ANNUAL RESEARCH REPORT 2021

One year of freshwater research

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Biodiversity
Habitats for freshwater species are diminishing

Environmental change
Water scarcity poses challenges for cities

Ecosystem services
Mining and industry put rivers under pressure

IGB
Leibniz Institute of Freshwater Ecology and Inland Fisheries

PHOTO: SOLVIN ZANKL

- Angling
- Aquaculture and aquaponics
- Biodiversity
- Dialogue and transfer
- Genetics and evolution
- Freshwater ecosystems
- Use and management
- Multiple stressors and pollutants
- Environmental change
- Behavioural ecology and swarm intelligence
- Water and matter cycles

Research for the future of our freshwaters

IGB is the largest German and one of the leading international centres for freshwater research. Our vision is to understand aquatic systems in all their complexity and to use this research knowledge to support the sustainable management of water-based resources and ecosystems. We think: scientific findings gained through excellent research provide a basis for wise decisions. A better understanding of freshwaters and all their ecological aspects supports policy-makers and society in coping with global challenges and in managing and conserving water bodies for the benefit of people and nature.

On the following pages we present selected research findings and activities from 2021. They are allocated to different topics, each of it contains all kinds of interesting information that we have compiled for you. For each topic, you will find further information, materials, experts as well as background information and the latest news on our website.

Have many aha moments while reading and discovering!

Dear Reader

PHOTO: DAVID AUSSERHOFER/IGB

Excellence and relevance are what IGB stands for. These terms reflect two basic observations: First, to be genuinely (and not only seemingly) relevant, scientific research must be of the highest quality. Second, it is important to think about the implications of our work and to communicate about it, even if applications may not be immediately apparent or may be rather complicated to explain. Curiosity-driven science is key to our development as a society. It keeps us alert to unforeseen ramifications and unexpected mechanisms and feedbacks, and precisely because of this, often helps us to solve application-oriented questions at a later stage. One guideline for relevance are the UN Sustainable Development Goals. These multidimensional goals organise the great challenges and opportunities we face as societies, besides making us think about the trade-offs that often hamper their realisation.

In our strive to combine excellence and relevance, IGB is moving towards organising its work and communication along new programme areas that deal with questions such as how to better protect aquatic biodiversity or how to use and manage water-based ecosystems and resources more sustainably in the Anthropocene. On the following pages, we outline some of our results that are central to IGB. They show key scientific insights that we have gained into how natural systems function and how they respond to stressors and management. The results also illustrate how important these insights and activities are to achieving the goals of sustainability.

All of this would not have been possible without the fruitful collaboration with many partners and stakeholders that supported and inspired our research, teaching and transfer activities. IGB faces ongoing progress and strategic transformation. Thank you for contributing to these developments and for supporting our work!

Yours

Luc De Meester
Director

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Good news

HR Excellence in Research Award

The "HR Excellence in Research Award" has been conferred on us by the European Commission once again in recognition of our HR development strategy. Every three years, the Institute is assessed according to the EU's HRS4R standard: Have the working and research conditions for our staff been improved? And are the further steps that we have planned for the next three years targeted and ambitious enough? The reviewers found: yes! For the next three years, we have set ourselves the goals of further improving equal opportunities, optimising our onboarding processes, enabling more hybrid working, intensifying communication within the Institute, and offering our junior researchers targeted career advice.

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➔ www.igb-berlin.de/en/news/hr-excellence-research-award

PHOTO: BIRGIT MÜLLER

Natural self-purification

Many pharmaceuticals or industrial chemicals are a major challenge even for modern wastewater treatment technology, and so these trace organic compounds and their transformation products end up in water bodies with the treated wastewater effluent. There, they affect aquatic organisms, alter ecosystems and threaten the quality of drinking water resources. However, trace organic compounds are also degraded, especially in the riverbed, where stream water and groundwater mix. The so-called hyporheic zone is very important for the biogeochemical turnover in water bodies. IGB researchers found that the concentration of trace organic compounds decreases more significantly in the hyporheic zone than in surface water. The more hyporheic exchange, the better. A near-natural riverbed as well as structures made of woody debris or large stones promote this process and help to reduce the load of trace organic compounds.

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Evolution of the sexes

Researchers have been studying the evolution of sex chromosomes for about 100 years. Yet many aspects of sex development in vertebrates remain a mystery. No wonder – the methods of reproduction are incredibly diverse, and some can only now be detected thanks to novel molecular genomic methods. Researchers led by Matthias Stöck from IGB and Lukáš Kratochvíl from the Czech Faculty of Science of the Charles University in Prague, together with an international team of experts, have summarised the knowledge and published it in two special issues of the Philosophical Transactions of the Royal Society B journal. The result is a unique scientific overview, including many open access papers.

