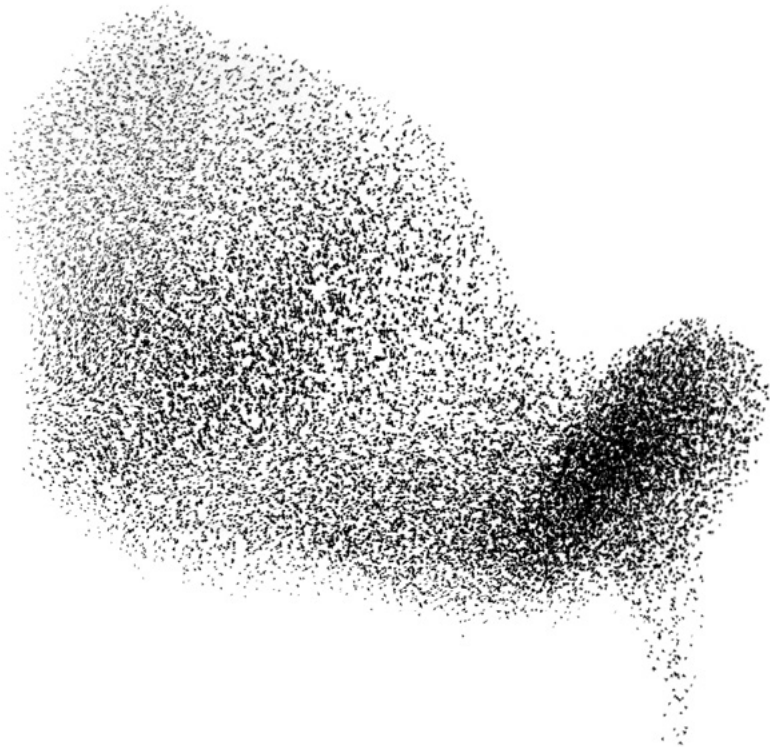


01 · 2017

FELD

MAGAZINE OF THE LEIBNIZ CENTRE FOR
AGRICULTURAL LANDSCAPE RESEARCH (ZALF)



TITLE STORY

**DECRYPTING
PATTERNS IN NATURE
WITH BIG DATA**

SUSTAINABLE DEVELOPMENT GOALS

17 »Sustainable Development Goals« are the centerpiece of the Agenda 2030, approved in 2015 by the United Nations (UN). The Agenda lays a foundation for global economic development in accordance with social justice and within the ecological boundaries of planet earth.

MORE INFO

<https://sustainabledevelopment.un.org/sdgs>

The research projects presented in this issue address the following Sustainable Development Goals:



NO POVERTY



ZERO HUNGER



GOOD HEALTH AND
WELL-BEING



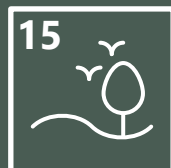
CLEAN WATER AND
SANITATION



CLIMATE ACTION



LIFE BELOW WATER



LIFE ON LAND

CONTENT

Researchers in Brandenburg are using **BIG DATA** in attempts to decipher correlations in nature. A correct interpretation of the large volumes of apparently complex data has so far proven very difficult. An excursion into theoretical physics eventually led to an interesting discovery: patterns in the sea of data. **02**

The »Agriculture for Biodiversity« project brings **SPECIES PROTECTION** onto fields and into the supermarket. Participating as a partner of science: one of the largest food retailers in Germany. **10**

Small farmers in Odisha in India have long suffered from extreme droughts. PhD student Anu Susan Sam makes use of **SCIENCE AS DEVELOPMENT AID**, to better enable farmers to help themselves. **20**

Were there already **FARMERS IN THE NEOLITHIC PERIOD?** How was food grown 5,000 years ago? Researchers have embarked on a journey through time with their computer simulations and made amazing discoveries. **30**

EXPERT INTERVIEW 28 · NEWS 34 · IMPRINT 36

TITLE STORY

DECRYPTING PATTERNS IN NATURE WITH BIG DATA



Researchers have spent 20 years gathering an enormous wealth of data in a study area in Brandenburg covering approximately 160 km²: sensors measure data in soil, groundwater and the air, but also observations of animals and studies of plants can help us better understand interactions in the environment. Previously, linking and correctly interpreting the data proved extremely difficult due to the enormous complexity as well as the sheer quantity of data – statements about natural correlations remained vague. An excursion into theoretical physics led a team of researchers to a new methodology and then to a discovery: patterns in the sea of data.



In water samples interactions between different measurement variables are visible as patterns.

Professor Gunnar Lischeid, Head of the Institute of Landscape Hydrology at the Leibniz Centre for Agricultural Landscape Research (ZALF), did not at first suspect that he would uncover a major error. He is interested in all kinds of water: ground-water, soil water, rivers, streams, ponds and kettle holes as well as everything that is transported in them, primarily fertilisers and nutrients. And so he was astonished to discover that many of the streams in the Uckermark region of Brandenburg were becoming cleaner over the years. The general assumption: »Our farmers are using less fertiliser.« A success for environmental protection? Prof. Lischeid and his team started to investigate.

