FELD

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AGRICULTURAL LANDSCAPE RESEARCH (ZALF)

TITLE STORY

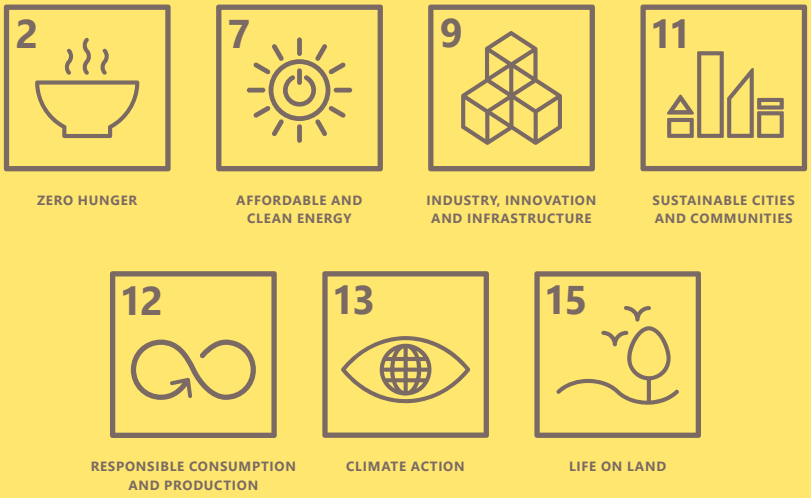
THE CONFLICT MANAGERS

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:



CONTENT

THE CONFLICT MANAGERS

Farm land is also a habitat for wild animals, some of which pose major challenges to agriculture. They cause damage to seeds and crops or kill farm animals. ZALF researcher Hannes König and his junior research group "Human-Wildlife Conflicts in Agricultural Landscapes" are working on new instruments for wildlife management to minimize these conflicts. Their research focuses on the biology and social acceptance of wolf, wild boar, European bison and co.

For some people it is a moment of happiness, others feel fear or even anger – the sight of a wolf in the wild provokes a wide variety of reactions. The predator was eradicated in Germany in the 18th century. Since the 1990s, wolves have gradually been returning and reclaiming large areas of their former habitat. More than 100 packs have now made themselves at home in Germany. The fact of this strictly protected species reproducing here is a success story for environmental protection. Livestock farmers, on the other hand, are generally less enthusiastic and view the return of the wolf with great concern. They fear for their livelihood if sheep or calves are killed on their pastures.

AGRICULTURAL LAND AND HABITAT

The agronomist Dr. Hannes König is researching conflicts like these. He heads the junior research group "Human-Wildlife Conflicts in Agricultural Landscapes", (LandSTRAT), at the Leibniz Centre for Agricultural Landscape Research (ZALF). Since 2017 the team has been investigating land use conflicts between humans and wildlife on agricultural land. In a number of projects, researchers in biosphere reserves in Germany and Sweden are identifying when and where damages occur, who is affected and how to reduce the risk.

The wolf is probably the most prominent example of how the debate on conflicts between humans and wildlife is sometimes conducted in a very emotional way. But it is not only the wolf leading to conflicts in agricultural landscapes. Cranes and wild boar are not always met with approval by farmers either. Wild boars root through the soil with their trunks in search of worms and insects and dig up the ground thoroughly. After an extensive nightly feast, a sounder of several animals leaves a field of devastation. Neither meadows nor pastures, cereal or corn fields are safe from them.

There is also trouble with the crane: especially in spring, when the large migratory birds return to their breeding grounds from the south. The seeds and seedlings in the freshly cultivated fields are a welcome food source. "Massive damage can be caused, especially to maize, legumes and crops such as potatoes and peas", says Hannes König.

Cranes on a harvested stubble field (above) and a herd of European bison on a field (below)

DAMAGE CAUSED BY WILDLIFE IS LESS THAN DAMAGE CAUSED BY CLIMATE CHANGE

In order to assess the extent of the conflicts and damage, the research team interviewed about 40 farmers who cultivate land in the Schalsee Biosphere Reserve in Germany and the Kristianstad Vattenrike Biosphere Reserve in Sweden. At the same time, they set up more than 60 photo traps at Schalsee and spent 14 months observing the activity patterns of wildlife in the various protection zones. The evaluation of many thousands of pictures enabled researchers to determine were the animals can be found, based on landscape structures, weather data and even the moon phases.

The interviews showed the damage caused by wildlife is perceived very differently. Whereas losses due to eating or rooting are insignificant for some farmers, for others the losses are considerable. However, it is noteworthy that the damage caused by wildlife is not the main concern for the farmers surveyed. It is rather droughts, floods, climate change and also price fluctuations on the markets reducing their incomes much more than wild boars and seed-eating cranes. The drought year of 2019 shows the damage caused

by climate change and wildlife may accelerate its effect: Many small water bodies in which cranes usually breed had dried out due to the lack of rain. As a result, the animals which did not have to look after their offspring, flew to the surrounding fields and ate their fill.

The wild boars also benefit from the increasingly mild winters. Their populations are growing massively – and with them the damages. The research group's photo traps reveal where wild boars are particularly fond of staying: at the border between forest and field, where the protective cover of the forest and the food sources on the fields are close together.

HUNTING AS A LAST RESORT

But how can systematic monitoring lead to improved wildlife management which minimizes damage to agriculture while protecting endangered species? "We identify times and areas where conflicts can occur more frequently – for example due to the life cycle of the animals, seasons or landscape structures", explains Hannes König. Hunting seasons and methods can be adapted wherever extensive damage is likely. Targeted measures to scare the animals away or diversionary feeding can protect the fields from the worst of the damage. In Sweden, incoming cranes have been kept away from fresh seeds for years by feeding them on selected areas. Initial trials in Germany also appear to be successful. In addition, experiments are being conducted with modified sowing times and depths to protect the seeds. Compensation payments from public authorities are also calming down conflicts.

Hunting of the cranes is possible as a last resort in Sweden, but this is strictly regulated and only allowed with a permit. "This happens rarely", stresses Hannes König. "Diversion feeding works as damage prevention, and in case it does not, a contact person and a transparent system for compensation payments are in place." Germany is now taking a similar approach to wolf management. Last years amendment to the Federal Nature Conservation Act allows wolves to be shot when farm animals are killed repeatedly. "Brandenburg has not made use of this so far", says Hannes König. "However, livestock owners now have an instrument in their hands for emergencies and no longer feel they are being left alone."

