UFZ HELMHOLTZ
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UMWELTPERSPEKTIVEN

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ESSAY

WHY THE ECOSYSTEMS OF THE FUTURE MUST BE MULTIFUNCTIONAL

The strategy to protect biodiversity until 2030 published by the EU Commission at the end of May 2020 is subtitled “Bringing nature back into our lives”. The question of how we can successfully reintegrate nature into our lives is essential for the survival of humanity and is by no means new. The dominant strategy so far has been to use increasingly more natural resources to improve our lives. We now see this growth-oriented approach coming to an end. We are overexploiting most resources, including the renewable ones – and have no more means of increasing them. Nevertheless, the spirit of the times is still characterised by the growth paradigm and the idea that it is possible to continue along this path by developing appropriate technologies or even using resources from the vastness of space. This paradigm is in complete contrast to scientific knowledge. No ecosystem – and the Earth is such a system – can constantly increase its primary production. Even the assumption of many economists that resources are replaceable by others overlooks the simple fact that we humans, as biological beings, depend on oxygen, water, carbohydrates, fats, and proteins as well as other elements. That is why there are objective limits to growth – an insight that the Club of Rome formulated as early as 1972 and which is more relevant today than ever. The idea that all we have to provide for our survival is clean air, clean water, and fertile soil overlooks the fact that this requires the diversity of life – the biodiversity of the Earth. Only this can ensure the functioning of ecosystems, maintain their productivity, and ensure the recycling of materials.

For decades, the idea of strictly separating ecosystem and landscape functions (i.e. the use and protection of the landscape) has been prevalent. On one hand, we operate intensive agriculture and forestry focused on maximum production and develop urban areas with high levels of densely populated areas. On the other hand, we designate areas that may be used little or not at all in order to protect animals and plants. Even some representatives of nature conservation advocate this separation. I think it is wrong, because it causes many problems: The quality of ground- and surface water is deteriorating, erosion by water and wind and desertification are increasing, and biodiversity and its direct positive consequences, including pollination of important wild plants and agricultural crops and control of pests, are rapidly declining. Selection conditions set by humans (e.g. pesticides, general environmental changes) lead to new evolutionary processes. These can lead to new resistances and the selection of new genotypes of wild plant or animal populations. Finally, the increasing constriction of natural systems also encourages the emergence and spread of pandemics – as we are currently experiencing with Covid19. The consequence is: We must bring nature back into our lives and economies and improve the multi-functionality of our ecosystems and landscapes.

> No ecosystem – and the Earth is such a system – can constantly increase its primary production.

What can science contribute? The crucial approach here is first to understand the diversity of life and the natural processes it sets into motion. We need a much better understanding of how organisms – whether microbes, plants, insects, or large mammals – interact with each

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Experimental ecosystem research meets global change

other and perform all the services that are essential to us. This is followed by questions of the adaptability of ecosystems to global change – both of artificial systems (e.g. agricultural or forest systems) and existing natural systems (e.g. large boreal coniferous forests, rainforests and savannah ecosystems). It is ultimately the task of science to deal with options for use and management – from the planning of diverse landscape structures to new land use systems (e.g. organic agriculture, agroforestry systems, and climate-stable forests as well as nature conservation concepts for anthropogenic ecosystems and cultural landscapes).

> The UFZ is also home to the world's largest experiment on the influence of land use and climate change on agroecosystems.

The scientists of the "Ecosystems of the Future" Research Unit of the UFZ are also committed to this task. They deal with the monitoring of essential biodiversity parameters, soil characteristics, and landscape variables as well as new remote sensing methods. They use modern laboratory experiments as well as artificial model ecosystems and field experiments such as those at the Bad Lauchstädt experimental station. More than 20 scientific experiments of various sizes and dimensions are currently being conducted here. These include the world's largest combined experiment in terms of land use types and plot size on the influence of land use and climate change on agroecosystems – the Global Change Experimental Facility (GCEF).

This issue of UmweltPerspektiven provides insight into this diversity as well as the 125-year history of this research station, which is becoming increasingly important at the international level. Among other things, it is to be developed into one of the approximately 250 sites of a European infrastructure for long-term research on ecosystems (eLTER RI), the development of which is coordinated here at the UFZ.

But we are more than just a part of the global scientific community. Because humans are both the cause of current problems and potentially part of the solution, we consider it important to communicate results to policy-makers and society. This is demonstrated by the work of our scientists in the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), the German Advisory Council on the Environment (SRU) and numerous other international and national bodies.

"Bringing nature back into our lives" is not a new variant of a "back to nature" movement. Learning from nature and working with it (and not against natural processes), developing natural land use concepts and technologies and, of course, making changes in our lifestyle and value systems are solutions that will enable us to have a future. On the other hand, producing and consuming more and more in order to accumulate more capital will leads us further into a dead end.

Dr Stefan Klotz
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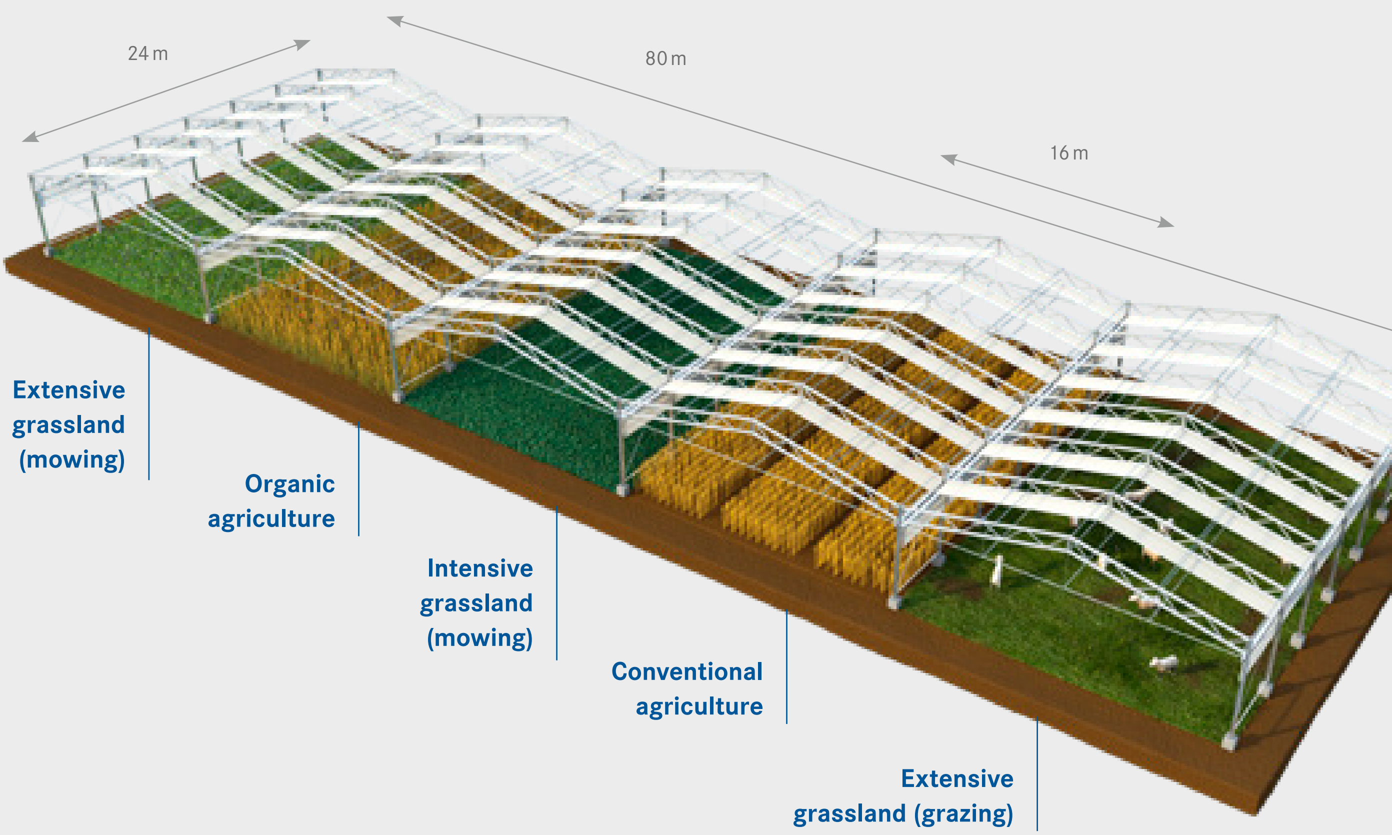
COVER STORY

EXPERIMENTAL ECOSYSTEM RESEARCH MEETS GLOBAL CHANGE

In 1895, the agricultural chemist Max Maercker founded an agricultural experimental station in Bad Lauchstädt, which is about 20 km south-east of Halle. In 1991, the station became the responsibility of the Helmholtz Centre for Environmental Research (UFZ). Meanwhile, it is attracting increasing national and international attention as a research station for experimental ecosystem research. At its heart is the Global Change Experimental Facility (GCEF) – an experimental facility where researchers can investigate the effects of climate change on land use and ecosystems.