BIG DATA IN THE UCKERMARK

The data which Prof. Lischeid can draw upon originates from an area studied by ZALF, which is located 90 km north of Berlin in the catchment area of the River Quillow in the Uckermark. Everything which is important for the environment has been measured there since the end of the 1990s: Weather and soil structures, tick and mosquito infestations, weeds and birds, groundwater levels and soil moisture. »Ornithologists, water experts, biogeochemists, landscape researchers and other scientists are gathering data and analysing processes here from entirely



In order to illustrate
 correlations and
 interactions in nature,
 we have to work with
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 together so that new
 reliable information
 emerges.

PROF. DR. GUNNAR LISCHIED

different perspectives«, says Prof. Lischeid. Due to the size of the research area, results can be transferred to other regions in Germany. In this way, important statements on interactions in the countryside arise, which are quintessential for environmental protection and nature conservation. »However: we scientists often look only at the data through our own specialist glasses. In order to illustrate correlations and interactions in nature, we have to work with extremely large quantities of data and link them together so that new reliable information emerges.« What had been lacking until now was a way to identify certain recurring patterns, not only in a small data set, but in a very large quantity of data. These patterns could represent the basis of an essential link in nature, which is as yet unknown to us or for which the evidence is missing.

»Of course we are aware of many correlations in nature. But there are interactions that we have previously been unable to explain«, says Lischeid. Plants that actually require dry soil, are suddenly also growing in moorland. Other plants evaporate almost exactly the same amount of water every year, even though rainfall and average temperatures differ significantly from year to year. Developments are the result of cause, effect and adaptation. If this principle is valid, then there must be patterns for comparable processes which repeat themselves. Certain correlations catch your eye immediately. For others, you require



very large quantities of data with as many different measurement variables as possible. Taking a closer look then no longer suffices, neither to simply identify all the links and interactions nor to demonstrate them. »I was therefore looking for an approach to track down the creative forces of nature in the flood of data.« A coincidence came to his aid in his search for clues.

BREAKING NEW GROUND IN THE FIELD OF ENVIRONMENTAL RESEARCH

»A former colleague of mine is a theoretical physicist. He gave me an insight into modern methods of analysis of large data sets, which have been used in physics for a long time.« Big Data is the key word: The term summarizes data which is too complex, too big or too fast moving to process with conventional computer systems and methods. For this, new methods and technologies are required. In business, for example, the data of hundreds of millions of Internet users is recorded simultaneously, linked and condensed into personal profiles within seconds. A complex algorithm calculates which advertising is shown to us during our visits to web pages, for example, where we might plan our next holiday. Thousands of pieces of measurement data feed mathematical models for day-to-day weather forecasts, help biologists to understand the construction of a cell and are used in physics for the representation of atoms. Fascinated by these approaches, the team led by Prof. Lischeid begins to employ these methods, thereby breaking new ground in environmental research. A first test case is already on his table: the changes in ground water quality in the Uckermark.

Prof. Lischeid's search for patterns begins. He and his team collect 2449 water samples from the streams, small natural ponds, so-called kettle holes, and from the groundwater in the Quillow area. A total of 96 different water bodies are examined for twelve measurement variables: the pH value, electrical conductivity, sulphate, nitrogen, chloride, phosphate, sodium, potassium, magnesium, calcium, ammonia content and organic carbon concentration: an entire ocean of figures. »Although environmental processes are very complex, they are often dominated by a small number of key processes. In this case I discovered that essentially the same five processes take place in these 96 measurement sites, albeit to varying degrees and with different time frames.« His resourceful companion: the computer. However the computer has one handicap – it is no great help in recognising patterns. This fascinating ability of our brain remains thus far largely closed to the computer. Prof. Lischeid therefore familiarised himself with »Big Data« approaches to data analysis and came across the »SOM-SM method«. This combines the processing power of a computer with the human capacity to recognize patterns. Each of the 2449 water samples is represented by a point on a diagram. Water samples with very similar values for all 12 measurement variables plot very close to each other. Those that are very different are placed far away from each other. A cloud of points of differing density emerges. Even at first glance patterns are recognizable: The location of points in the figure reveals a lot about which samples are similar, which ones display a typical pattern and which

Measurement values of 12 solutes from more than 2000 water samples are shown here in a figure using the SOM-SM method. Different colours indicate, for example, the level of contamination.



groups of measurement sites are different. The decisive factor is that these patterns are determined by all twelve measurement variables. Using different colors in the same figure, the values of individual measurement variables or individual measuring sites can be shown and changes to individual measurement variables over time can be seen. For the human brain it is very helpful that the position of the points in the figure always remains the same, only the colors of the points change. »In this way even very large data sets can be investigated very efficiently with the aid of computers« says Lischeid.