An anesthetized young European bison is being collected as part of a pending resettlement. This resettlement will be accompanied by a medical examination, after which the bison will be equipped with a telemetry transmitter to track the animal's movements in real time.

At the moment the team is still evaluating the night shots. These should show when and where wild boars are active at night so they can be hunted efficiently. Full moon nights play a special role here, because without night vision equipment hunting is only possible in moonlight. The researchers want to find out whether the animals have become more cautious as a result of their experiences on nights of the full moon.

The story of a strictly protected European bison which immigrated from Poland three years ago shows that reaching for a rifle can also be premature. "A few hours after its arrival, it was illegally shot by hunters in Brandenburg", says Hannes König. A mistake that also occurred due to inconsistent instructions from authorities and misunderstandings in the reporting chain. By setting up a European bison management system, the aim is to be better prepared in future as well as to prevent possible damage. "It is likely for the European bison to re-establish itself in Germany", predicts König. "In western Poland alone, near the German border, there are now around 300 animals." The colossuses, which weigh up to a ton and are thus larger than their relative, the American bison, can be dangerous, particularly for traffic. The same applies to the moose, which is also gradually returning to Germany. "This is why we must recognize the potential for conflict and develop plans for management" explains the researcher.

LIVESTOCK FARMERS FACE CHALLENGES

In order to collect the necessary data, the researchers are equipping up to 30 European bison and moose that are living close to the border between Poland and Germany with transmitters. In this way they can determine the migration routes of the animals and compare them with land use data to find out where the animals prefer to be. The transmitters could also be used as early warning systems, which show in real time when an animal approaches the border, a field, or a busy road. Examples of successful European bison management in Poland, where the rare animals are driven from arable land using drones, also show how conflicts can be avoided. "We can learn from this to develop scientifically based instruments for wildlife management", explains Hannes König.

While the European bison and moose are still rarely considered a nuisance in Germany, the image of the wolf has already been considerably damaged. Often unjustly, says Hannes König. "Livestock killings in a wolf 's territory are more likely to be random events. Food analyses show over 95 percent of wolf 's prey consists of wildlife", he explains. The research group's

data also shows the wolves often being found in areas where wildlife populations are high and where food can easily be found. However, in areas where the wolf likes to stay, it also kills more farm animals. Hunting deer, stags, or wild boar more intensively where possible would be a measure to make a region less interesting for wolves and would protect grazing animals. The researchers now want to verify this thesis with further data. Nevertheless, with the return of the wolf, our way of keeping livestock on pastures has to change. Particularly in landscapes with high wolf density, electric fences and livestock guardian dogs are necessary to make it as difficult as possible for the wolf to hunt grazing animals. "These protective measures must be consistently implemented by the livestock owners", emphasizes König and is now starting to observe a change in thinking. "It takes time, persuasion and also experience, but an effort well spent, as it can reduce and minimize conflicts in the future."

THE AGRONOMIST

Dr. Hannes König is head of the junior research group "Human-Wildlife Conflicts in Agricultural Landscapes" at ZALF.

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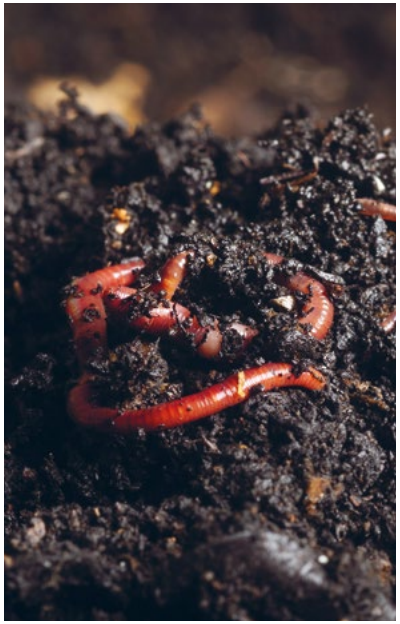
USING CROP RESIDUES MORE EFFICIENTLY

They are left over after harvest: crop residues such as straw or leaves. What happens to this material now can have a great influence on the humus content of the soil and thus on its fertility, as well as its climate footprint. Researchers at ZALF are looking for ways to make the best use of the crop residues from our fields.

Once the combine harvester has cut the cereals, removed the grain from the husks and loaded the harvest onto the trailers for transport, the field becomes quiet. What is left behind are dead plant remains, stubble, straw, and roots in the soil. The straw is often later pressed into bales and used as animal beddingin the stables. Some of it however, is also chopped into small pieces during the harvest and remains on the field. Then countless worms, woodlice, bacteria, and fungi attack the valuable food. An entire army of soil organisms decomposes the plant material, drags it into underground passages, crushes it and digests it into humus.

Like a sponge, the humus in the soil stores water and nutrients. Farmers calculate how they can balance the content of this valuable substance, which experts also call "organic matter" using the so-called humus balance. The type of cultivation, the crops grown, the fertilization and many other factors determine the build-up and depletion of humus. The higher its content, the more fertile and healthy the soil. "There is a long list of positive effects", stresses agricultural ecologist Dr. Tommaso Stella. "These range from increased water storage capacity to protection against erosion."



Earthworms (left) and other soil organisms decompose the crop residues, pulling them into underground passages and crushing and digesting them into humus (right).