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➔ www.igb-berlin.de/en/news/evolution-sexes

Knowledge of fisheries

Current studies and research findings on the topics of commercial and recreational fisheries, aquaculture, stock management and species conservation in inland, coastal and marine ecosystems are featured in the new fisheries journal called the Zeitschrift für Fischerei (or FischZeit for short). All articles are peer-reviewed, written in German, and freely accessible online. The journal is published by the Division of Integrative Fisheries Management at Humboldt-Universität zu Berlin in cooperation with IGB. We wish you an interesting read!

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➔ www.igb-berlin.de/en/news/journal-fisheries-research


PHOTO: SEBASTIAN HENNIGS

The return of the sturgeon

After more than 30 years, adult specimens of the European sturgeon were sighted again in the Elbe and Dordogne rivers in 2021. They originate from the joint reintroduction programme of IGB and the French INRAE, which started more than a quarter of a century ago. In an interview, IGB researcher Jörn Geßner tells of obstacles and fortunate occurrences along the way. And he makes clear why sturgeon reintroduction into the North and Baltic Seas will continue to be difficult despite the past successes: plans to intensify the development of the Oder, and recently also the Elbe for inland navigation, are imposing an increasing threat to the habitat of these and many other species in our river ecosystems.

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➔ **Read the interview:** www.igb-berlin.de/en/news/sturgeon-returns


PHOTO: KAT AUSTEN

Birch trees remove microplastics

Microplastic-polluted soils could be remediated with the help of trees. As researchers from IGB have shown, birch trees absorb microplastics through their roots during the growth phase. For this purpose, the researchers in this interdisciplinary project led by Berlin-based art studio, Studio Austen, labelled microplastic beads (5-50 µm) with fluorescent dye and added them to the soil of potted trees. After five months, in collaboration with researchers at the GFZ Potsdam, they examined root samples using fluorescence and confocal laser scanning microscopy and found fluorescent microplastic in different sections and layers of the root system. The percentage of root sections containing microplastic particles ranged from 5 to 17 per cent in the experimental trees.

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www.igb-berlin.de/en/news/birch-trees-remove-microplastics-soil

Environmental awareness

In a longitudinal study with 1,000 respondents each from Germany, France, Norway and Sweden, researchers found out why we should not focus too closely on fish species when promoting water protection in Germany. Compared to people in the other European countries, Germans have little connection to fish. Which does not mean that they have no basic ecological values: they are simply more receptive to arguments regarding water quality or holistic biodiversity conservation.

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www.igb-berlin.de/en/news/fish-species-conservation