AMAZING EVIDENCE

Using these »Big Data« approaches, the alleged success story of the clean rivers and streams was ultimately revised: the researchers were able to show a gradual change in water quality in the streams, however not in the groundwater and so they became suspicious. A second feature in the clouds of points brought them onto the right track: the groundwater levels had dropped in comparison to the previous years. The reason for the improvement in the quality of water was not a reduced use of fertilisers, but the weather. In recent years which had been warm and dry, only little heavily contaminated water from the arable land had found its way into the streams. During this time they were fed with less polluted

groundwater from a greater depth. »It had nothing to do with the fact that farmers were working differently, but simply with the different water levels. Using our procedures, we were finally able to scientifically prove this.«

But this was not the only error Prof. Lischeid was able to rectify using the new models. »In various kettle holes in Brandenburg and in Mecklenburg-Western Pomerania, plant protection products were found which farmers in the catchment areas we investigated claimed they had never used. Suspicions arose immediately: Are the farmers cheating? »Our analyzes were able to absolve them: the kettle holes are in contact with the groundwater, plant protection products are often transported for kilometres under the earth.« Misjudgements such as this in the field of environmental protection can have devastating consequences – for farmers, for nature, for human beings. »Using »Big Data« approaches, we can investigate the effects of interventions in the environment, e.g. through nature conservation, and explore and identify the causes of changes in a much more differentiated way. Today we have the technical capacity to change the material flows and habitats of plants and animals to a degree that threatens the foundations of human life. Environmental research can use these new approaches to uncover correlations and draw attention to developments before they become irreversible.«



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PROF. DR. GUNNAR LISCHIED

researches water – in all its facets and interactions. He is Head of the Institute of Landscape Hydrology at ZALF and holds an eponymous professorship at the University of Potsdam. Following studies of Agriculture and Geology at the Universities of Bonn and Göttingen, he obtained his doctorate in Forestry Sciences and qualified as a professor in the Department of Hydrology.

UNITED FOR SPECIES PROTECTION— FROM THE FIELD TO THE SHOP COUNTER



Around 28,000 animal and plant species worldwide are classified as endangered. An issue we are also increasingly encountering on domestic meadows and fields. For wherever land is intensively cultivated, less space remains for segetal flora, farmland birds and insects. In the »Agriculture for Biodiversity« pilot project, scientists are now linking the competitiveness of farmers to nature conservation and are receiving support from one of the largest food retailers in Germany.

They are the singers rejoicing in the arrival of spring, but their song is becoming increasingly rare. The skylark population has declined dramatically over the past 30 years, in some regions by up to 90 percent. The overall populations of agricultural birds in Europe has halved since 1980, a similar trend can also be observed in other species groups like butterflies. Every time a species of animal or plant becomes extinct, it is not only genes, colors, shapes and sounds that are irretrievably lost. Important ecosystem services are also threatened by this, such as the pollination of many food plants by insects, the climate-regulating function of plants or also the beneficial effects on people of a landscape characterised by natural diversity.

In the meantime, every eighth species of bird, approximately 130 types of segetal flora, every third amphibian and half of the insects in Germany are at risk. »The pace at which species are becoming extinct is alarming«, says Dr. Karin Stein-Bachinger from the Institute of Land Use Systems of the Leibniz Centre for Agricultural Landscape Research (ZALF). »More than half of Germany's surface area is used for agriculture. This creates habitats for animals and plants, yet at the same time also poses a risk.« One reason for this: Fields and meadows are worked on just when plants and animals are reproducing. »Renouncing chemical pesticides and mineral nitrogen fertilizers in organic agriculture is already a good basis for nature conservation. If we want to stop the extinction of species, then we need to review the nature conservation aspects of more areas in agricultural farming, identify alternative cultivation methods and make them assessable« says Dr. Karin Stein-Bachinger. What has been missing until now is a suitable and recognized benchmark for practice. This is where the »Agriculture for Biodiversity« comes in, a pilot project which was initiated jointly in 2012 by the environmental organization WWF Germany and the ecological farming association Biopark, under the scientific direction of ZALF. So far, 60 farms in Mecklenburg-Western Pomerania, Brandenburg, Saxony-Anhalt and Schleswig-Holstein are actively participating.

Among the endangered species is the European Tree Frog (top). Extensively used buffer strips at the edges of small water bodies are important habitats for amphibians in the summer and winter (bottom). Saltatoria, butterflies and other insects also benefit from this.



Whinchats (left) breed late in the year and are therefore particularly vulnerable to mowing in grassland. By leaving out small-scale areas while mowing during the breeding period, e.g. along fences (right), breeding success can be effectively enhanced.