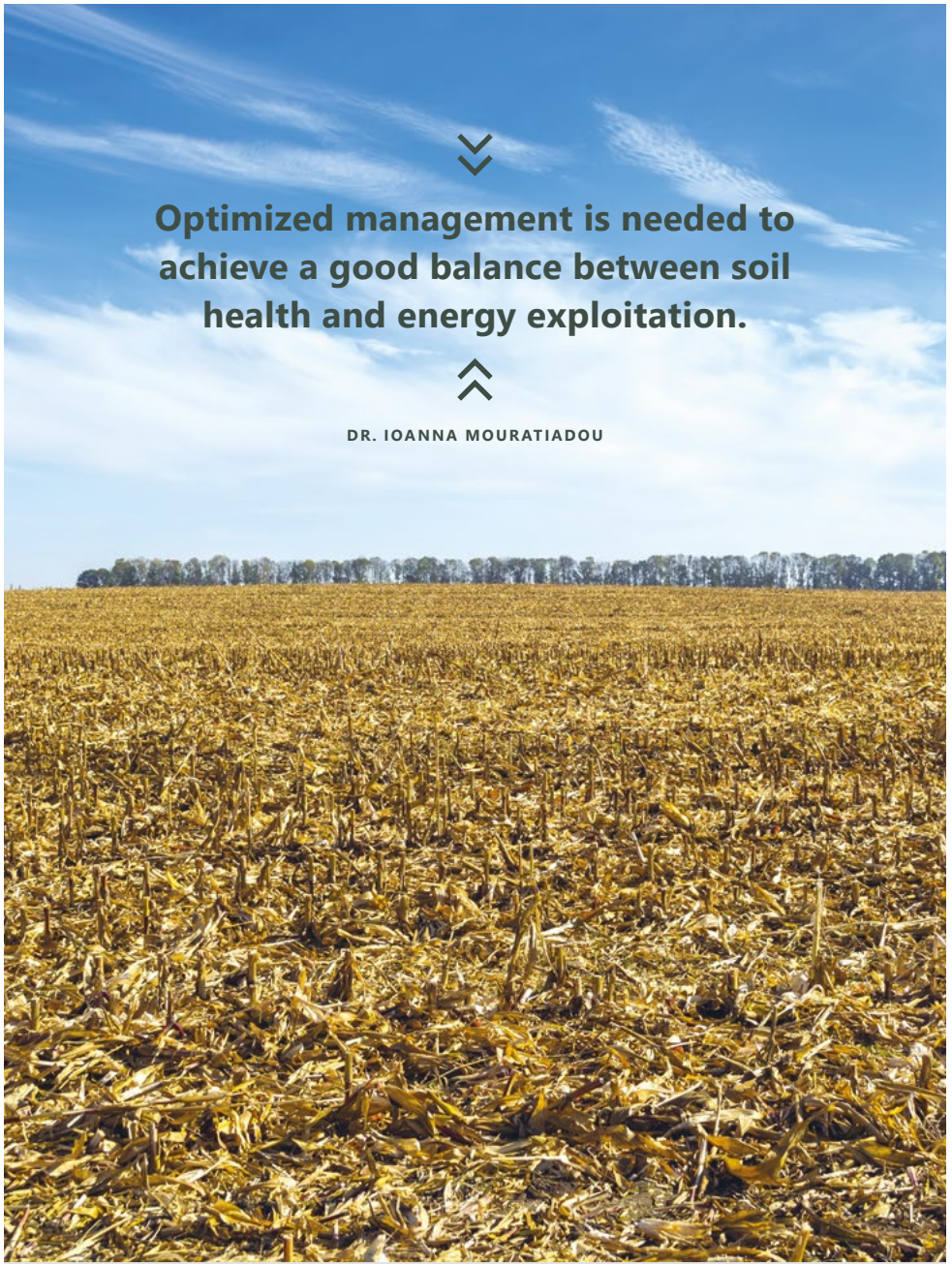
SOILS IN BALANCE AND THEIR ROLE AS CARBON SINKS

Dr. Ioanna Mouratiadou and Dr. Tommaso Stella, together with colleagues from the Universities of Utrecht and Bonn, are conducting research in the EU-funded "SUSTAg" project into the role of crop residues in the carbon balance of the soil. At the same time, they want to find out how the material can best be used for the production of bioenergy without harming the soil. "As a bioenergy resource, crop residues could make an important contribution to achieving the goals of the 2015 UN Climate Change Conference by reducing emissions from fossil fuels", says Mouratiadou.

One of the initiatives launched at the 2015 UN Climate Change Conference was the "4 per 1000" initiative, which aims to increase the proportion of organic carbon in the upper soil layers by 0.4 percent every year. Growing plants extract carbon dioxide from the air through photosynthesis, use the converted carbon for their growth and release oxygen back into the atmosphere. If this plant material is permanently stored as organic carbon in arable land, it removes climate-impacting carbon dioxide from the earth's atmosphere. This could offset some of the CO_2 emissions caused by human activity and very effectively protect the climate. At present, however, most agricultural soils lose more organic carbon than they bind – the balance is negative in many places. It is therefore important to consider very carefully whether crop residues should be used for bioenergy production or whether it is better to leave them on the fields.

CROP RESIDUES AS AN ENERGY RESOURCE

"Generating energy from crop residues has a major advantage in that there is no competition between food production and energy production", explains Mouratiadou. This is different, for example, in the case of maize cultivation, where large areas of arable land are used solely for biomass production for biogas plants and are therefore no longer available for food production. "However, if too much material is taken from the field, the carbon content decreases, which in turn has an effect on the fertility of the soil and its capacity to sequester carbon", is how the agricultural economist explains the conflict. In interviews with farmers, authorities and associations in North Rhine-Westphalia, the scientists asked what barriers and concerns are currently preventing that bioenergy is being generated from the material. It turned out that the fear of losing humus and thus soil fertility is indeed the greatest concern.



The part of the crop residues that is not left on the fields is used, among other things, as mulch cover for strawberry fields.

This is why farmers leave some of the plant remains on the fields to rot after harvesting in order to preserve the humus in their soils. The remainder ends up primarily as lanimal bedding in stables or becomes a substrate for mushroom cultivation or mulch cover for strawberry fields. These competing forms of use, but also the technological limitations and lack of financial incentives lead to the fact that harvest residues have so far been used little to generate energy.

But Mouratiadou is convinced there is still room for development in this system. “Optimized management is needed to achieve a good balance between soil health and energy exploitation”. The researchers used mathematical models and various management scenarios to determine what form such management could take, in which the crop residues could be used for energy production with the lowest possible emissions and without harming the soil.

DECISION-MAKING AIDS FOR FARMERS

“There is no one-size-fits-all solution for the best management”, emphasizes Tommaso Stella. Agricultural systems are complex. Climate, soil, type of land use – all these factors influenc emissions, yields and the carbon cycle.