GCEF (Global Change Experimental Facility) – the consequences of climate change for land use

The diagram shows one of a total of ten experimental blocks, each with five plots, in which different land use variants are tested. In total, the GCEF comprises 50 plots. Half of the plots are cultivated under the climate conditions currently prevailing in Bad Lauchstädt. On the other half, scientists simulate climate scenarios predicted for Central Germany around 2070. The standard measurement programme of the scientists includes a wide range of data to record the effects of climate change on differently managed ecosystems.

STANDARD MEASUREMENT PROGRAMME

Micro-climate

– Air humidity and temperature at three different altitudes
– Moisture and temperature of the soil at three different depths
– Photosynthetically active radiation at three different altitudes and global radiation
– Precipitation

Plants

– Yields of each plot: On agricultural plots, biomass, dry matter, development stages, carbon, and nitrogen are recorded; on grassland plots, the height of plants and species are also recorded
– Functional characteristics of leaves and roots in selected species
– Genetic composition of populations of individual species

Soil chemistry

– Different fractions of the carbon pool and total nitrogen content
– Nutrients available (nitrogen, phosphorus, potassium)
– pH value

Soil biology

– Dynamics of plant litter degradation
– Microbial activity (respiration, biomass, enzymes)
– Composition of the fauna
– Molecular analyses of the microflora

Creating a sample archive

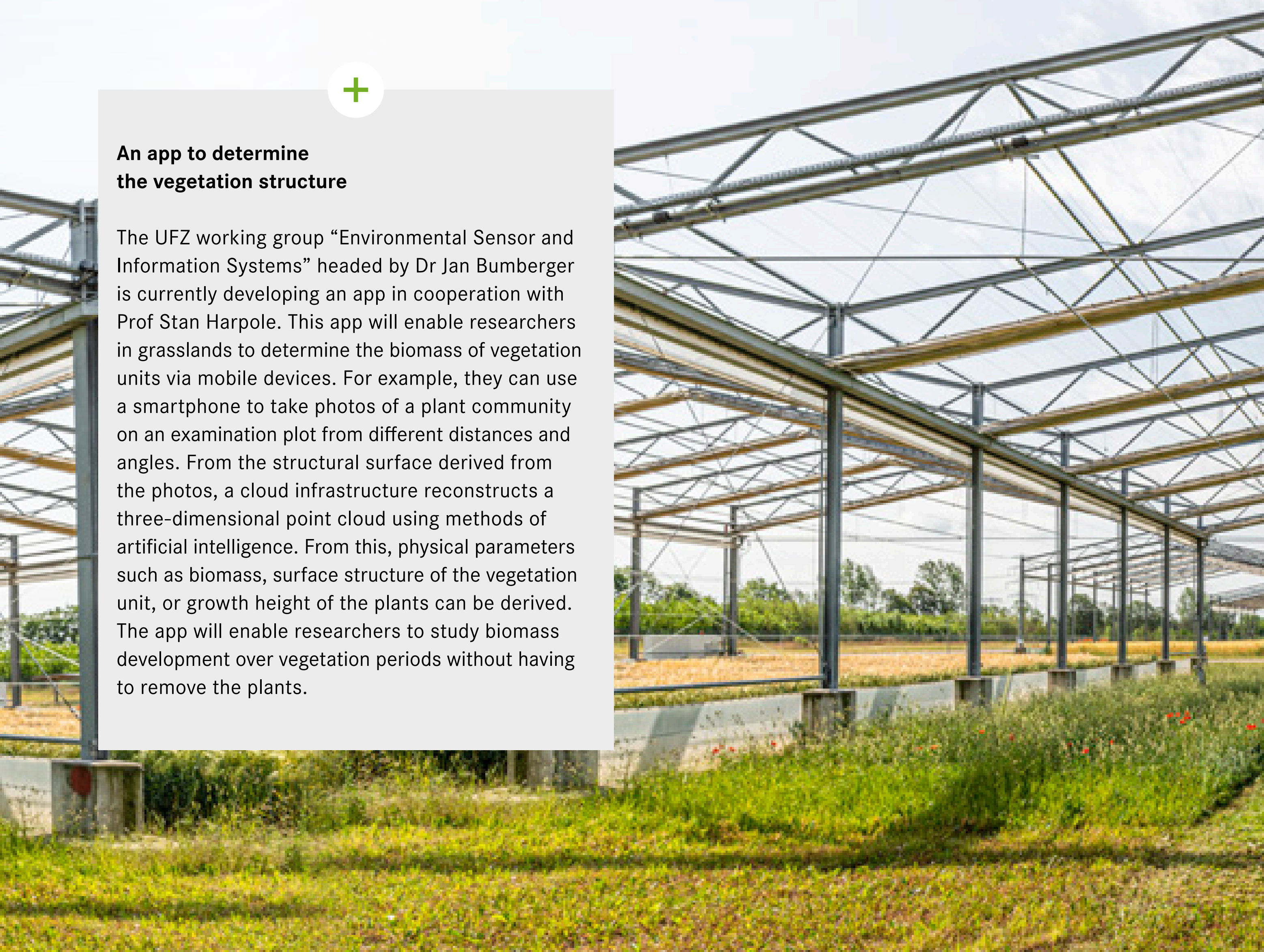
Archiving retained samples of dried and deep-frozen plant and soil material for future analysis.

The south of Saxony-Anhalt has large areas of arable land on fertile loess-black earth soils. The good soils offered excellent conditions for agricultural scientists from the University of Halle. Around 125 years ago, they set up an agrochemical experimental station one kilometre outside Bad Lauchstädt on the road towards Delitz am Berge. They wanted to learn more about soil fertility, agricultural yields, and the consequences of fertilisation. In 1902, they established the Static Fertilisation Experiment, which is still being conducted. In the meantime, not only the number of field experiments but also the diversity of infrastructures has significantly increased. The focus of the substantive issues has also been considerably expanded. More than 20 scientific experiments of various sizes and dimensions are currently running at the UFZ site in Bad Lauchstädt. The topics include for example the modelling of carbon and nitrogen dynamics in the soil, succession on arable land, the adaptation of oaks to climate change, international field experiments and the consequences of fertiliser and drought on grassland. At the centre of the research station is the Global Change Experimental Facility (GCEF). Dr Martin Schädler, scientific coordinator of the GCEF, is still enthusiastic about the facility seven years after its construction. “The GCEF is the flagship of the UFZ research station in Bad Lauchstädt and the world’s largest climate experiment in terms of surface area”.

The GCEF integrates not only realistic land use scenarios but also future climate fluctuations.

The federal government as well as Saxony and Saxony-Anhalt have invested around € 4 million in the GCEF, which is tucked away behind farm buildings on the approx. 40-hectare research station. In 2013, 10 large steel scaffolds were erected in the chernozem (black earth) over a total area of 7 ha. Among them, experimental plots that represent typical agricultural land use in Central Europe were created. These include conventional and organic agriculture, intensively used grassland with mowing, and two forms of extensive grassland use (i.e. mowing and grazing by a flock of sheep that has found a home in the station). The highlight of the facility: In five of the 10 experimental blocks, the researchers are simulating the climate that will most likely shape Central Germany in 2070. This means temperature increases of 1–2 °C; up to 20 % less precipitation in summer, and about 10 % more precipitation in both spring and autumn. “The ability to manipulate precipitation according to our model is the great advantage of this system", says Schädler. This experiment thus integrates not only realistic land use scenarios but also climate fluctuations that will determine both our present and future environment. The five other blocks, which are identically managed, are exposed to the current climate conditions. They serve as control areas.