∨
**Nature protection
 is only possible in a
 triad between farmers,
 conservationists and
 consumers.**

**This is the only way to give
 farmland birds, segetal flora,
 amphibians and others a chance.**

∧
 DR. KARIN STEIN-BACHINGER

A CATALOG OF NATURE CONSERVATION SERVICES

Over the last few years, a team from ZALF, headed by the biologist Frank Gottwald and Dr. Karin Stein-Bachinger, has been examining the impact that certain nature conservation measures have on wild animals and plants as well as on agriculture. »Ornithologists again and again sat in camouflage tents to observe farmland birds«, says Frank Gottwald. »They like to nest in legume-grass which is grown on organic farms for feedstuffs and soil improvement«, seemingly good conditions for farmland birds. But the legume-grass is mown before the young birds can fly – only a few survive this. Night-flowering Catchfly and Field Nigella are only rarely found in the fields today. They do not bloom until the summer when the cereal crops are already ripe. The problem: the fields are cultivated immediately after harvesting. This means that the herbs are ploughed under before they can fructify. The experts have evaluated their observations and developed proposals as to how these conflicts could be resolved. »If the legume-grass is mown later or part of an area is left unmown, the nests of the farmland birds are not destroyed. This also helps leverets, amphibians, butterflies and saltatoria, which find food and cover in the higher vegetation.« The experts have compiled more than 100 nature conservation ideas for fields, meadows and pastures, the maintenance of the landscape and the protection of individual species. Specially trained nature conservation consultants help farmers to filter out those, which are useful for their location and farming procedures.

SPECIES PROTECTION CONCERNS US ALL

»Nature conservation normally means an additional burden for farmers«, explains Dr. Karin Stein-Bachinger. »He not only has to invest more time, he also has to put up with losses in yields. To compensate for this, support from food retailers and consumers is also required. «The retailing company EDEKA therefore pays farmers a premium for certain products, as a kind of nature conservation bonus. There are no additional costs for consumers. The products are marked with a specially designed »Agriculture for Biodiversity« logo.

To achieve certification, farms must collect nature conservation points. For this, the researchers at ZALF, together with a team of 40 experts from the fields of nature conservation, agriculture, science and administration, evaluate every nature conservation measure with credit points. »The number of credit points varies according to how effective the measure is for the protection of wild animals and plants and their habitats. Thus there is up to one point per

hectare for delaying tillage after the harvest, eight weeks of not using legume-grass during the breeding season brings three points per hectare, and if sub-areas are even left unmown over the winter, that is worth ten points.« A farm must have a minimum number of credit points per hectare to receive the nature conservation certificate. The system therefore enables both very small, but also very large farms to be evaluated. More than 50 organic farms in north-east Germany have already been certified.

This nature conservation evaluation of farms is currently unique in Germany. Nature conservation is not practised classically for a single species or single site. »With the farmers we have for the first time been able to implement nature conservation with agriculture on a large scale and comprehensively on a total area of around 40,000 hectares«, says Dr. Karin Stein-Bachinger. A specialist jury distinguished the project as ground-breaking in the UN Decade on »Biodiversity« in 2016. Now it's up to the customer. Through purchasing the products, anyone can make a contribution to the enhancement of biodiversity. A tracking code takes the customer to the website of the project at www.landwirtschaft-artenvielfalt.de, where they can inform themselves and find out what services the farms are providing for nature conservation. Thus far the nature conservation products have only been available for purchase in the EDEKA supermarkets in Northern Germany. »It is our aim to get more organic farms involved from other regions in Germany«, says Dr. Karin Stein-Bachinger. The pilot project has set a precedent: from 2017 studies will be carried out in ten pilot farms in southern Germany.

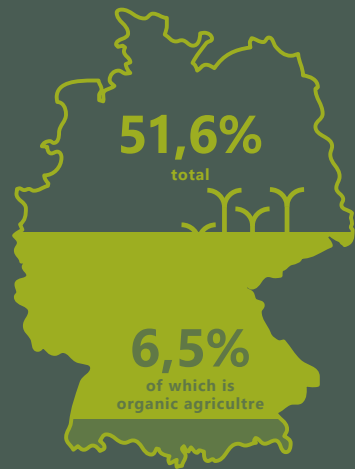


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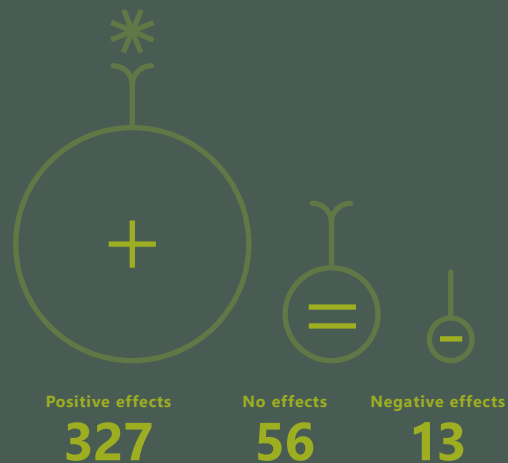