Mathematical simulations help to calculate the best possible measures. Soil composition is proving to be an important factor: "On sandy soils, it may even make sense to leave all the biomass from crop residues in the fields", says Stella. Until now, soil properties, for example, have hardly been considered in the humus content balances. Yet it makes a big difference whether a farm in the sandy Uckermark or on the rich soils of the Magdeburger Boerde plows its crop residues under. The researchers recommend that the type of soil should be taken into account in the humus balance.

However, the scientists also stress that the appropriate management of crop residues alone will not suffice to solve the problem of the declining humus content. How the soil is cultivated and fertilized, or which catch crops are grown – these are all important pieces of the puzzle that are decisive for the overall picture. "Our simulations provide information on how the systems react to certain changes and enable better predictions to be made", says Stella.

After harvesting, farmers leave some of the plant remains on the fields to rot in order to preserve the humus in their soils.

For farmers, this can lead to useful tools and decision-making aids that indicate under which conditions crop residues can be used for bioenergy or when they are better left on the field. "It also depends on what farmers and society want for their farm and for their region", Mouratiadou emphasizes. "There are complex interactions between economic factors, emission levels, soil health, water quality and much more." Agricultural land is not all the same and its use is different. A management system balancing these different demands is needed. Stella and Mouratiadou's research shows that an integrated, site-specific management of crop residues based on humus compensation, optimized fertilization and winter soil cover offers the greatest potential for balancing these conflicts of interest.

On sandy soils, it may even make sense to leave all the biomass from crop residues in the fields.

DR. TOMMASO STELLA

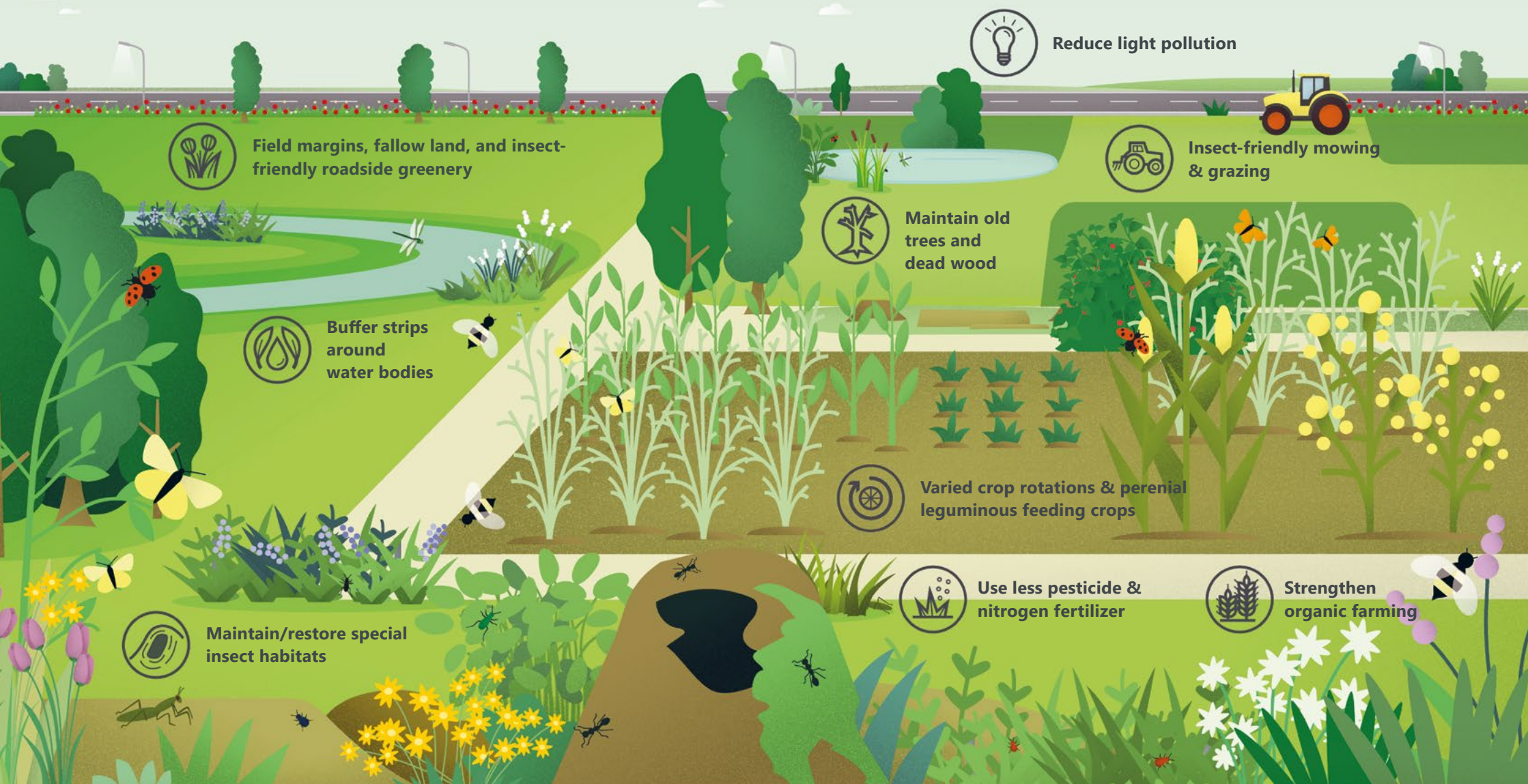
THE RESEARCHERS

Dr. Ioanna Mouratiadou works in the Working Group "Provisioning of Ecosystem Services in Agricultural Systems" at ZALF. Dr. Tommaso Stella conducts research in the Working Group "Integrated Crop System Analysis and Modelling".

INSECT PROTECTION

WHAT WE CAN DO TO MAKE INSECTS FEEL MORE AT HOME IN LANDSCAPES

Insects have a hard time in our agricultural and cultural landscape. Their number and diversity have been declining for decades. For this reason ZALF is working together with other partners from science and agriculture on an insect protection program for Brandenburg. On behalf of the Brandenburg Ministry of Agriculture, Environment and Climate Protection of the State of Brandenburg, a catalogue of measures for the protection of their habitats is being developed for an entire federal state by representatives from science, agriculture, nature conservation and politics.