Around 40 national and international academics conduct research at the GCEF. They are supported by 16 doctoral students. They have used the data collected day by day since 2015 as part of a standard measurement programme. These include general weather data as well as data on the microclimate, soil chemistry and biology, biomass development, and individual functional characteristics of plants and animals. The scientists who conduct project-related research at the GCEF also collect further data and parameters and make them available to the cooperation partners. This wealth and variety of data and possibilities as well as the ever-increasing archive of samples of dried and frozen plant and soil material, are what make the GCEF so attractive as a platform for experimental environmental research. If you stroll around the site with Martin Schädler, you will discover research equipment everywhere on the plots. This includes temperature and humidity sensors, radiation meters, marker flags, and flowers packed in nets to measure the effects of pollinators. And at certain times of the year, the area is teeming



An app to determine the vegetation structure

The UFZ working group "Environmental Sensor and Information Systems" headed by Dr Jan Bumberger is currently developing an app in cooperation with Prof Stan Harpole. This app will enable researchers in grasslands to determine the biomass of vegetation units via mobile devices. For example, they can use a smartphone to take photos of a plant community on an examination plot from different distances and angles. From the structural surface derived from the photos, a cloud infrastructure reconstructs a three-dimensional point cloud using methods of artificial intelligence. From this, physical parameters such as biomass, surface structure of the vegetation unit, or growth height of the plants can be derived. The app will enable researchers to study biomass development over vegetation periods without having to remove the plants.

with researchers who collect various parameter data. “In ecology, we need field data because it allows us to create models and then continually check and refine them”, he says. This increases its potential as a forecasting tool. The results from the field are important not only for science. Agriculture and policy-makers are also pressing for information on how global warming affects agricultural use, particularly in the light of the droughts of the previous two years. Which land use types will be most affected by the predicted changes? Which adaptation measures make sense? And how will the soil change in the long term? These are typical questions that are asked time and again.

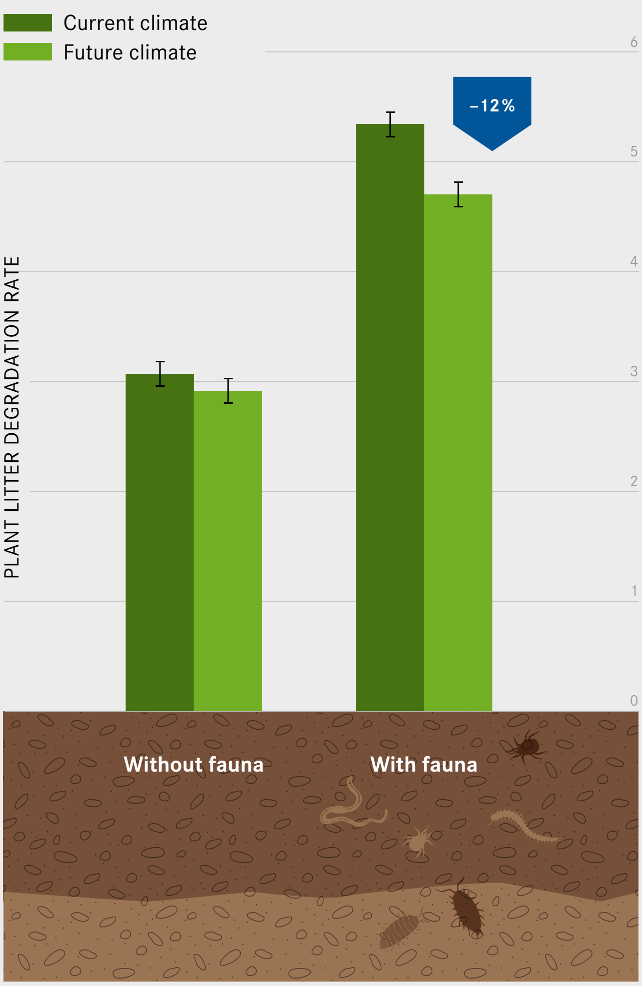
Moving from short-term patterns to long-term trends

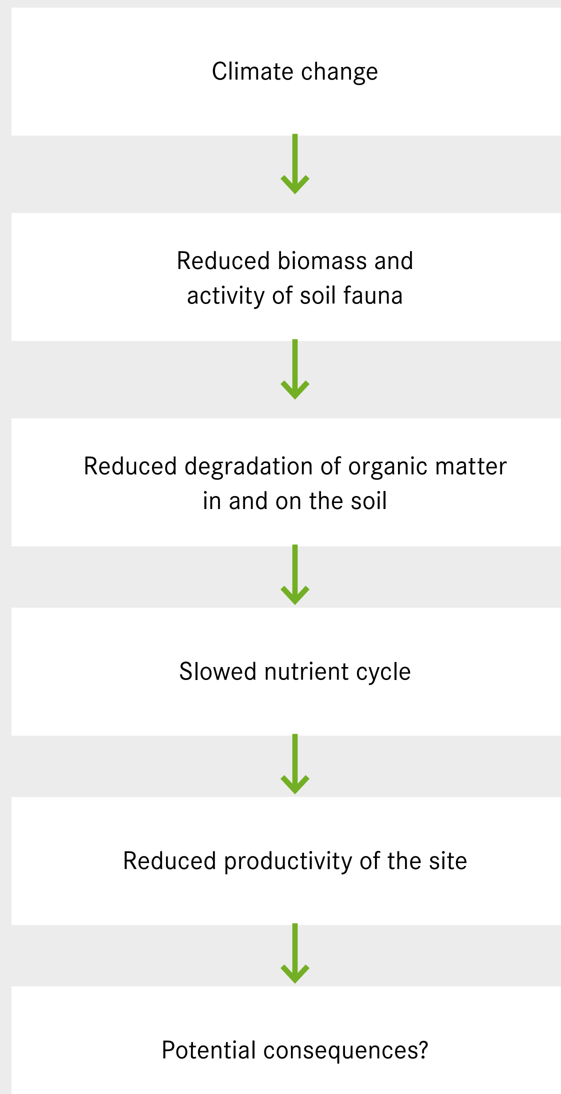
The GCEF will operate for at least 15 years. It thus offers researchers the unique opportunity to pursue fundamental questions that wouldn’t be sufficiently addressed in only three to five years (typical duration of a project). “The different annual climate conditions, the natural fluctuations in species communities, and the dynamics of many ecological processes mean that this research must be long-term in order to provide a solid knowledge base”, says Martin Schädler. Even if final results for some questions are not expected for 10 years, the researchers are still able to present exciting interim findings.

Role of soil fauna under future climate conditions

Previous results show that under future climate conditions and more intensive land use, both the biomass and activity of the soil fauna will decrease. This slows the decomposition of organic matter (plant litter). However, whether these processes will also lead to a reduction of mobile nutrients in the soil with lasting negative consequences for plant growth can be proven with certainty only over the next few years.

The negative effects of climate change on plant litter degradation are not so much due to the altered influence of microbes but rather mainly to a modified fauna. At least that is what the results for the period 2015 / 2016 show.





Sources: Yin, R., Eisenhauer, N., Gruss, I., Schmidt, A., Purahong, W., Siebert, J., Schädler, M. (2019): **Climate change does not alter land-use effects on soil fauna communities.** *Applied Soil Ecology* 140:1-10. | Siebert, J., Thakur, M.P., Reitz, T., Schädler, M., Schulz, E., Yin, R. Weigelt, A. & Eisenhauer, N. (2019): **Extensive grassland-use sustains high levels of soil biological activity, but does not alleviate detrimental climate change effects.** *Advances in Ecoogical Research* 60: 25-58. | Yin, R., Eisenhauer, N., Auge, H., Purahong, W., Schmidt, A., Schädler, M. (2019): **Additive effects of experimental climate change and land use on faunal contribution to litter decomposition.** *Soil Biology and Biochemistry* 131: 141-148.

— UFZ doctoral candidate student Sara Wahdan and intern Chakriya Sansupa are spreading bags of plant material on the arable land of the GCEF in order to study the degradation of plant material and infestation with pathogens under changing climatic conditions.

For example, under future climate conditions, agricultural productivity will decline by 20–25 % for all five land use variants. According to Schädler, this can be explained above all by reduced precipitation in summer. This affects the plants in their main growth phase. An effect that even the slightly higher temperatures throughout the year and the higher rainfall in spring and autumn will not be able to compensate for.