FACTS & FIGURES

Share of agricultural land in Germany



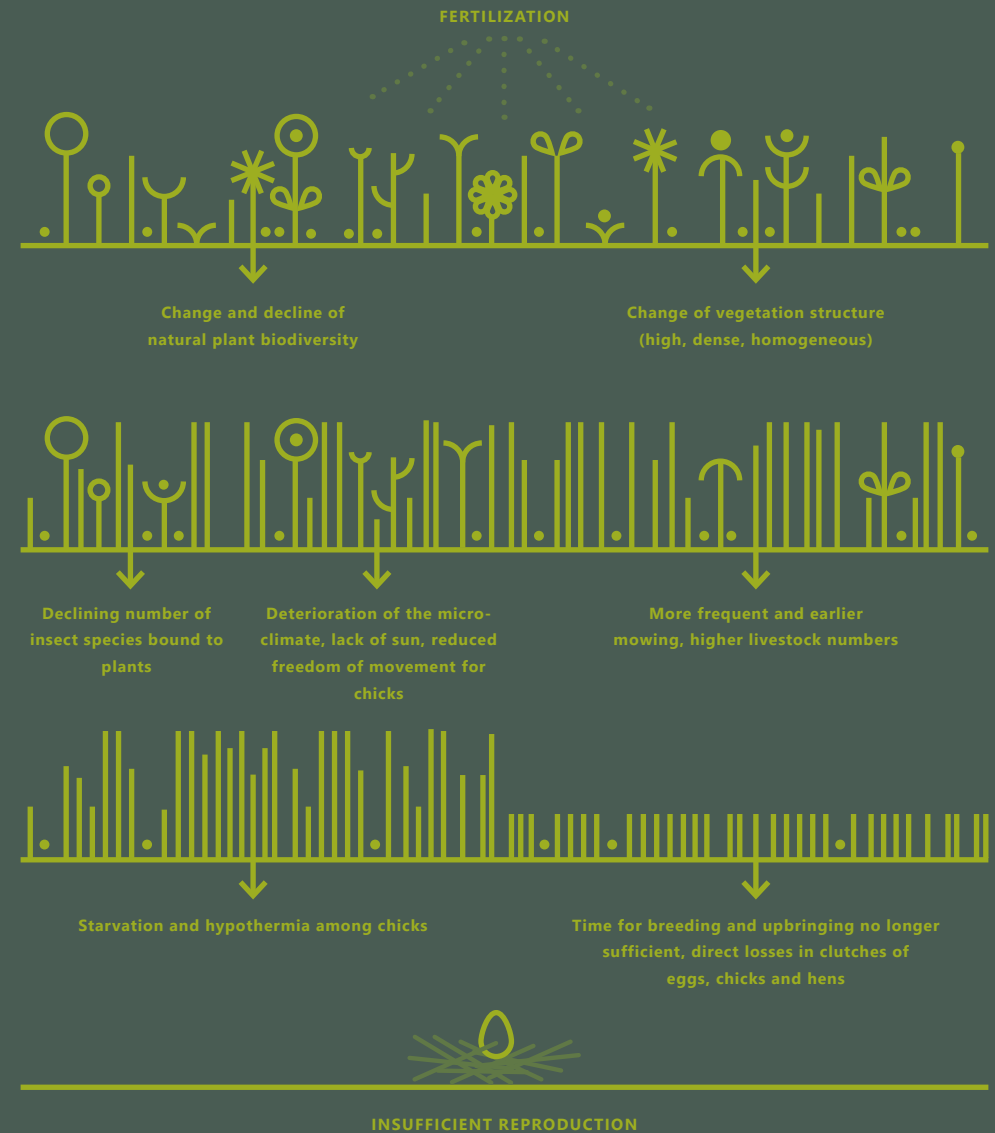
Number of studies demonstrating the proven effects of organic farming on biodiversity in comparison to conventional farming*



Population trends of European agricultural farmland birds and butterflies in grassland in percent



The influence of fertilization on the reproduction of ground-breeding birds in grassland



SCIENCE AS DEVELOPMENT AID: INDIA UNDERGOING (CLIMATE) CHANGE



Extreme droughts have long threatened the lives of small farmers in the state of Odisha in India. In recent years, however, the number of natural disasters has increased. Science can play an important role to better enable those affected on site to help themselves. As part of a working group located in Müncheberg in Brandenburg, Indian doctoral student Anu Susan Sam is looking for solutions for one of the worst affected regions in India.



Insidiously the disaster reveals itself. In the beginning the people in the East Indian state Odisha are still waiting for the monsoon, which usually brings rain to the fields of small farmers between the beginning of June and the end of September and lets their crops grow. With each new day of sunshine their hopes fade. The lack of rain is becoming increasingly a life-threatening disaster for the rural population in India. According to the Centre for Research on the Epidemiology of Disasters (CRED), approximately 4.25 million people died between 1900-2015 as a consequence of extreme droughts. Odisha experienced 49 floods, 30 droughts and 11 hurricanes during this period. Ongoing climate change has exacerbated this trend in recent years. Anu Susan Sam, a native Indian and PhD student at the Institute of Socio-Economics of the Leibniz Centre for Agricultural Landscape Research (ZALF) has now, together with her colleagues, researched one of the worst affected regions of India for the first time: What conditions prevail locally? What are the risk factors? What is needed most, where could development aid be best applied? Her findings are not only of interest for crisis management in this region, but also contain important

approaches for other arid areas and for dealing with climate change in the affected regions.