THE CITY PARK AS AN ECOSYSTEM

Every day we humans change the image of our environment. This influence is particularly intense in urban areas. Here, emissions and the degree of soil sealing by building development are particularly high. In a study conducted in Berlin, ZALF researchers are investigating how urbanization affects important ecosystem functions of green spaces in our cities.

When Gabriela Onandia walks through the capital, she sees the city through the eyes of a biologist. What she sees are habitats shaped by traffic, buildings, streets and artificially created green spaces. She sees ecosystems being shaped and intensively used by humans, which can nevertheless be surprisingly diverse. Gardens and parks, forest clearings and even cemeteries – these are the kinds of grassland areas that Onandia's research looks at more closely – and for that she has to identify and measure herbs as well as grasses.

"Grassland areas are an important part of the city, but their ecosystem functions are not very well researched", explains the scientist. In a study conducted by the BMBF-funded research project „BIBS", she and her team are investigating what these ecological systems look like and how they function in the city, which biotic communities they characterize and which ecosystem services – such as the binding of carbon dioxide and the regulation of the water balance – they provide for people.

"Urbanization is rapidly changing natural ecosystems around the world", says Gabriela Onandia. The results of her study provide new insights into whether the functions of ecosystems in the city are changing, how they respond to rapid change, and how they can be protected better. The researchers' statements are also interesting for urban planning – after all, urban green space is used intensively for leisure and recreation, while at the same time influencing groundwater and air quality as well as the climate in the city.

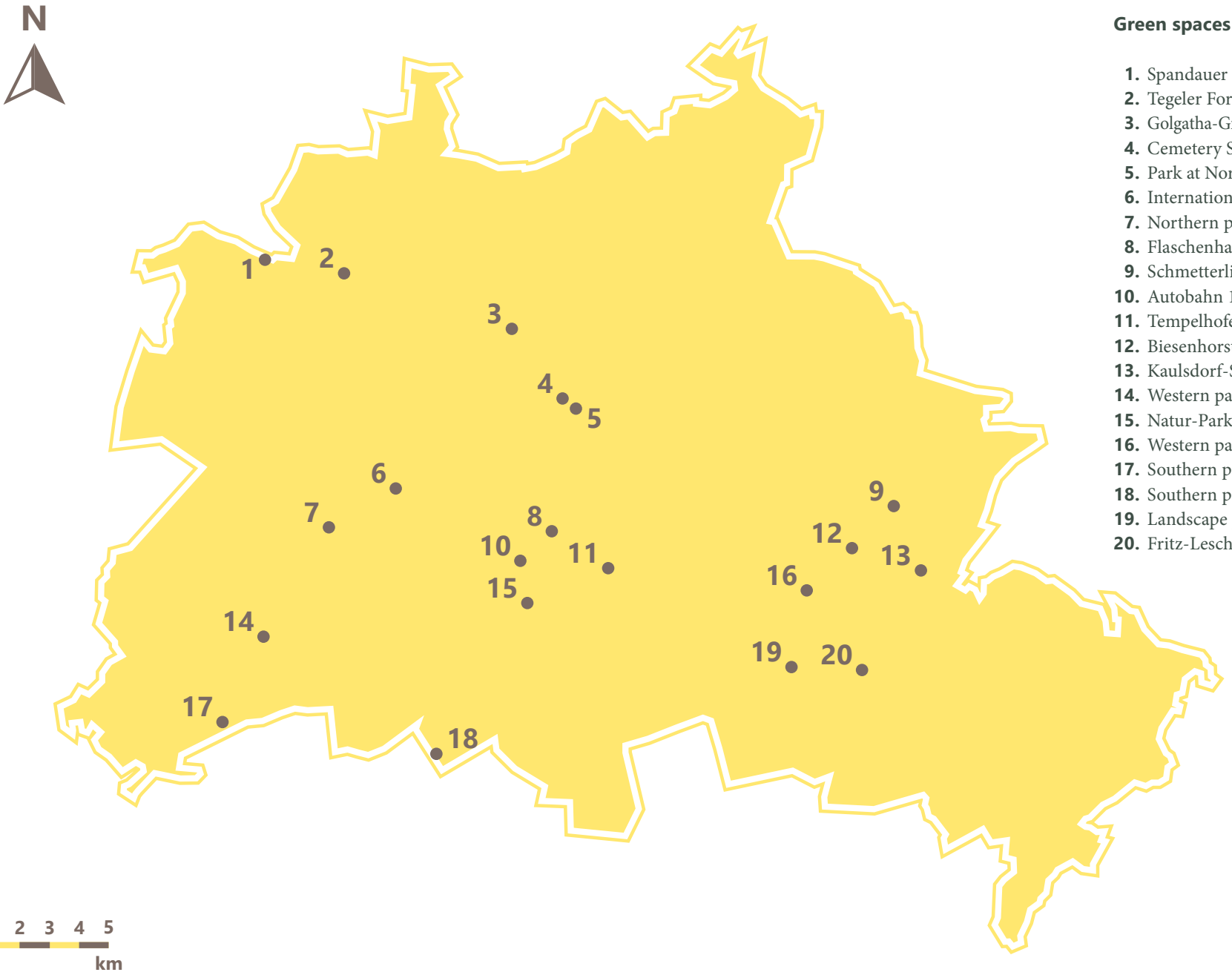
HIGH BIODIVERSITY, MORE STABLE ECOSYSTEMS

In a field study, Gabriela Onandia examined the water balance, the nitrogen cycle, the biomass and the species composition at 20 selected locations in Berlin – including the Tempelhof Field, the Johannisthal Landscape Park in Adlershof or the St. Hedwig Cemetery in Reinickendorf. In doing so, she discovered a striking number of plants that are not native to the region. Experts refer to these immigrant species as "neophytes", some of which have been spreading in their new home for many decades. Canadian goldenrod, hoary alyssum or Canadian horseweed seem to feel particularly comfortable in the urban environment. About one third of the perennial species included in the study were non-native. Previous studies suggest neophytes can alter important ecosystem functions, which makes them particularly interesting for ecological research. One explanation for why neophytes are so successful in urban grassland could be that they find a greater variety of habitats in urban areas than in the rural agricultural landscapes, which are more likely to be cleared. .