An unexpected pattern was observed in the decomposition of soil organic matter by invertebrates, bacteria, and fungi. This elementary process provides important plant nutrients such as nitrogen and phosphorus. Until now, it had been assumed that species-rich systems can adapt better to higher temperatures. The soil ecologists were thus all the more surprised that, at first glance, the bioactivity on the extensively used, species-rich meadows and pastures of the GCEF decreased more strongly with increasing temperature than on intensively worked, species-poor meadows. According to Martin Schädler, this can be explained by the fact that other species take over the functions of those that are disappearing. However, the observations also indicate that species-rich systems can react quite well after a kind of shock at the beginning of a disturbance. “So far, these are exciting patterns. But in order to identify long-term trends, we need to collect much more data”.

GrENE-Net – an evolutionary experiment

Arabidopsis thaliana is an inconspicuous plant species, the genome of which was completely decoded in 2000. This makes it quite interesting for research. Since 2017, scientists around the globe have been investigating which of the 231 different places of origin of the plant are most vital in which places and under which climatic conditions as part of the GrENE-Net evolutionary experiment. Forty-five research locations in Europe, North America, and Asia are involved in the experiment, including the UFZ research station in Bad Lauchstädt. Under the direction of plant genetics expert Dr. Walter Durka from the UFZ, researchers are analysing and sequencing the flowers and leaves of the Bad Lauchstadt series of experiments. Results are expected by the end of 2020.

https://grenenet.wordpress.com/news/

Source: Johann Georg Sturm (1796): **Deutschlands Flora in Abbildungen.** *Drawing by Jacob Sturm*

The GCEF researchers have also identified changes within the plant litter layer under changing climatic conditions. This top soil layer of organic waste plays a central role in the nutrient cycle. However, it can fulfil this role only if the bottom fauna in particular (i.e. woodlice, mites, springtails, and nematodes) have ideal conditions for decomposition. This is obviously not the case with lower rainfall and higher temperatures in summer. At the GCEF, it was shown that under warmer conditions, the decomposition rates in the plant litter layer of all five forms of land use fell by an average of 10 % and up to 36 % in grassland in some cases. "If this accumulates over the years, it can have negative consequences for soil fertility", says Schädler.

We need such realistic field experiments like the GCEF worldwide.

If temperatures rise, not only the behaviour of the soil fauna but also that of micro-organisms such as fungi and bacteria changes. Prof François Buscot at the GCEF is currently investigating this. The soil ecologist is using wheat growing on GCEF land to investigate the dynamics of bacteria that activate phosphorus (an important plant nutrient) in the soil. Buscot and his team found out that phosphorus mobilisation is effective in warmer conditions as well. Depending on the developmental phase of the wheat, this function is taken over by bacteria previously not known to be able to perform this task. "Given the diversity of soil micro-organisms, there are obviously always some that are able to help plants perform under less than favourable conditions", says the UFZ researcher. He sees this as proof that soil biology can adapt to climate change – provided that the biodiversity is preserved. However, this is more the case in organic farming than in intensive agriculture.

Another GCEF experiment showed that an increase in temperature and drought also increases the risk of pathogens. The UFZ soil ecologists found this out by incorporating wheat litter into the soil after harvesting. The recycling of harvest residues is a common practice to stabilise the organic matter content of the soil. However, plant litter is always colonised by fungi, and many of them have pathogenic effects on the crops. "We wanted to know whether the spectrum of these fungi shifts under changing climatic conditions", explains François Buscot. To his surprise, this spectrum has expanded. Under future climate conditions, the diversity of pathogens in the plant litter and thus the

— As part of his doctoral thesis, Martin Andrzejak is interested in the influence of climate conditions on insect pollination and thus on plant demography. In one of his experiments, he placed bags over the flowers of the plants to prevent pollination.

— A magnifying glass and identification guides are essential to be able to correctly identify the plant species growing on the plots. This is the only way in which conclusions can be drawn about how biodiversity in extensively and intensively managed grasslands is changing as a result of climate change.

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SOILCan – using lysimeters to investigate soil processes

The Bad Lauchstädt research station is part of the SOILCan lysimeter network, which is integrated into the nationwide TERENO network for soil observation. As part of SOILCan, soil hydrology and carbon and nutrient cycles as well as greenhouse gases and plant diversity have been studied on 13 research plots in different climate zones in Germany since 2010. The aim is to find out what effects climate change has on soils. In Bad Lauchstädt, UFZ soil systems researcher Prof Hans-Jörg Vogel placed 18 lysimeters – steel containers filled with soil – in the ground. These are used to record and analyse the water migrating through the soil column as well as the nutrients and pollutants contained within it. Initial analyses show that under dry conditions, plants make efficient use of the increasingly scarce water resources in the soil because water losses by evaporation at the soil surface are reduced. The memory of soils for longer dry periods was measured, and new insights into how rainwater is distributed within the soil profiles were gained. For example, depending on the soil structure, vertical infiltration can be significantly faster than uniform moisture penetration of the topsoil.

www.tereno.net

potential risk of infection for wheat will increase. “We could be faced with more and new infectious diseases in crops in the future”, he warns.

These ecological field experiments make this experimental facility so special in the view of François Buscot. Together with his UFZ colleagues Dr Stefan Klotz and Dr Harald Auge, he initiated the establishment of the GCEF in 2008. “We are able to study the influence of climate and land use on regional biodiversity under realistic conditions. This is certainly extraordinary”, he says. This is also underlined by a study published last year by biodiversity researchers from Central Germany in the journal “Global Change Biology”. According to this, most ecosystem–climate field experiments are unrealistic because they are not based on common climate predictions for the region in question. As a result, there is almost no reliable data on how the ecosystems will develop. “In order to predict how plant communities will react to climate change and what our ecosystems will look like in the future, we need realistic field experiments like the GCEF worldwide”, says Tiffany Knight, who has been a Humboldt Professor at the University of Halle, the German Centre for Integrative Biodiversity Research (iDiv), and the UFZ since 2016.

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Trophin Oak/PhytOakmeter – the oak as a model tree

The common oak *(Quercus robur)* is widely distributed in Europe and is therefore an excellent model for studying the effects of global change on long-living forest trees. Since 2010, UFZ soil ecologists Dr Sylvie Herrmann and Prof François Buscot have been investigating how oak cuttings react to different species such as moths, nematodes, springtails, and fungus-like root pests in certain growth phases as part of the TrophinOak project in Bad Lauchstädt. For example, they found out that the shoot-stretching phase is crucial for the development of the oak. A symbiotic mycorrhizal fungus plays an essential role in combating drought stress or extreme temperature fluctuations. At the same time, UFZ researchers are analysing how the oaks they breed react to different soils and climatic conditions in different regions of Europe in the PhytOakmeter field experiment.

www.ufz.de/trophinoak-phytoakmeter

Using mini-ecosystems to analyse the behaviour of individuals

The entire UFZ research location benefits from the scientific appeal of the GCEF. This is because other research experiments have also been set up there. Biologist Prof Nico Eisenhauer analyses on a small scale what the GCEF researchers are researching on a large scale in the iDiv-Ecotron – a research platform with 24 miniature ecosystems in which light, temperature, and precipitation can be adjusted to suit the respective research question. The Leipzig-based German Centre for Integrative Biodiversity Research (iDiv) and the UFZ have raised € 3.7 million for this facility. Since 2017, Eisenhauer has been able to bring animal and plant species together in these experimental chambers and investigate how ecosystems react to them. “The advantage of these closed systems is that we can measure temperature and air/soil humidity under absolutely controlled conditions, analyse how roots grow with underground scanners, or even track the behaviour of individual beetles”, he says. He can also react quickly and flexibly to current research questions in the miniature ecosystems. When the subject of insect mortality came up at the end of 2017, he and colleagues from the University of Jena demonstrated that the decline in insects affects the frequency and flowering period of certain plants in grassland. For example, wood sorrel blooms later when there are fewer insects. And while the population of *Trifolium pratense* shrinks as insects decline, the frequency of Plantago lanceolata increases.

> In the miniature ecosystems of the iDiv-Ecotron, ecological mechanisms can be specifically studied and understood in detail.