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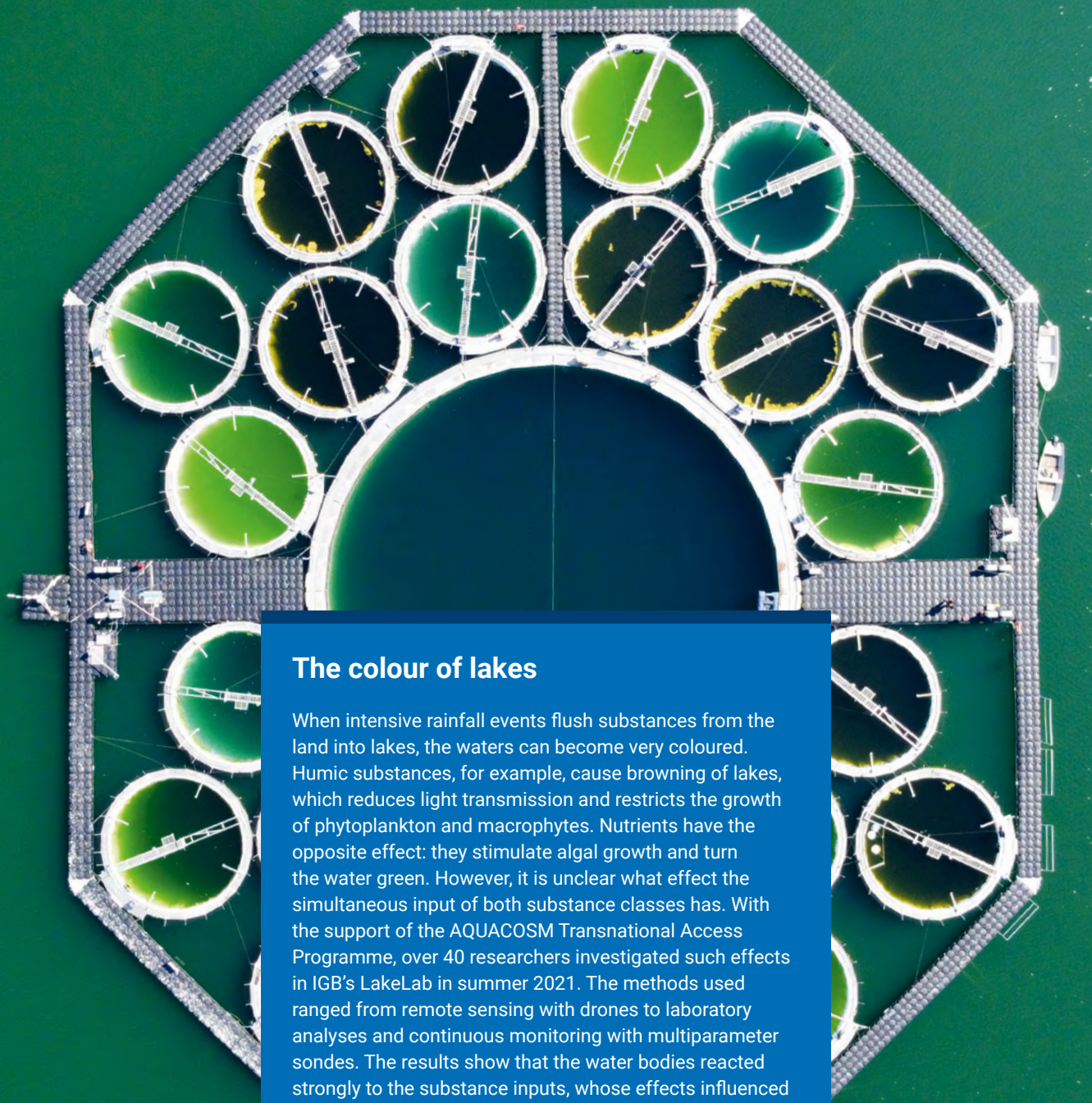
Outlook: 100 years of SIL

We are looking forward to hosting the 36th Congress of the International Society for Limnology (SIL) as a hybrid conference on the campus of Freie Universität Berlin from 7 to 10 August 2022!

www.sil2022.org

PHOTO: ANDREAS JECHOW/IGB



The colour of lakes

When intensive rainfall events flush substances from the land into lakes, the waters can become very coloured. Humic substances, for example, cause browning of lakes, which reduces light transmission and restricts the growth of phytoplankton and macrophytes. Nutrients have the opposite effect: they stimulate algal growth and turn the water green. However, it is unclear what effect the simultaneous input of both substance classes has. With the support of the AQUACOSM Transnational Access Programme, over 40 researchers investigated such effects in IGB's LakeLab in summer 2021. The methods used ranged from remote sensing with drones to laboratory analyses and continuous monitoring with multiparameter sondes. The results show that the water bodies reacted strongly to the substance inputs, whose effects influenced each other. Not only the composition and biomass of the phytoplankton were affected, but also its depth distribution. Realistic predictions of the effects of climate-induced heavy rainfall events must therefore take into account the interactions of all relevant factors.

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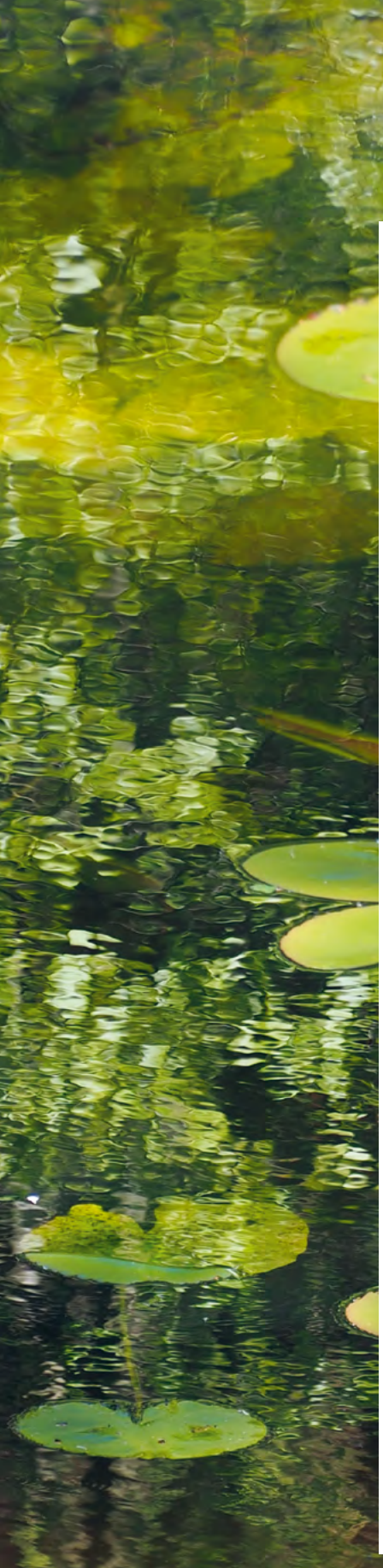

