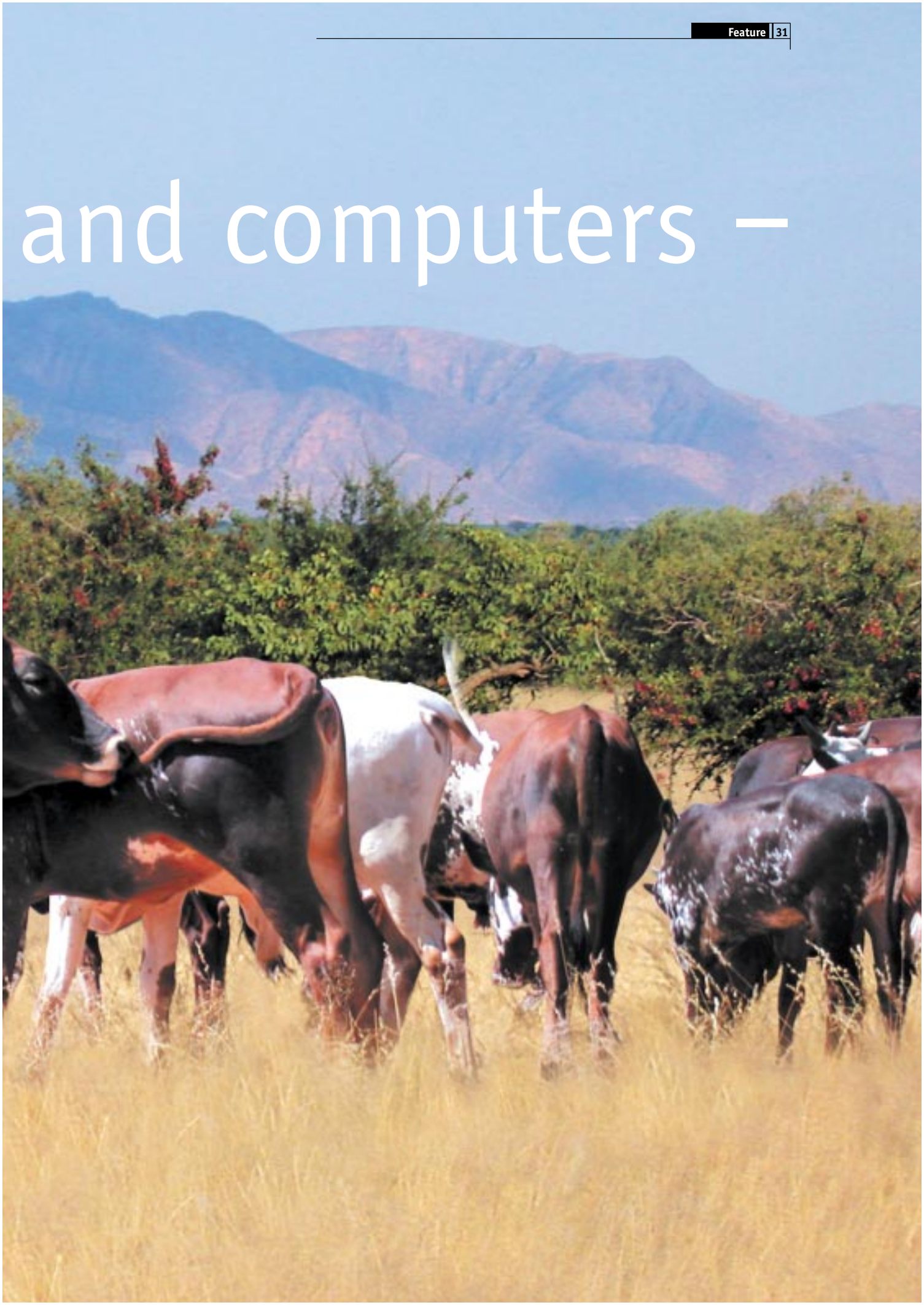
www.peer-initiative.org

Savannahs, cattle
sustainable land use in Namibia?