The researchers were also able to demonstrate another connection, already known from habitats that are little influenced by humans, in Berlin's urban grassland ecosystems: The greater the biodiversity, i.e. the more plant species that occur in a given area, the greater the above-ground biomass. This is an important parameter for ecologists, as it allows statements to be made about important ecosystem functions.

"Different species use different resources", is how Gabriela Onandia explains the positive correlation. For example, while one species only develops shallow roots and primarily uses nutrients and water from the upper soil layers, the neighboring species roots deep into the soil and thus uses other sources of nutrients. "Depending on local conditions, higher biodiversity can thus contribute to the stability of the ecosystem, as some plant species survive better than others, for example during longer periods of drought or heat", adds Prof. Gunnar Lischeid, who heads the ZALF working group in which Gabriela Onandia is doing her research.

The researchers take samples on a grassland area.



Green spaces surveyed in Berlin

1. Spandauer Forst
2. Tegeler Forst
3. Golgatha-Gnaden & Johannes-Evangelist-Cemetery
4. Cemetery St. Hedwig
5. Park at Nordbahnhof
6. Internationales Congress Center ICC Berlin
7. Northern parts of Grunewald
8. Flaschenhalspark
9. Schmetterlingswiesen
10. Autobahn 103 at Schöneberg
11. Tempelhofer Feld
12. Biesenhorster Sand
13. Kaulsdorf-Süd Mahlsdorf-Süd Forst
14. Western parts of Grunewald
15. Natur-Park Schöneberger Südgelände
16. Western parts of Volkspark Wuhlheide
17. Southern parts of Grunewald
18. Southern parts of Lichterfelde
19. Landscape park Johannisthal / Adlershof
20. Fritz-Lesch sports field

NEW ENVIRONMENTAL CONDITIONS AFFECT ECOSYSTEM FUNCTIONS

Life in the city is characterized by numerous influences that do not exist outside of large settlements and traffic routes: Large buildings shade areas for long periods of the day, increasing traffic pollutes the air quality with high emissions, more and more surfaces are sealed with asphalt and are thus impermeable to water. Such city-related, comparatively new environmental factors significantly influence the water and nutrient cycle of grassland areas, the study's data show.

The researchers determined the water-use efficiency of the plants, which increases under drought stress, and the nitrogen utilization, which allows conclusions to be drawn about the nutrient cycle. "We were able to show that the differences in ecosystem functions observed between the sample areas can be explained primarily by these new urban environmental factors", says Gabriela Onandia. Plant communities in the vicinity of particularly densely populated residential areas, for example, were strongly influenced by emissions from households and traffic. Car exhaust fumes and dog excrement have led to an excess supply of nitrogen. This changes the use and recycling of nutrients in comparison to plant communities in more remote areas.

"Urban habitats often have a very high biodiversity, even on areas which look very unspectacular and untidy for the layman", adds Lischeid. However,

It is important to recognize the value of urban green spaces and to preserve them.

DR. GABRIELA ONANDIA

too much tidyness is often at the expense of biodiversity. "On the other hand, the ill-considered or well-intentioned enrichment of local biodiversity, for example through the release of alien species, wild disposal of garden waste and animal droppings, has fatal effects on the flora and fauna, which are already under stress in urban areas with their many and varied burdens."

The investigations provide initial insights into the ecology of the big city, which is subject to its own specific living conditions. "Today, many landscapes around the world are being urbanized", says Gabriela Onandia. "It is important to recognize the value of urban green spaces and to preserve them. We all have a role to play here."

THE SCIENTIST

Dr. Gabriela Onandia works at ZALF in the Working Group "Dimensionality Assessment and Reduction" in the Data Analysis and Simulation Research Platform.

INSECT PROTECTION

When insects are suffering, so is the environment.

Dr. Weißhuhn, you are currently developing a program of measures to better protect insects. What is special about this initiative?

Insect mortality has been a topic of discussion in society and politics for a long time. Last year, in Brandenburg two public initiatives to protect insects were launched - one by farmers and the other by conservationists.. Together with the State Ministry of the Environment, the founders of the initiatives, land users, scientists and other stakeholders, we want to pool the existing knowledge on insect mortality and develop strategies to combat it. In working groups and workshops, we bring together many people with quite different expertise – from the maintainers of green spaces to beekeepers and farmers. The knowledge that amateur entomologists, for example, bring to the table is enormous. Around 70 people contributed on a voluntary basis in three different working groups. The first group looks at the agricultural sector, the second at other forms of land use such as forestry or urban green spaces, and the third examines the state of knowledge and identifies gaps in research. A scientific advisory board comprising nine researchers from ZALF and the Senckenberg German Entomological Institute (SDEI) examines the proposals which have been developed.

What have you achieved so far?

There is a collection of about 50 measures that we believe have great potential to reduce insect decline. Fact sheets have been preprared for each, telling about the ecological effectiveness, implementation challenges, and potential conflicts or synergies with other environmental goals.

What do these recommendations for action say?

In general, we must prevent the occurrence of phases in which all of the resources of the insect world are lost through „clear-cutting“ our fields and green spaces. The goal is a landscape that is once again more diverse in terms of structures and species. This can be ensured, for example, with hedges, dead wood and piles of stones or natural roadsides. A lot can be achieved with little money, and this also applies to green spaces. Urban greenery can be made more species-rich, mowed less and, for example, enhanced with dead wood. Gravel areas and soil sealing should be reduced. Another issue which has so far received too little attention is light pollution.