Odisha is one of the poorest of the 29 Indian federal states. The life of the farmers in the villages even without natural disasters is one characterised by poverty, economic underdevelopment and exclusion. More than 80 percent are small farmers who cultivate their fields in the same way as it has been handed down from generation to generation. Their only resource is often an oxcart. They can often not afford fertilizer, plant protection products and irrigation. They live in windowless mud huts with low thatched roofs, which can hardly withstand the storms. More than 95 percent of the households have neither a water connection nor toilets. Diarrhoeal diseases, allergies, skin diseases, and respiratory diseases are widespread. Most of the villagers are illiterate. While the sons are sometimes sent to school, daughters have to help in the household. The devastating droughts of recent years also often destroy the last bit of livelihood remaining to the people. The worst thing is the loss of the harvest. Many do not survive the bitter famine.

LACK OF EDUCATION AND POVERTY ARE THE BIGGEST RISK FACTORS

In order to thoroughly investigate the situation of traditional small farmers in this region, Anu Susan Sam interviewed 157 households in four different communities. Data was collected on population structure, on livelihood, on health, on social networks, on physical, financial and natural resources, as well as on the effects of natural disasters on the families. In this way, a network of information about risk factors and interactions was created.

During her investigations, Anu Susan Sam found out that the lives of these people were under even greater risk due to the ongoing climate change. The people in the villages of Odisha often have no financial reserves, are mostly uninsured and relief efforts only very rarely reach them. And yet there are tiny differences between the villages. Households which, in addition to cultivating fields, also keep cows, buffaloes, goats and chickens are less vulnerable. Families who can send their sons to building sites, factories and restaurants outside the village have a reliable income. A minimum level of health care strengthens them for these difficult periods. »Our studies show that improvement of health facilities, adequate water supply and food security would substantially reduce human exposure to natural disasters«, says Anu Susan Sam. »But the most important thing is the literacy of the people, especially of the women and girls, who often bear the responsibility for feeding the entire family. With knowledge, e.g.



Hunger, disease and water shortages resulting from periods of drought threaten the lives of the people in Odisha.

adapting the cultivation of their fields to climatic change, they can break new ground, control their destiny even better themselves – in the village, but also outside.« This first study is the prelude to further research in the region. In a next step, the ambitious young researcher wants to penetrate even deeper into society: Plans include studies on the role of women and on the issue of labour migration.

SCIENCE AS DEVELOPMENT AID

Anu Susan Sam came to ZALF via the German Academic Exchange Service (DAAD), and is already the fifth employee from a developing country to be supervised by the Deputy Director of the Institute of Socio-Economics, Prof. Harald Kaechele. »I train scientists who can speak on international issues such as climate change, labor migration and food security in a scientific context. With our research work and field studies on site, we offer practical solutions which are also transferable to other affected regions. Back in their home countries, the researchers can then campaign within institutions and projects, so that financial resources for example are invested where they can actually achieve something.« This is science as development aid.



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Practical and quickly implementable solutions are developed through close connections on site with the people affected.



CLIMATE CHANGE, FOOD SECURITY, SUSTAINABILITY

Solving the challenges of the future at the
landscape level.

Mr Ewert, you can look back on over 25 years of research experience in agricultural science, specifically in Plant Cultivation and Mathematical Modelling. What aroused your curiosity for this discipline?

I grew up on a farm and became interested in the diversity of agricultural production systems at an early age. My scientific interest started with my studies in university. Through modelling, I finally saw an opportunity, depending on the question, to reduce complex relationships to their essentials.

With stations in the south of England, Denmark, the Netherlands and Germany, as well as guest visits to New Zealand, Japan and Australia, you are internationally very experienced. What brought you to Brandenburg and ZALF?

Interdisciplinary cooperation is extremely important when answering the great questions of our time. What influence do agricultural systems have on climate change? How can we feed a growing world population while at the same time ensuring the sustainable use of natural resources? What opportunities do technological developments offer for the design of agricultural landscapes? These are but a few of the challenges to which, due to their complexity, we can only develop solutions through the close collaboration between different disciplines. ZALF offers excellent opportunities for this interdisciplinary cooperation.

Are bits and bytes the way to the agriculture of the future?

Interdisciplinarity and digitization are two sides of the same coin at ZALF. Work has already been done here for a long time with large and comprehensive quantities of data on the most diverse aspects of the landscape. Progressive digitization and developments in the field of »Big Data« are opening up completely new opportunities for us: In addition to our experi-

ments in the laboratory, in climatic chambers or on our 150 hectare research station, we generate comprehensive data which we use, among other things, for computer-aided modelling. In this way we can explain interactions between individual processes right up to the landscape level. This leads us to new approaches in the development of agricultural landscapes of the future.

And what are the benefits of the results of your research?

On the basis of our models and data, we develop specific instruments, with which actors in agriculture, in policymaking and consultation among others, can sustainably manage both economically and environmentally, or can implement such management institutionally. Our spectrum here is very broad, ranging from land use strategies adapted to climate change, for example in Brazil and India, up to specific technical solutions, for example for the implementation of environmental and nature conservation measures in our local agricultural sector.