In another experiment, Eisenhauer brought together ladybirds, aphids, and larger decomposing organisms such as earthworms and springtails. His aim was to find out how different densities of aphids and ladybirds affect the soil fauna, how the interaction of decomposer and ladybird density affects aphids in their choice of habitat, and what consequences the presence of herbivores and their predators has on ecosystem functions. The result: as the number of ladybirds decreased, the number of aphids increased, plant species such as the field bean grew less well, and soil communities changed. “The community structure of these micro-organisms depends on the frequency of the ladybirds because the communities are linked above and in the soil”, explains Eisenhauer. Plants link these food webs together by serving as the primary food source in both subsystems and by reacting to changes in the environment by altering their growth and chemical constituents. “With research approaches like these, which allow the behaviour of individual individuals of animal and plant species to be merged with biodiversity research, the iDiv-Ecotron is an important part of the research station”, says the ecologist.

This also leads to joint projects. For example, it is planned to take soil from a tree experiment being conducted in Bad Lauchstädt and incubate it in the experimental chambers. Ecological mechanisms can thus be specifically studied and understood in detail. “This experimental facility represents an important link between the controlled greenhouse and microcosm experiments and the large and more natural field studies”, says Eisenhauer.

— 24 of these miniature ecosystems are part of the iDiv-Ecotron. This allows the researchers to completely control the environmental conditions and measure ecological processes – for example, through the targeted use of certain species (e.g. crickets (*Acheta domesticus*); photo above). The aim is to use this manipulation of interacting animal and plant species to investigate the effects on ecosystem functions in more detail.

Unique hub for global comparative studies of grassland

Infrastructures such as the GCEF and the iDiv-Ecotron also ensure that the field experimental station in Bad Lauchstädt attracts international attention. In addition to being part of DroughtNet, the global drought network, and DragNet, which studies interactions between land use change and nutrient input, the facility has also been part of the Nutrient Network (NutNet) since 2015. In this long-term experiment, researchers are investigating how grassland ecosystems react to the input of nutrients such as phosphorus and nitrogen in more than 130 areas around the globe. How does the productivity of grassland affect biodiversity and vice versa? How do nutrients such as potassium, magnesium, and calcium affect meadows and pastures? How does plant diversity change through the input of nutrients from the atmosphere or through grazing? UFZ and iDiv researcher Prof Stan Harpole and his team in Bad Lauchstädt are investigating central questions such as these on 24 surfaces measuring 5 metres × 5 metres each. On the grassland areas, the ecologist surveys the coverage ratio of each plant species, the availability of light, and the nutrient content of the soil and analyses the consequences of fertilisation and grazing. The experimental set-up and the questions are identical at all NutNet sites, which are distributed over different climate and vegetation zones of the earth. The data can thus be easily compared. Technical infrastructure is hardly necessary, and the costs are correspondingly low. This is why scientists from regions with fewer research funds are also involved. All this makes the network interesting for Stan Harpole. “We need global answers to global problems. The strength of NutNet is that we can bring together the results of the many individual locations and thus come up with global solutions”, he says.

We need global answers to global problems.

Stan Harpole, who developed the idea for NutNet as a post-doctoral fellow with his colleagues at the University of California in Irvine, found that plant growth on grassland depends not only on the availability of common nutrients such as phosphorus and nitrogen but also on potassium, magnesium, and calcium. “It is not just a single factor but rather a combination of many factors and nutrients that determines which plant species find an ecological niche in a particular area”, he says. It is still unclear which nutrients play which role in this process. This is only one of several research questions that Stan Harpole will continue to work on. “The research station in Bad Lauchstädt is a unique hub for scientists because it offers excellent infrastructure and sufficient space for further experiments”, says Harpole. For example, Bad Lauchstädt is to become one of 250 sites across Europe for the European Long-Term Ecosystem Research Infrastructure (eLTER RI). Coordinated by the UFZ, this infrastructure is to be made operational by 2024. The aim is to collect and analyse biological,

— **DroughtNet is a research network in which ecologists have been studying the effects of frequent and severe droughts on terrestrial ecosystems at more than 100 locations worldwide since 2015. The effects vary greatly depending on the type of ecosystem. In Bad Lauchstädt, project leaders Prof Nico Eisenhauer (University of Leipzig, iDiv) and Dr Harald Auge (UFZ) have created 25 experimental areas of 4 m^2 each. Ten of them are covered; because there is 55 % less precipitation, drought conditions prevail. The researchers vary not only the precipitation but also the supply of nitrogen, phosphorus, and potassium. Preliminary results indicate that drought has a particularly strong effect on soil processes and that the soil can recover from it only very slowly.**

https://drought-net.colostate.edu

biogeochemical, hydrological, and socio-ecological data in all European biogeographical areas according to common standards.

The research station in Bad Lauchstädt, which was founded as an agricultural experimental facility in 1895, will thus continue to develop. In the coming years, the researchers will increasingly reap the fruits of their scientific fieldwork. Agriculture will also benefit from this: Valuable conclusions for future land use can be drawn from the scientific findings.

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— Two maize genotypes with different root characteristics grow on a 4,000 m^2 field trial.
Through the Plexiglas windows embedded in the ground, researchers can observe the roots as they grow.

PROJECT

UNDERGROUND VISIT

Many important questions about the future are being decided underground. How abundant will harvests be in the future? Is the food supply secured? And how much greenhouse gas will the world's soils be able to store? All this depends on a complex web of relationships between soil, plant roots, and micro-organisms. But nobody knows exactly what is going on there. In 2018, a priority programme of the German Research Foundation (DFG) coordinated by the UFZ was launched. This is intended to shed more light on the subject using modern analytical methods.

Roots hold many secrets. Botanists know that these plant organs are capable of astounding achievements. For example, a fig tree in South Africa has sent a root about 120 metres down to tap a water source. The average root is able to make its way through the soil, tap into nutrients and resources, and communicate with bacteria and fungi.

But all of this takes place largely in secret. “Root research is difficult because the soil is not transparent”, says Prof Doris Vetterlein, who coordinates the DFG priority programme at the UFZ. For this reason, it has been possible to analyse only individual aspects of the complex underground events. However, experts in microbiology, plant genetics, soil chemistry, soil physics, and modelling have joined forces. Together, the team of 18 research institutions wants to shed light on the processes in the rhizosphere.

“This is the contact zone in which the roots directly influence the soil”, explains Doris Vetterlein. This area is often teeming with bacteria and fungi as well as nematodes and other soil dwellers. Here, you will often find good living conditions for the most diverse requirements in the smallest of spaces. This mosaic of mini-biotopes is created largely by the plants themselves. They release a whole range of organic compounds into the soil. These compounds can change the pH value or mobilise nutrients, among other things. Some of these substances also act as a chemical message, which attracts certain bacteria and fungi and drives others away. In this way, the roots can create an environment of the most useful neighbours.

For example, at their tip, they release a mucoid substance that helps them penetrate the soil. This cocktail of polysaccharides is used by many micro-organisms as food. However, whether it is actually released depends on the properties of the soil. If the soil lacks the micro-nutrient boron, for example, the plant may not be able to produce the mucus. “We can investigate such complex processes only in an interdisciplinary way”, emphasises Vetterlein.

The main subjects in these studies are often plants that grow in pots in the laboratory. But there are many issues where this is not enough. “If, for example, you want to know how roots acquire nutrients, you have to provide them with a larger soil volume”, explains the agricultural biologist. For the maize plants used in the project, all processes beyond the first three weeks will be investigated in the field.

The central field experiment of the DFG priority programme takes place on the premises of the UFZ experimental station in Bad Lauchstädt. The project participants created a 4,000 m^2 trial field there in 2018. “That was a huge effort”, says Vetterlein. The area is divided into 24 small plots, each of which had to be excavated to a depth of 1 m. One half of each plot then had to be filled with a precisely defined sandy soil and the other with a loamy one. Each of these mini-fields now grows either maize plants with fully developed root hairs or plants in which these structures are defective.

The team can now examine the physical, chemical, and biological processes that take place in the rhizosphere for different soil types and root forms. The researchers often have to work on an extremely small scale. This is because even though maize roots can grow several metres to the side and downwards, most of them are only very thin. Approximately half of them have a diameter of 200 µm at most. Nevertheless, even the finest roots are under close observation. With the help of Plexiglas windows embedded in the ground and high-resolution images from computer tomography, the researchers can watch the roots grow. They have installed numerous sensors that provide information about the water balance at different soil depths or the water transport in the stalk. There is also a whole range of physical and chemical tests. Part of the microbiological work involves using a toothbrush to brush the soil particles off the tiny roots and examine them for fungi and bacteria.