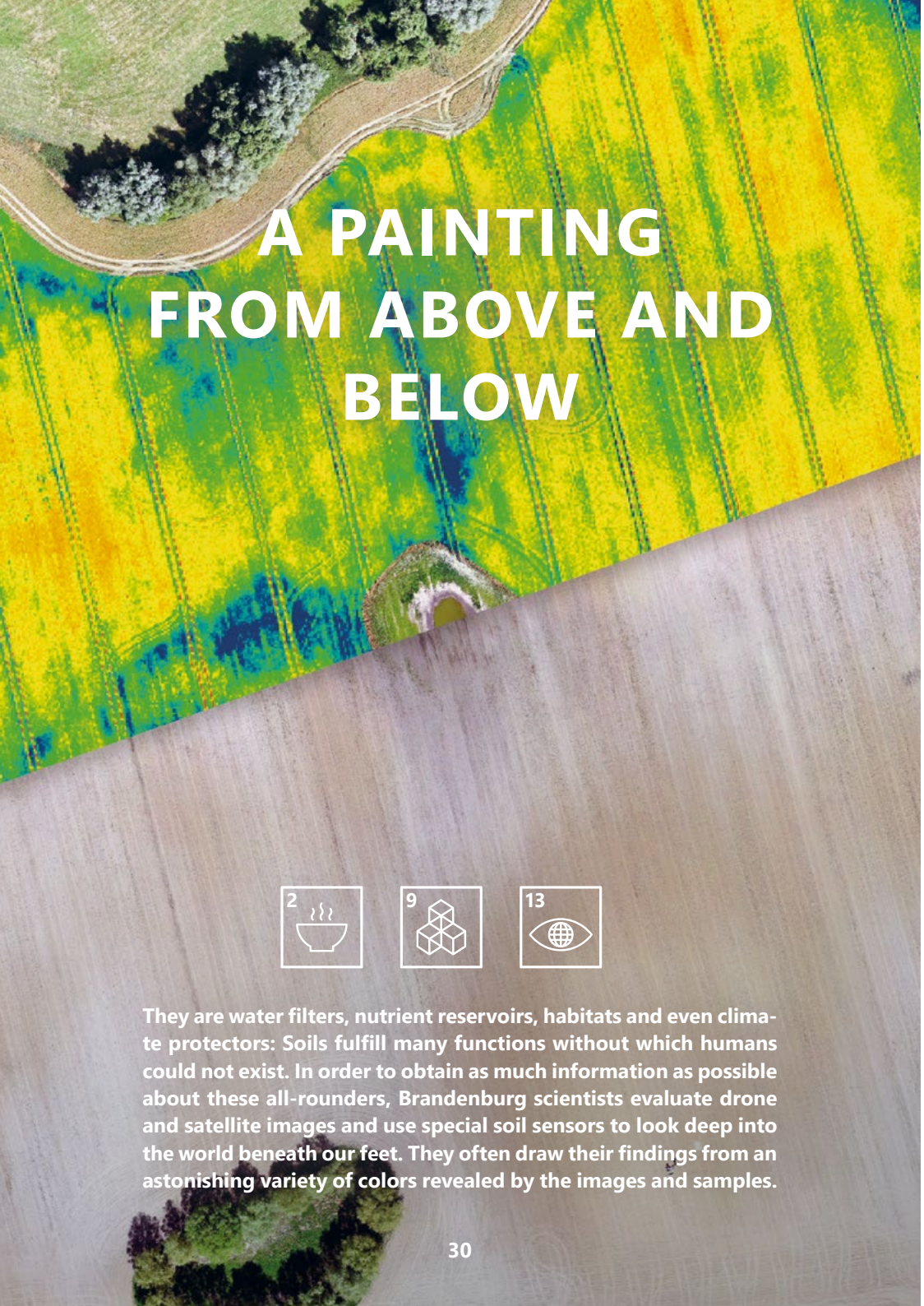
What will happen if we are not successful in better protecting the insect world?

Insects are a very strong indicator of the state of ecosystems. If this group of animals, which can occupy all sorts of niches, is having a hard time, so is the environment at a whole. Many other things that we take for granted are then at risk. Among birds, the number of insectivores has declined the most in recent decades. With the insect program, there is now a plan supported by many groups to tackle these challenges in Brandenburg.

The infographic on page 18 shows what we can do to make insects feel at home again in our landscape.

PETER WEISSHUHN

works in the Working Group “Impact Assessment of Land Use Changes”. ZALF coordinates the “Brandenburg Insect Protection Program”.



A PAINTING FROM ABOVE AND BELOW

They are water filters, nutrient reservoirs, habitats and even climate protectors: Soils fulfill many functions without which humans could not exist. In order to obtain as much information as possible about these all-rounders, Brandenburg scientists evaluate drone and satellite images and use special soil sensors to look deep into the world beneath our feet. They often draw their findings from an astonishing variety of colors revealed by the images and samples.

They could spring from an artist's palette: a bright ochre, a soft grey, a dark brown that almost merges into black. The aerial view of a field taken in the Uckermark in Brandenburg shows a rich spectrum of different colors. Prof. Michael Sommer and Dr. Martin Leue can already identify an important soil property from these colors alone. "The darker the soil, the more carbon is bound by the iron oxides and clay minerals it contains", explains Sommer, the pedologist.

Sommer and Leue have been fascinated by this color spectrum for many years. The carbon comes from dead plants and their roots, which are taken up, digested, and converted by micro-organisms and other soil organisms. Only a small part of it finally binds itself firmly to the soil particles and thus forms humus. This humus is a reservoir of water and nutrients and thus a guarantee for soil fertility. At the Leibniz Centre for Agricultural Landscape Research (ZALF), Sommer and his colleagues have spent many years researching how erosion by wind and water influences the distribution of carbon and other soil properties and components in the landscape.

The variety of colors found on the surface of the earth is also reflected in its depths. This is shown by drill cores the researchers take within the farmland. They find consistently dark-colored soils in dips where the fertile, humus-rich soil is deposited, which the wind and rain and also the plow have removed from the neighboring hilltops and slopes. On the hilltops, the cores show only thin layers of grayish-brown, less fertile topsoil. Underneath it is light gray and hard. The plant roots do not reach deep into the soil here. "This diversity of differently eroded soils in a very small area and thereby also the different growing conditions for plants is typical for large parts of the landscapes used for agriculture", explains Michael Sommer.

SOILS AS DYNAMIC CARBON RESERVOIRS

In terms of carbon, Sommer divides the soils into two categories: "Either they are in equilibrium with current environmental conditions or they are out of balance", he explains. Equilibrium means that over several years a soil absorbs as much carbon as it releases as CO_2. In this case, the amount of humus does not change and the soil behaves in a "carbon neutral" way.