What is the largest and from your point of view the most urgent challenge in agricultural landscape research?

We are particularly concerned with the question of how to react to the consequences of global population growth, the increasing scarcity of natural resources, as well as climate change. Food security on the one hand and the sustainable use of natural resources and our environment on the other: these have to be balanced.

PROF. DR. FRANK A. EWERT

has been the Scientific Director of ZALF since 1st March 2016. The focus of his work is in the fields of Crop Science and Mathematical Modelling with reference to Agricultural System Research.

THE FARMERS OF THE NEOLITHIC



1



How did people grow their food 5000 years ago? In search of answers, Brandenburg scientists have travelled through time with the aid of computer simulations and made amazing discoveries.

The people of the Neolithic, who inhabited the alpine upland between Upper Swabia, Lake Constance and the Swiss Jura mountains from approximately 4300 BC to 2500 BC, built stilt houses on the shores of lakes and fens. Their houses were built of wood and clay, offering space for sleeping and cooking, for hunting and fishing equipment and even for storage. For their diet, people already kept cows, pigs, sheep and goats, they hunted game and fish, gathered nuts, berries and mushrooms. During excavations, archaeobotanists also found traces of cereals, pulses, flax and poppies – testimony to arable production. But how did they work their fields? Did they use natural fertilizers, did they pull up weeds, indicating they were gardeners and farmers, or did they continually decamp, where they would clear or burn down a new piece of forest and thus obtain fertile land? Scientists from the Swiss University of Basel have been examining the lives of people in the New Stone Age (Neolithic) for decades. One of the great unresolved questions: Why did the people of that time relocate their settlements approximately every 10 to 25 years? Did the fields not yield enough to feed the villagers? In order to find more precise answers to the »how« of arable farming, the Swiss researchers approached the Institute for Landscape Systems Analysis of the Leibniz Centre for Agricultural Landscape Research (ZALF) under the leadership of Dr. Claas Nendel.

ARCHAEOBOTANY MEETS AGRICULTURAL SIMULATION

The scientists based in Müncheberg in Brandenburg have specialised in using computer models to simulate plant growth dependent upon soil, climate, water and nutrients. »We use MONICA to calculate how climate change could affect the cultivation of wheat, maize or soya, whether an increase in temperature is positive or negative for crop yields. We develop models for carbon-efficient methods of cultivation and advise ministries and associations«, is how Dr. Claas Nendel explains his team's work. MONICA is a simulation model developed by the scientists from ZALF. They are continually testing the program, performing field trials, feeding the models with data and observing whether the results calculated correspond to reality. »So far we have made forecasts with MONICA for the future of agriculture. But we never made a journey into the past before.« The scientists at ZALF began to feed MONICA with the data saved by their Swiss colleagues. The researchers chose emmer, one of the oldest known grains still occasionally cultivated today, as a study object. As emmer has hardly altered through cultivation over the millennia, comparisons with today's plants are possible. Climate experts confirm that the weather 5000 years ago was similar to today. The soil on which emmer was cultivated at that time was almost



2



3



4

certainly cleared forest soil. Assuming these basic conditions, the researchers allowed their computer to play out different scenarios. »We wanted to know how long a field would have remained fertile.« The first hypothesis: The people would burn the future area for cultivation using a »slash-and-burn method«, which brings very high yields in the short term. They sowed and reaped what grew on the field – no additional soil management was undertaken. »After one or two harvests, the soil would have been so poor in nutrients that cultivation would no longer be worthwhile on these areas and the settlers would have to exploit new forest areas using slash-and-burn tillage.« The agricultural modellers calculate that with this method of cultivation, the fields would be continually moved further from the center of the settlement – after 25 years this would already be an hour's walk. »In order to feed themselves, the people would have to constantly relocate« explains Nendel. There are findings which contradict this hypothesis, suggesting that only a part of the group of settlers actually moved. Therefore the researchers investigated a second hypothesis: The fields were cultivated intensively at that time already, and farmed to achieve a longer period of use lasting several years at least. »The archaeobotanists found weeds that only grow on cultivated soils. The people of that time also fertilized with cow dung. Our calculations show that they did not have enough dung from their cows to fertilize all the land, but for some of it,« explains Nendel. After running through various models, the more probable variant emerged: The people of the alpine upland 5000 years ago were already strategically thinking farmers. By using all of the knowledge available to them – mixed cultivation with peas, fertilization with cow dung, compliance with fallow periods – they could have lived in one spot for several decades. So there must have been another reason for their relocation. The results of the simulations by ZALF are now flowing into the Swiss scientists' attempts at reconstruction and are contributing to a reappraisal of the life of the people from the stilt houses in the Neolithic period and the drawing of new conclusions about the history of their settlements and agriculture.