Doris Vetterlein is already quite satisfied with the progress of the experiments so far – even if the team didn’t have a particularly easy time in 2019. “First, the spring was too cold. And then the summer was too dry”, the agricultural biologist recalls. “And in between, the ravens devoured our expensive seeds”. Nevertheless, the initial results are already emerging. It has been shown that intact root hairs are important for the absorption of nutrients by plants. However, it is still unclear whether this also applies to the supply of water.

Over the next few years, the project staff intend to collect many more pieces of the puzzle for the new image of the rhizosphere. Above all, they want to know exactly which processes take place where and when. This is the only way to find out how soil, plants, and micro-organisms maintain their closely interwoven relationships. “We believe that they form a self-organised system that can develop a certain stability against disturbances on its own”, says the researcher. This would be of interest not only for future harvests and food supplies but also for the role of soils as reservoirs for greenhouse gases. The roots still have many exciting things to tell.

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PROJECT

SOIL IN A GENERATIONAL EXPERIMENT

Every year, manure and mineral fertiliser are spread, and plants are sown, harvested, and analysed. And all this according to a scheme that is almost 120 years old. Generations of scientists and technicians have kept the Static Fertilisation Experiment in Bad Lauchstädt going since 1902 – despite years of drought, wars, and political upheaval. This perseverance is starting to pay off. This is because soils react only slowly to changes in the environment and land use. Anyone who wants to know how their performance can be maintained must therefore observe their development over a long period of time.

The experiment looks like a mosaic. Not only do winter wheat, spring barley, and maize alternate but the growth and greenery of the plants also differ significantly. The reason for this can be found in the soil – and in the history of the UFZ experimental station in Bad Lauchstädt. In 1902, the agricultural scientist Wilhelm Schneidewind and his examiner Willi Gröbler set up a large-scale fertilisation experiment here. “Back then, people wanted to know how organic and mineral fertilisers affect the yield and quality of harvests”, explains Dr Ines Merbach, who has been responsible for the experiment at the UFZ since 2000. A 4 ha area was divided into 250 m^2 plots, each of which received different amounts of fertiliser. Some got their nutrients from larger or smaller amounts of manure. Others received mineral fertilisers with different combinations of nitrogen, phosphorus, and potassium. And the “zero plots” were not fertilised at all for comparison.

“There have, of course, been changes over the years”, says Ines Merbach. In 1978, on the initiative of humus researcher Prof Martin Körschens, who later headed the Soil Research Section at the UFZ for many years, the experiment was extended so that the fertilisation variants were “reversed” on one quarter of the area. Since then, the plots of land enriched with humus have received little fertiliser, and those with little humus have received a lot. Finally, in 2015, the original crop rotation was changed. While Winter wheat and spring barley were maintained, the labour-intensive potatoes and sugar beet were replaced by maize.

However, the basic principle of the long-term experiment with its different fertilisation variants still applies today. The effects can be seen in the standard measurements taken over the years. In addition to the pH value, these include the carbon, nitrogen, phosphorus, and potassium content of the soil. The large differences that have developed between the individual plots are striking. The range of carbon content is more than 18 tonnes per hectare. With respect to phosphorus and potassium content, there are differences of 36 milligrams per 100 grams of soil. Because the data is measured over long periods of time, the experiment is important for agricultural research and beyond (e.g. to calibrate sensors for remote sensing).

Today, scientists from various disciplines have the opportunity to find out more about the physics, chemistry, and biology of the soil. Prof François Buscot, who heads the Department of Soil Ecology at the UFZ, is interested in the complex biotic communities that populate the subsoil. “We know that there is a much greater biological diversity under our feet than above ground”, says the mycologist. Two handfuls of soil alone contain seven billion bacteria – about as many as there are people on Earth. There are countless fungi and small animals.

Without their activities, things would look bleak for farmers and the Earth’s ecosystems. After all, the soil dwellers are continually converting dead organic material into humus and making nutrients available for the plants. “They work as a team. Different taxonomic groups are responsible for each step”, explains Buscot. He and his colleagues want to find out how these groups work. After all, soils are known to react slowly to change. Areas in which the use has been precisely documented for over a hundred years are thus a treasure trove for him. “For example, we found out that the networks of soil organisms are of varying complexity depending on the fertilisation”, says Buscot. For example, mineral fertiliser tends to create simple-structured communities, whereas farmyard manure creates much more diverse and thus more stable communities.

— Maize harvest in the Static Fertilisation Experiment 2019. The different colours of the plants clearly show the different nutrient supply in the individual plots.

The long-term experiment in Bad Lauchstädt not only provides new insights into the underground work flow but also into the role of soil as a climate protector. Every kilogram of carbon that soil absorbs and traps does not end up in the atmosphere as a greenhouse gas. But just how much can it store? Under what circumstances and for how long? This can be determined only if you have very long time series", says Prof Hans-Jörg Vogel, head of the Soil System Science Department at the UFZ. It is known that the size of the carbon store depends on the location and land use. The more fine material the soil contains and the more carbon is introduced each year via crop residues, roots, and organic fertilisers, the more it stores. Most of it is converted by microorganisms and made available to plants. The content of stable organic carbon (humus) in arable soils is only 1–4 %. And even this can be released again through the activities of soil dwellers. Contrary to what was previously assumed, it is not protected by its chemical form against the attacks of bacteria and the like. "We now know that it lies in a place within the porous soil structure where the micro-organisms cannot get to", explains Vogel. If the structure of the soil is regularly disturbed (e.g. by tillage), this carbon is easily released again.

UFZ employee Dr Uwe Franko and his colleagues can simulate such dynamic processes with computer models such as CANDY (Carbon And Nitrogen Dynamics), CIPS (Carbon In Pore Space), and CNP (Carbon Nitrogen Phosphorus). They enter information on soil properties, weather, and land use and use them to calculate the transitions between carbon pools. In the future, the virtual image is to become even more detailed. Researchers are currently building an even more complex model called BODIUM, which will mathematically describe soil cultivation and the burrowing activity of earthworms. However, scientists must continually verify how realistic the computer models are by using real measured values. All the better that this experiment was started in Bad Lauchstädt almost 120 years ago.

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PORTRAIT

MOLECULAR BIOLOGY IN THE FIELD

Using the methods of molecular biology and population genetics, Dr Stefan Michalski at the UFZ takes a closer look at the world of plants. How will species, communities, and ecosystems change when climate change leads to increased temperatures and long periods of drought in some regions? What happens in the genome when habitats are divided into increasingly smaller fragments? Is there perhaps variation in the genes of plants that enable them to adapt to new conditions?

In the valley, the flowers of *Achillea millefolium* sway high above the ground. At higher altitudes, the same plant resembles a bonsai. A similar balancing act is performed by *Arrhenatherum elatius*, which grows much further up into the sky in warm Italy than it does in cooler Sweden. In times of climate change, don't such differences also offer good opportunities to adapt to environmental changes? Dr Stefan Michalski is currently investigating this question at the UFZ. As part of other projects, it provides some deep insights into the evolution of far more plants than just *Achillea millefolium* and *Arrhenatherum elatius*.

When the researcher explains his plans, one soon realises that the answer to such obvious questions is not quite so easy. But he is able to describe even complicated matters in a simple and clear way. It is no wonder that he won the first round of the 2006 "Understanding Science" competition sponsored by the UFZ when he was a 29-year-old doctoral candidate. His lecture "Vom Winde verweht … wenn Wissenschaft in die Binsen geht" [Gone with the wind … a rush hour for science] is nothing more than the popular translation of his work: "Population genetics and reproductive biology of rushes *Juncus atratus*".

In his research, these plants have now been relegated to the background in favour of other species. "Whether it makes sense to let *Arrhenatherum elatius* and *Achillea millefolium* from the warm south grow further north or at higher altitudes where climate change is driving up temperatures depends not only on the ability of these plants to adapt to a warmer environment", explains the botanist and molecular biologist. After all, there is a whole range of factors that influence the growth of plants. The plants native to the south are also adapted to shorter days and longer nights in the summer months. But climate change does not change the day lengths. The plant, which has made its way to the north, knows the increased temperatures from its southern home. However, it remains to be seen whether it can cope with the long days and short, bright nights in Sweden's summer months as well as many other factors such as different soils or unknown pathogens.

Stefan Michalski at the UFZ is examining precisely such questions. How do human-induced changes such as climate change or the fragmentation of habitats affect the genome of native plants? What potential for adapting to these new circumstances is hidden in the genes? The researcher does not expect simple answers to these questions. Michalski knows that he must first slowly come to grips with the basics.