However, such soils are rare in agriculturally used landscapes. Many soils affected by erosion are "unsaturated" in terms of carbon. Actually, they are still able to bind carbon until their equilibrium is reached and could thus reduce the CO_2 content in the atmosphere. Leue and Sommer are therefore

Prof. Dr. Michael Sommer (left) is head of Research Area 1 "Landscape Functioning" at ZALF as well as the Working Group "Landscape Pedology", in which Dr. Martin Leue (right) is also a researcher. In the middle, six cores are shown, which illustrate the variety of soils on a single field with soil erosion.

convinced that these soils have great storage potential.

Even soils that have not been eroded can still bind additional carbon. This potential could be exploited using a system of soil cultivation that was developed in the 1960s and is almost forgotten today. "Fractional deep tillage" is the name of the method which, instead of plowing only 25 cm deep, as is usually the case, involves plowing 50-centimeter-deep and 10-centimeter-wide stripes at 70 centimeter intervals. Fertile topsoil is thus brought into the subsoil, which significantly promotes plant growth. At the same time, low-carbon subsoil is mixed into the topsoil, allowing it to bind new carbon. "After five to ten years, the humus content of the topsoil is back to the level it was before the fractional deep tillage", explains Michael Sommer. "The carbon stocks in the soils thus increase overall – and that is good for the climate and for soil fertility." The Federal Ministry of Food and Agriculture (BMEL) is extremely interested in the method and is financing a project on the subject at ZALF until 2022.

THE EARTH'S THREE-DIMENSIONAL SKIN

Now it is all about identifying the exact location and storage potential of such soils as quickly and efficiently as possible. How much carbon a soil can actually absorb depends on many factors. Iron oxides and clay minerals are of particular importance here. The researchers indirectly determine these with the helpof special soil sensor technology optimized at ZALF, which includes optical methods as well as infrared and X-ray fluorescence spectroscopy. "We only need 30 minutes to measure a core, which is incredibly fast", says Martin Leue. "This enables us to analyze many cores relatively cheaply in a short period of time, and we can also examine larger sections of landscape at high resolution."

In the next step, the researchers are bridging the gap to Agriculture 4.0 and combining the data obtained with information from modern, drone and satellite-based remote sensing. The result is spatially high-resolution, three-dimensional soil information. They show where there are particularly fertile or heavily eroded areas in the field in detail. Using mathematical models, the researchers also want to create a three-dimensional digital image of the arable soils in the future in order to be able to exploit the carbon storage potential even more effectively and further increase soil fertility in a targeted manner. "This type of soil landscape modelling is the future, and we are just beginning to enter this uncharted territory", Sommer explains enthusiastically.

However, digitalization alone is not enough: At the same time, the researchers' expert knowledge of pedology needs to be linked with the comprehensive experience of local agricultural practice. Many a farmer is astonished at first glance by the colorful pictures of his fields. Many years of experience, for example about "problem areas" in the field, are quickly confirmed, which can be supported by the soil information. "This builds trust, also for us to then be able to test innovations together, such as deep tillage and other adaptation strategies", says Sommer, looking to the future.

querFELDein

In November 2019, the Leibniz association's new online blog »querFELDein« was launched. Initiated and coordinated by ZALF, seven research institutions are currently communicating comprehensive facts, news and ideas about the agriculture of the future on www.quer-feld-ein.blog. What do sustainable farming systems look like? Is our consumer behaviour still in keeping with the times? What does digital progress do in the field, what can organic farming contribute? So far the blog only offers its articles in German.

LEIBNIZ-INSTITUTE FOR FRESHWATER ECOLOGY AND INLAND FISHERIES (IGB)

INSECT MORTALITY DUE TO LIGHT POLLUTION!?

Climate change, pesticides and land use changes alone cannot fully explain the decline in insect communities in Germany. A clear task for the light pollution researchers at the IGB: They have found that regions which are experiencing a sharp decline in flying insects also suffer from high levels of light pollution.

EBERSWALDE UNIVERSITY FOR SUSTAINABLE DEVELOPMENT (HNEE)

TREES AGAINST DROUGHT: ACCEPTANCE STUDY

Agroforestry systems provide protection for more sustainable land use in drier climates such as Central Asia, but farmers are very skeptical about trees on their fields. Why is this? A study by HNEE in Kyrgyzstan is looking for answers.

LEIBNIZ CENTRE FOR AGRICULTURAL LANDSCAPE RESEARCH (ZALF)

WORKING TOGETHER

Where does our food come from? More and more consumers are asking this question in the light of food scandals, environmental damage, and climate change. Some of them are turning to new models of food supply in search of an alternative to the agricultural industry. ZALF researchers investigated these networks, which could also be a remedy for the increasing divide between agriculture and society.

GERMAN INSTITUTE OF HUMAN NUTRITION POTSDAM-REHBRÜCKE (DIFE)

AN INTERVIEW WITH PROF. SUSANNE KLAUS: WHAT IS THE IMPORTANCE OF PROTEINS FOR OUR HEALTH?

Proteins are made up of chains of amino acids, most of which our body cannot produce itself and which therefore have to be supplied through food. Proteins are therefore essential for life. We spoke about their important role for our health with Prof. Susanne Klaus, Head of the Department of „Physiology of Energy Metabolism" at the German Institute of Human Nutrition Potsdam-Rehbruecke (DIfE).

Read on and join the discussion on:

www.quer-feld-ein.blog

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Leibniz Association

Mission of the Leibniz Centre for Agricultural Landscape Research (ZALF) is to deliver solutions for an economically, environmentally and socially sustainable agriculture – together with society.

As a contribution to overcoming global challenges such as climate change, food security, biodiversity conservation and resource scarcity, we develop and design crop systems, integrated in their landscape contexts, that combine food security with sustainability.

The work of the research centre orients itself along three dimensions:

LANDSCAPE FUNCTIONING
How do agricultural landscapes function?

LAND USE AND GOVERNANCE
How can we sustainably develop and shape intensively used agricultural landscapes?

AGRICULTURAL LANDSCAPE SYSTEMS
What will future agricultural landscapes look like?

A novel research infrastructure provides the necessary interdisciplinary excellence:

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