1 — Flaxfield Catchfly, 2 — Field Woundwort, 3 — Poppy
Seed Capsule, 4 — Barley



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ACROSS THE FIELD



SURVEY **MORE GREEN ON BERLIN'S** **ROOFTOPS?**

Scientists from ZALF have asked Berliners about their acceptance of urban agriculture: initial results show that the establishment of roof gardens gained the greatest support for food production. The majority of respondents would be willing to pay more for food produced in the neighbourhood, if this were combined with social and environmental objectives. At www.zfarm.de, you will find an interactive map showing 7000 potential Berlin rooftops which are suitable for »greening«. These make up about 5 million square metres.



www.zalf.de/en/aktuelles/



EVENT

SCIENTISTS IN DIALOGUE: **PULSES IN THE LIMELIGHT**

On 28th October 2016, ZALF invited guests to the Leibniz Association Building in Berlin for an interactive panel discussion on »Pulses – an old foodstuff with a great future«. Scientists from four Leibniz Institutes approached the topic of pulses from different scientific disciplines. Around 75 interested persons followed the debate on genetics, cultivation and matters relating to animal feed as well as nutritional issues and participated actively in the discussion through social media.

RESEARCH

RAIN FOREST: **FIELDS INSTEAD OF FORESTS?**

The Amazon is the largest rainforest in the world and the lungs of the earth. But it is shrinking daily. A German-Brazilian research network called »Carbiocial«, under the direction of the University of Göttingen, explored what land use strategies that protect the forest could look like. Challenges lie in using the land more effectively and for longer time-spans. Scientists at ZALF did important groundwork for this.



FIELD TRIAL

AGRICULTURE AND RESEARCH ON **THE WAY TO THE FUTURE**

The conference proceedings for the field day »20 years of Lietzen field tests« have been published. They cover a wide range of topics: from the challenges of Agriculture 4.0, to the importance of field trials for agricultural advisory services, to developments in soil cultivation and technology right up to the history, establishment and course of the field tests. Research results from 20 years of Lietzen field tests are also presented.

CITIZEN SCIENCE

PLANT PROTECTION VIA **MOBILE APP**

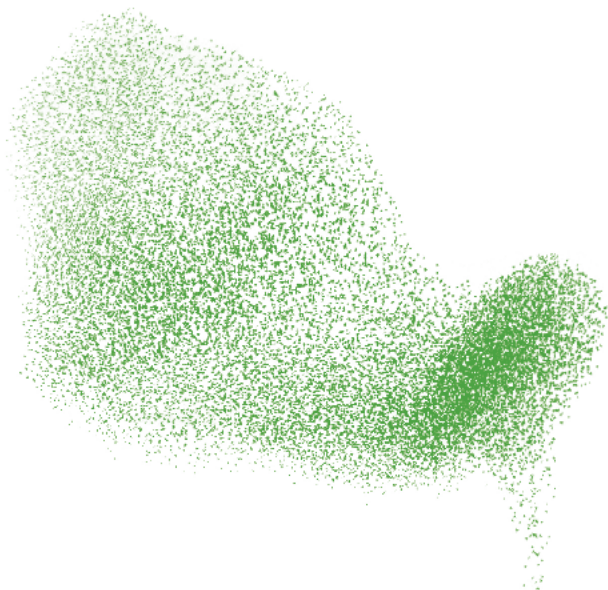
A new research project has been launched at ZALF, which relies on the cooperation of citizens: For this the researchers are using a smartphone application from the technology start-up PEAT. With the aid of the »Plantix« app, plant diseases can be discovered more quickly, and more effective measures can be taken. The software recognizes plant diseases and pests from photographs and gives tips for their treatment and prevention. The database currently includes approximately 175 common plant diseases and pests, as well as about 40,000 photos.

RESEARCH

GLOBAL FOOD SECURITY: **SACKLOADS OF HOPE**

German research institutions are searching worldwide for solutions to alleviate hunger in the world. With its »Scaling-up Nutrition (Scale-N)« project, a team of researchers at ZALF is in the process of developing short and long-term opportunities for improving food security in Tanzania and other countries. A white sack full of holes is only one step of many.





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The mission of the Leibniz Centre for Agricultural Landscape Research (ZALF) is to explain causal relationships in agricultural landscapes and to provide society with sound information for the sustainable use of these landscapes through excellent interdisciplinary research. The research expertise is focused on three core topics.



LANDSCAPE FUNCTIONING

The focus of Core Topic I »Landscape Functioning« lies on studying natural-scientific basics in order to improve the understanding of relevant processes and interdependencies on the landscape scale.



LAND USE AND IMPACTS

The research in Core Topic II »Land Use and Impacts« looks at agricultural production and ecosystem services within a landscape context. With explicit consideration of the diverse feedback mechanisms, occurring in agricultural landscapes at various spatial and temporal scales, useful effects are identified and their transition into agricultural practice prepared.



**LAND USE CONFLICTS AND
GOVERNANCE**

Core Topic III »Land Use Conflicts and Governance« analyzes the preferences of various land users and the resulting land-use conflicts. The research looks at what instruments and institutions are required to achieve sustainable and conflict reducing land use.

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