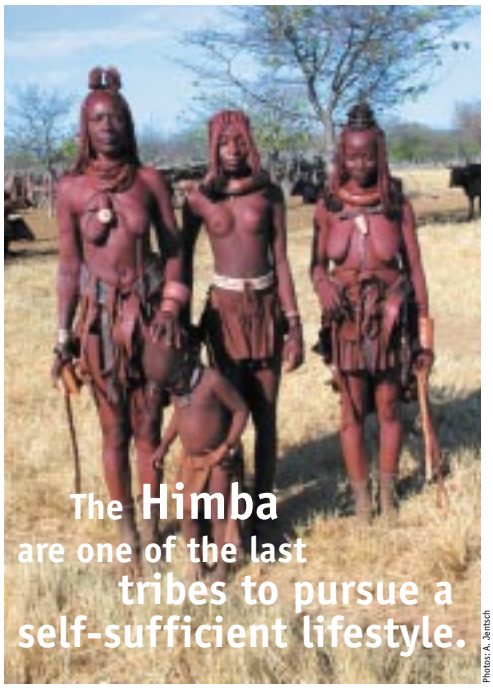
Photos: A. Jentsch

Two-thirds of the African continent are dry areas with annual rainfall below 50 mm. Unsuitable land use in the African savannahs has led to starvation and disease. According to UN Secretary-General Kofi Annan, “Drought and desertification threaten the existence of over a billion people in more than 110 states in the world.“ Farmers and the indigenous population in Namibia are seeking the right balance for sustainable grassland farming in very different ways. Scientists from the University of Cologne and UFZ are researching the savannah ecology, and combining ecological and economic information on two farming systems in simulation models.

and computers –



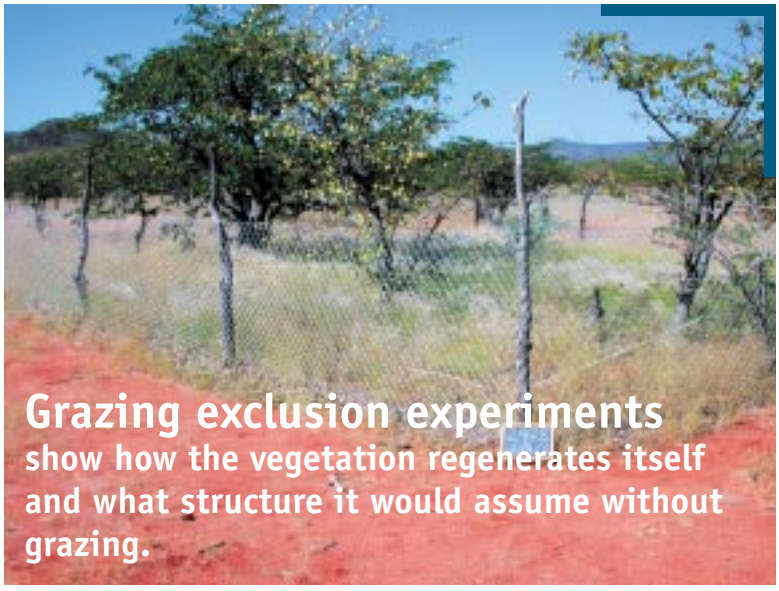
The semi-nomadic Himba in northern Namibia are one of the last tribes on the planet to pursue a traditional, self-sufficient lifestyle almost completely isolated from the rest of the world. In Kaokoland, where the 16,000 Himba live, rainfall is very irregular, and periods of drought lasting years are by no means infrequent. In order to sustainably use the savannah, the cutting and felling cycle used to be geared to rainfall. The Himba's grassland protection rules include for example detailed information on the cutting cycle and strict protection regulations



Photos: A. Jentsch

such as bans on cutting down trees and the designation of protection zones used as emergency pasture in times of drought. There are countless examples of how applying the wrong rules or no rules at all can easily lead to overuse and hence irreversibly harm sensitive ecosystems. This slashes the productivity of grassland and the number of trees, and increases soil erosion by a factor of ten.