For example, climate researchers are convinced that in some regions in eastern Germany, climate change will lead to longer periods of drought during growth periods. Michalski and his colleagues are thus investigating how well these two species adapt to such changes using *Trifolium pratense* and the sweetgrass *Bromus erectus*. At the CGEF (Global Change Experimental Facility) in Bad Lauchstädt, they investigate a large number of plants to determine a whole range of characteristics: How high do clover and bromegrass grow? When do they flower. How many leaves does a plant produce? How many inflorescences does a plant have? How much biomass? How soft are its leaves? And how many hairs does it have? The last two questions provide important information on the risk of the plant ending up in the mouth of a herbivore. If a leaf is very tough and hairy, many herbivores will try to find other material that is easier to digest.

The research team measured around 2,000 plants in 2019. With the help of the genetic fingerprints that were also taken, they now estimate how many of the differences observed can be traced back to the genetic material. They can also draw conclusions on how well the plants could adapt to changes. Initial results show that the genetic material of *Trifolium pratense* does indeed contain charac-

Dr Stefan Michalski

— sitting in a flowering meadow is, at least figuratively speaking, in the middle of his research: After studying biology at the Universities of Jena and Leipzig, the botanist and molecular biologist examined the reproduction and genetic material of *Juncus atratus* as part of his doctoral thesis at the UFZ and the University of Halle. In addition to this species, the UFZ researcher is now investigating a whole range of other meadow plants with his "Molecular Biology in the Field".

teristics that help it to cope with drought summers such as 2018 and 2019. And the genetic material can also use this potential. Although *Trifolium pratense* initially suffers from the lack of water, it adapts to the problem in the following generations and grows better again.

Even though he spends long hours in the laboratory and has a family with four children waiting at home, Michalski has no intention of giving up his hobby of photography, which he has cultivated since his youth. Unfortunately, you need a lot of time if you don't simply want to take pictures of a landscape but rather want to capture a particular occurrence just as the morning fog has begun to lift. In a similar situation, others would perhaps give up their hobby. Michalski, on the other hand, has borrowed an antiquated technique from the early days of photography. He has made a pinhole camera – for example from empty film cases. He then attaches some of these simple cameras, which are loaded with black-and-white photographic paper, to trees and other objects. After days, weeks, and often even months between laboratory work and family life, he collects his pinhole cameras. And finds a natural work of art on the photographic paper. Every day, the light of the sun has taken a slightly different path over the contours of the landscape captured through the pinhole.

He has not yet given up his enthusiasm for rushes, which stems from his doctoral thesis. After all, these plants can break down harmful substances (e.g. the toxic phenol) in the soil. Michalski would like to know whether plants of the same species of rushes, each with different genetic characteristics, can complement each other in this natural waste removal process and thus improve decomposition. Anyone who knows Michalski also knows that he will find a time-saving way to address this issue as well.

—

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INTERVIEW

BIODIVERSITY IS OUR INSURANCE FOR THE FUTURE

The Corona crisis has made it obvious and confirmed the fears of many experts. If humans intervene too much in nature, they not only irretrievably destroy biodiversity but also increasingly expose themselves to the risk of getting in touch with harmful viruses. Prof Josef Settele, UFZ agricultural scientist and co-chair of the Global Assessment of the Intergovernmental Platform on Biodiversity and Ecosystem Services IPBES, therefore advocates that biodiversity and mankind should be seen as part of the mutually supportive community buffering damage caused by climate change, parasites, or pesticides. This requires a transformative change in society – to which everyone can contribute.

Humans often regard nature either as a renewable resource that can be exploited almost at will or as a wilderness untouched by humans. You also see biodiversity as a form of insurance for the future. Why?

The evolutionary potential of species lies in their genetic diversity. It reduces the risk of species extinction because there are always individuals within a species that are better able to cope with changes of the general living conditions (e.g. induced by climate change) than the average of all populations of a particular species. In principle, the same applies at the species level. The more species of a group we have, the greater the chance that one can stand in for the other under changed conditions. This is important. Let's look at this in the case of bee species beyond the honeybee: The honeybee is only one of thousands of different species of bees. While it is doing quite well – which is not so surprising for a human-managed animal – the situation for wild bees is much more critical. In Germany about half of the wild bee species are red-listed, which means endangered. The more species we lose, the lower the potential for a suitable species to stand in when conditions change. This is relevant for practically all ecosystem services but is particularly well understood and easier to communicate in the case of pollination.

Prof Josef Settele

— born in Marktoberdorf / Bavaria in 1961 – studied agricultural biology at the University of Hohenheim. In 1992, he received a doctorate for his thesis "Influences of the intensification of irrigated rice cultivation on the terrestrial arthropod communities of Philippine rice terraces". He habilitated at the University of Hohenheim in 1998 and re-habilitated at the University of Halle in 2002. Since 1993, Josef Settele has been working at the UFZ, where he now is head of the Department of Conservation Biology and Social-Ecological Systems. Since 2016, he has been Associate Professor of Ecology at the University of Halle. Settele was scientific coordinator of many international research projects and most recently co-chair of the Global Assessment of the Intergovernmental Platform on Biodiversity and Ecosystem Services IPBES between 2016 and 2019. From July 2020 onward, he was appointed as member of the German Advisory Council on the Environment (SRU).

Is it possible to speak of a mutually supportive community (i.e. a community in which humans and nature stand up for each other)?

The view of biodiversity as insurance is not so much about direct monetary compensation for damage (as is the case with the collective body of the insured human policyholders). It rather concerns the elimination of a cause of damage or the reduction of the risk of loss of a species or variety if it can be functionally replaced by another species or variety (at least to a considerable extent). So the damage or risk is limited through the replacement of another species or variety – and this also in terms of economic consequences for humans. The contribution of pollination (i.e. above all the work of wild and honey bees) to human nutrition has a global monetary value of several hundred billion euro per year.

Another example is the banana. The now popular "Cavendish" variety has been grown as a replacement for a variety affected by fungi. But it is now threatened itself – again by a fungus, Panama disease TR4. Solutions to this problem could be resistant, genetically modified bananas. However, it is often the case that, sooner or later, the harmful organism adapts to such varieties. It thus overcomes resistance, especially when these varieties are grown on large areas as monocultures. A diversified crop with a greater diversity of varieties is much less susceptible to damage because it is more likely to contain varieties that are affected less by the pest. It is precisely these varieties that form the basis of future insurance.

At what point does the aspect of a mutually supportive community come into play?

The diversity of life is part of the mutually supportive community that is created in cases of damage caused by climate change, parasites, or pesticides. In the event of damage, biological diversity enhances ecosystem services to the benefit of humans. As part of our research at the UFZ, we have shown that irrigated rice cultivation in Asia does not have major pest problems as long as no insecticides are sprayed against pests. If these are used the diversity of beneficial organisms is heavily impacted. This enables the pests to recover and grow much faster without enemies. This first leads to serious outbreaks followed by decreased yields. In this system, avoiding insecticides preserves a high level of biodiversity. This always includes many species that can act as opponents of the pests.

What role must humans play?

If the conservation of biodiversity represents a form of insurance for the future, humans have the option to "take out a policy" and commit themselves to actively protect the diversity of life. They can thus fundamentally change their relationship to and understanding of "nature", which are core pre-conditions for the transformative change that the international community has adopted as the basis for future-oriented development within the framework of the Global Assessment of the Intergovernmental Platform on Biodiversity and Ecosystem Services IPBES.

Distribution atlas of butterflies and burnet moths of Germany

Which butterfly species are found in which regions? Which species have disappeared in recent decades? And which still have a chance? And where have newcomers established themselves? The answers to such questions are provided by the new atlas, a joint effort of scientists and practitioners, including the UFZ. This is the first time that a pan-German overview of the occurrence of these popular insects has been available.

The new atlas, which is only available in German language, presents the 184 butterfly species native to Germany as well as the 24 burnet moths. It features attractive photos, detailed distribution maps of all species, and short portraits summarising information on habitats, biology, threats, and protection.

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Price: € 49,99

What are further core elements of such transformative changes in order to preserve biodiversity as an insurance for the future?

It is ultimately a question of our entire economic system, which must be reconciled with nature. Ecology and economy must be integrated. There is a reason why the two terms sound very similar: they are both based on the Greek work “oikos”, which means house. Everyone – from consumers and private companies to regional and national governments to the international community – has a role to play. Such a transformative change – both at the national and international level – is an important prerequisite for a sustainable future.