The usage and social rules of the Himba are of equal interest to ethnologists, biologists and modellers because they provide a chance to study a centuries-old type of land use and to research the principal rules of sustainable land use under extremely varied environmental conditions. Since 1995, Dr Anja Schulte, a botanist from the University of Cologne, has spent a number of months every year in Kaokoland. Together with other scientists she set up a bush camp consisting of tents and off-road vehicles in the immediate vicinity of a Himba family, and is now studying how grazing affects the structure and dynamics of the savannah. For this purpose, 50 long-term observation areas and grazing exclusion experiments were carried out in a number of settlement areas (a large Himba family lives in huts made of branches and clay in an enclosure area protected by wooden fencing). Fenced-off areas are used to observe how the vegetation regenerates itself and the structure it would assume without grazing. The most striking change during the first five years after grazing exclusion was the increase in perennial grasses. The dominant tree species in large sections of Kaokoland is the mopane (*Colophospermum mopane*). At the study areas, Dr Schulte recorded the crown diameter, trunk circumference and traces of usage and erosion on each mopane, as well as the respective composition of species in the grass layer.



The scattered tree stock and the closed grass cover characterise Kaokoland as secondary savannah: a cultural landscape shaped by human usage. The different grazing rhythms of the Himba nomads form an anthropogenic disturbance regime and along with weather fluctuations are the main factor behind vegetation dynamics and biomass production in the savannah landscape. African savannahs are also susceptible to natural disturbances like fire, widespread plagues of caterpillars, and local soil disturbances. In spring 2001, vegetation ecologist Dr Anke Jentsch from the UFZ aided the outdoor studies in Kaokoland by surveying the disturbance regime on the long-term observation areas. Although disturbance events can have a locally destructive impact, by acting as an ecological buffer they make an indispensable contribution to the savannah's dynamic stability as a whole.

To assess the stability of this cultural landscape under various climatic and usage scenarios, and to compare it with other forms of use, the idea was born at UFZ of creating a simulation model which combined information on vegetation ecology and population biology with rainfall data. The aim was not to accurately reproduce reality in the mopane savannah, but rather to understand the cause-and-effect processes taking place and to study their role within ecological relations. Understanding the ins and outs and being able to predict the effects of anthropogenic changes caused to the ecosystems pave the way for their protection. UFZ's scientists are no strangers to such work, since the Department of Ecological Modelling has been developing and analysing models of arid and semiarid savannah systems for many years.

Photos: T. Stephan

The hundred paddocks at Gamis farm are managed on a rotational grazing system.

The problem of the adapted usage of the savannah is one which is faced by both the indigenous population and modern farms. The former rely on their traditional knowledge handed down over the centuries; the latter trust in modern grazing strategies. What exactly are the differences? The modellers from UFZ have been studying Gamis farm, southwest of Windhoek on the edge of the Namib desert, where Karakul sheep are bred. The farmer here sticks closely to a package of grazing rules compiled over many years' experience. The rules have made him much more successful over the years in managing the 300 sq km area than many of the neighbouring farms. The strategy of the Gamis farmer is largely based on the idea that in order to maintain the vegetation system in the long term, it needs to be granted a 'breathing space' between grazing periods to recover. For this purpose he divided the farm into 100 paddocks and developed a rotational grazing system in which a third of them remained unused and hence protected during the growth period. Nevertheless, applying this principle is not always possible for economic reasons. In dry years, for example, literally every stalk of grass is needed to feed the sheep in order to maintain the number of Karakul. Hence, the vegetation is only given a chance to recover in wet years. The farmer's strategy certainly makes sense from the angle of sheep breeding, but how is it for the vegetation? After all, 'breathing spaces' in wet years but not in dry ones when the vegetation is weaker clashes with current expert opinion. To study how the different breathing-space regimes affect the number of sheep and the vegetation more exactly, Birgit Müller and Dr Karin Frank modified and analysed a simulation model at the UFZ. And using it they showed that the seemingly counter-intuitive Gamis strategy actually benefits the vegetation after all. The reason is that only in wet years is there enough moisture available for the grass to perform enough photosynthesis to recover. Hence the approach taken by Gamis farm works because the economically successful policy is also ecologically sustainable.

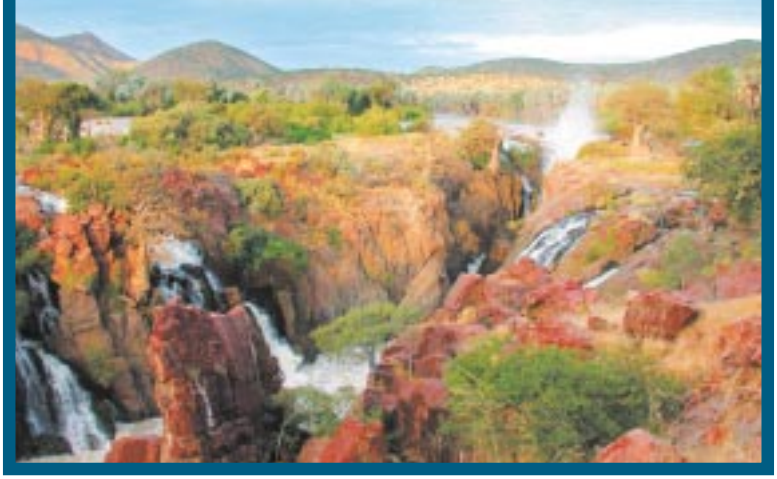
Does this mean we now have two different solutions to the same problem, or are the basic principles the same? The initial findings indicate that the grazing rules of the Himba follow the same basic principles as those of the Gamis farmer. This in turn shows that we are probably dealing here with general principles of ecology. UFZ's modellers are now studying the question of whether the proven management system at Gamis farm can also be recommended under different climatic, ecological or economic conditions, with equal importance being attached to both ecology and economics. ■

Photo: A. Jentsch

The Himba and the dam

The African savannas only contain a few tribes who still maintain the formerly predominant semi-nomadic grazing system. Examples include the Fulani in the Sahel in Mali, the Woodabe in Nigeria and Cameroon, the Illabaken Tuareg in the Niger, the Pokot and Turkana in Kenya, and the Himba in north-western Namibia.

The Himba drew global attention when they successfully opposed a dam project which threatened their very basis of life. In November 2000 the World Commission on Dams argued that 40–60 million people all over the world had lost their homes through the construction of large dams. And the same fate seemed to await the Himba. A dam project on the River Kunene on the Namibian-Angolan border was originally intended to produce a reservoir almost 400 sq km in size to be used for hydropower. The World Bank has since announced that it will not finance this scheme under any circumstances, and the Namibian government is now reviewing the use of alternative energy resources.



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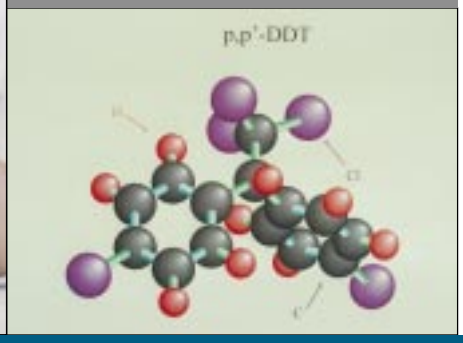

CHEMICAL ECOTOXICOLOGY

PUBLISHED BY: UFZ-Umweltforschungszentrum Leipzig-Halle
in der Helmholtz-Gemeinschaft
EDITED BY: Dr. Reinart Feldmann, Doris Böhme
DESIGNED BY: **WOHLFAHRT**
PRINTED AND BOUND BY: Druck-Strom, Leipzig

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In December 1991, UFZ Centre for Environmental Research Leipzig-Halle was set up by the German government along with the regional governments of Saxony and Saxony-Anhalt as a member of the Helmholtz Association of National Research Centres. Ninety per cent of its basic funding is supplied by the Federal Ministry of Research, with the remaining 10pc being shared equally between the states of Saxony and Saxony-Anhalt. UFZ currently employs about 650 personnel at its three sites in Leipzig, Magdeburg and Halle. It also runs field experiment stations in Bad Lauchstädt and Falkenberg.

Through its research work the UFZ shoulders responsibility for the environment – nowadays not just for the remediation, renaturalisation and reshaping of stressed landscapes but increasingly for preventive environmental research helping to reduce and even rule out hazards and risks to mankind and nature in the first place. Building on a solid scientific foundation, interdisciplinary research departments closely combine scientific research into landscapes and environmental medicine with the social sciences, ecological economics and environmental law. Techniques and methods developed at UFZ have since been incorporated into regulations and laws, and are also practically applied in for instance industry and nature conservation.

UFZ is currently stepping up its activities at a European level, as well as globally, including with countries from Latin America and the Middle East.

UFZ's central focus is "Research into sustainable land use and securing the quality of life in the cultural landscape." By adopting this forward-looking profile, the UFZ has bolstered its original position within the programmes of the restructured Helmholtz Association.