Humanity is still far from a partnership with nature. This can be seen, for example, in the development of pandemics.

Studies have shown that shrinking habitats and associated behavioural changes in animals increase the risk of diseases being transmitted from animals to humans. Most pathogens are still waiting to be discovered; we are only just scratching the surface. Many experts were not overly surprised by the outbreak of the corona virus.

Why?

Humanity is creating the conditions for diseases to spread. We reduce the barriers between humans and the host animals in which such viruses naturally circulate. The spread of a pandemic influenza as well as many deaths was inevitable. And we can expect that there will be other pathogens – some with much more serious effects. For example, the expansion of land use leads to the loss of habitats. This, in turn, results in higher population densities of some generalists (i.e. species which then find ideal conditions) and also more contact with humans. The species that survive sometimes change their behaviour and increasingly share living space with more of their kind and even with humans.

The Global Assessment, which was published in 2019 by the Intergovernmental Platform on Biodiversity and Ecosystem Services, shows that many governments fail to prevent the destruction of nature. Should we consequently expect more pandemics?

The probability of pandemics increases as ecosystems and biodiversity are increasingly destroyed. But it gives me hope that our IPBES report was positively received by a wide range of people and also by political decision-makers. Initiatives have been launched to counteract the degradation of nature – in line with activities such as Fridays for Future and other initiatives involving agriculture or food trade. Finally, important elements of the report can be found in the new EU biodiversity strategy.

You call attention to the link between the destruction of nature and pandemics. What is your hope?

There are two main reasons for this. First, it is important to recognise this link so that we understand what the indirect – and often most the important – causes of pandemics are. This enables us to apply the precautionary principle instead of waiting and then combating the symptoms – which is what we are currently forced to do. The link between health and the conservation of natural resources is obvious. I therefore hope that the knowledge and experience of such interrelationships will contribute to a much improved willingness to address transformative change in our society as a way out of the crisis (as the IPBES report has shown).

Does climate change increase the risk of new types of epidemics?

The risk of flu-like viruses being transmitted is lower in warm and humid weather. But climate change is making it possible for species that have not previously been found here to settle in Germany. A well-known example is the Asian tiger mosquito, which was already identified in Hamburg and is a notorious carrier of tropical diseases such as Zika fever.

The link between natural destruction and the risk of epidemics has so far been seen more as a matter for (sub)tropical countries. Is there a real risk to us as well?

I would consider the real risk here to be minimal, especially because we already know a great deal about the theoretically possible species, which are usually vertebrates. Our eating habits are different; the game we hunt is clearly defined. Wilderness has long been a thing of the past for us; we live in a cultural landscape that has grown over long periods of time and has been shaped by humans. But on the other hand, the recent spillover of a modified Corona-virus from minks to humans in Denmark tells us to be careful.

In the light of the pandemic, how can the EU show that it is drawing the right conclusions from the biodiversity crisis?

At first glance, this has little to do with the corona pandemic – but it is nevertheless important. The plan for the next period of EU agricultural policy was adopted last year by the EU Council of Ministers. If it remains as it is, not only is biodiversity threatened, but the "European Green Deal" of Ursula von der Leyen is doomed to fail before it has even begun. For this reason alone, it is urgently recommended that improvements that closely link all financial flows to ecological guidelines and also monitor compliance be made. So far, these have tended to be warm words and declarations of intent. German and European bio-economical strategies must be subject to the same restrictions. Because biodiversity is, of course, also a global concern, it is also necessary to consider the external impact (e.g. by reducing the import of biomass for animal feed and biofuel). If this happens, the EU can enter negotiations at next year's UN biodiversity conference in China, where a new agreement on biodiversity protection is to be adopted, with a completely different level of credibility. The recently published "from farm to fork" strategy of the EU provides hope, especially when conceived and implemented in combination with the new Brussels biodiversity strategy. However, there is still plenty of room for improvement.

Dr Ines Merbach

who holds a doctorate in agriculture, has been working at the experimental station since 1987 and is therefore a mainstay of Bad Lauchstädt. In 2002, she took over the technical coordination of the station operation. She coordinates the execution of the experiments and is the contact person for everyone working at the station – whether scientists, doctoral students, or technicians. She is particularly proud of the new soil profile and the long-term experiments, the continuation of which is particularly important to her.

From left to right

Steffi Wagner

Renate Hintz

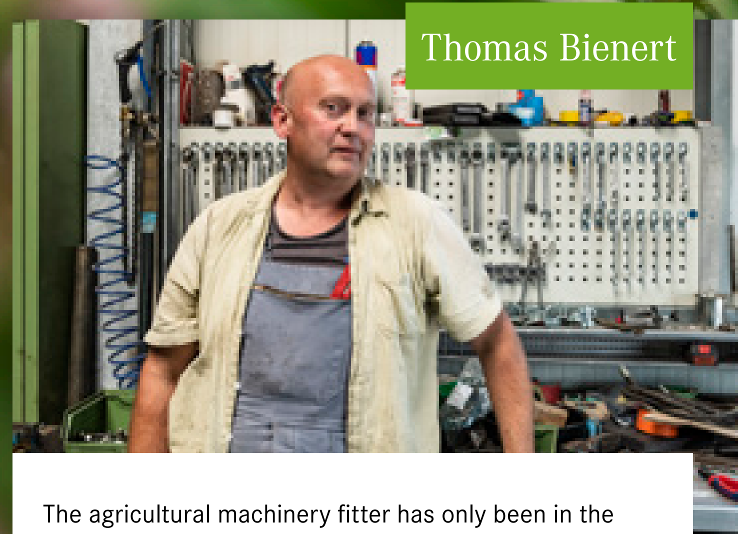
Christa Wolfram

Where would the scientists be without

the energetic employees, who day after day and year after year make sure that the Bad Lauchstädt research station is fully operational.

Andreas Schubutz

The Bad Lauchstädt herd of sheep 2020. Amidst mother animals and lambs is the new shepherd, Andreas Schubutz. He took over this job from his grandfather at the beginning of the year. Since then, he has been looking after the sheep and also taking care of maintenance work in the area.



Thomas Bienert

The agricultural machinery fitter has only been in the team since 2018. He has spent many years of his working life in a market garden and therefore has a good feeling for plants. This combination of technical understanding and green thumb already makes him indispensable for the experimental station.

Birgit Sawall

Sabine Straßenburg

Since the founding of the UFZ, these women have patiently supported generations of students and doctoral candidates from all over the world in laboratory and field experiments. They are not fazed – even when they have to deal with over 8,000 test tubes at once. When weeding in the biodiversity experiments, they are deterred neither by scorching heat in summer nor cold and wet weather in spring or autumn. Finally, they make sure that the many plant samples taken throughout the year are sorted, dried, ground, correctly labelled, and allocated accordingly.

Eckhard Winter

He came to Bad Lauchstädt in 2002 with a lot of professional experience in agricultural testing and agricultural engineering. Since then, he has been providing the necessary technology for the numerous experiments. Rationalisation is "his" subject. He is constantly tinkering with new solutions because no (new) machine is so good that it cannot be improved.

Sven Meyer

Gerd Schubutz

Konrad Kirsch

Morning feeding and control round. Sven Meyer drives the tractor. He has been working as a technician in Bad Lauchstädt since 2002. He is therefore incredibly well versed in everything to do with experimental technology, which he learned from scratch. To the right of the trailer is Konrad Kirsch – technology expert, weather god, and communication wizard – who, since 2013, has been ensuring that the GCEF is working properly. To the left is Gerd Schubutz, who has been working tirelessly at the experimental station for almost 15 years and has been looking after the GCEF flock of sheep since 2014.

UFZ RESEARCH STATION BAD LAUCHSTÄDT

Location data of the experimental station

Area 43 hectares

Location outskirts of Bad Lauchstädt | 51°23“ north latitude; 11°52“ east longitude

Height above sea level
118 metres

Soil black earth/chernozem
Soil value number 94–98

Average Temperature
9,0°C (1896 – 2019)

Average Precipitation
483,5 mm (1896 – 2019)

The 5 driest years since 1896
2018 – 254,0 mm
1982 – 260,8 mm
1911 – 264,9 mm
1991 – 271,9 mm
1947 – 316,9 mm

Aerial view André Künzelmann/UFZ | **Map material** Google, GeoBasis-DE/BKG 2020

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