The small ones

Why ponds and kettle holes are also worth protecting

5 questions to 5 experts

Small bodies of water, i.e. natural ponds, kettle holes and pools, account for 30 to 50 per cent of the world's standing water. Owing to their size, however, the importance of small water bodies was long underestimated. As a result, they are scarcely mentioned in regulations and legal provisions. It is now known, however, that because of their abundance, heterogeneity, exceptional biodiversity and biogeochemical potency, small water bodies play an important role in catchments, landscapes, and possibly even on a continental scale that is completely out of proportion to their small size.

PHOTO: STEVEN KLEINSASSER ON UNSPLASH

PD DR THOMAS MEHNER

Mr Mehner, your newly launched EU project PONDERFUL is all about small freshwater ecosystems. This involves you taking a close look at an area in northeast Germany. How beneficial are kettle holes and pools not only there, but elsewhere, too?

In the lake-rich landscape of northeast Germany, small bodies of water such as kettle holes, pools, puddles and ponds are often overlooked or perceived as having little value. Yet this is not the case. After all, they are key to aquatic biodiversity, for example as stepping stone habitats for almost 70 per cent of the regional freshwater species in Europe. They create island-like connections between dispersed habitats, enabling animals to recolonise or repopulate habitats. In addition, these small water bodies play an important role in mitigating climate impacts and in climate adaptation. They provide a wide range of ecosystem services, including regulation of the carbon cycle, water supply, flood protection, groundwater recharge and local recreation. In our region, however, we have lost 70 to 80 per cent of kettle holes and puddles due to desiccation – partly as a result of recent summer droughts. It is not yet clear what impact this will have on biodiversity and ecosystem services.

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DR SABINE WOLLRAB

Ms Wollrab, you are involved in modelling the spatial distribution of species in the landscape. How important is it to have a network of small water bodies? Will we lose species and populations if there is a dramatic decrease in the number of small freshwaters?

Small water bodies such as kettle holes provide habitat for many species in northeast Germany, significantly increasing biodiversity in the landscape. The number of small water bodies and their distance from each other have a major impact on species diversity. The fewer water bodies exist and the greater the distance between them, the less probable it is that species will reach these water bodies. Water body density has a particularly large impact on species that are passively distributed, such as plankton organisms, or species with a short dispersal range. A loss of small water bodies due to desiccation or other factors therefore always results in a loss of important habitat. Since we must assume that small water bodies will dry out more frequently in the future or fall dry permanently in the wake of global warming, this will also have a negative impact on the number and abundance of species. In fact, our model analyses suggest that there are critical thresholds of habitat availability, which depend on the dispersal range of individual species. However, further research is needed to determine specific thresholds. Small water bodies are not only habitats for aquatic organisms, but also an important source of water for terrestrial animals. It is therefore very important to protect this habitat.

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DR MINA BIZIC

Ms Bizic, you have also conducted research into small water bodies in a northeast German agricultural landscape recently, using environmental RNA to investigate how the type of land use affects biotic communities in the water. What did you discover?

Our work, undertaken as part of the Bridging in Biodiversity Science (BIBS) project, involved using environmental DNA and RNA to obtain a holistic picture of biodiversity in the study area. Besides using deep sequencing of marker genes to follow the distribution of organisms – from bacteria to mammals – in small water bodies and their environments, we also extracted the identity and gene expression patterns of active communities from the RNA data. Contrasting the DNA results from pond water with that of the sediment taught us that, in the past, it mattered whether a small water body was surrounded by forest, grassland or arable land, whereas today, after decades of intensive land use, biodiversity is more or less homogeneous. The RNA work showed us that this homogeneous community continues to react to input from its environment, such as field fertilisation, at least for a while. So, although intensive agriculture has already changed the previous state of biodiversity in recent decades, communities continue to respond to land management. In order to prevent further degradation of biodiversity, therefore, it is essential that we understand the immediate effects of local agricultural practices on small water bodies. Environmental RNA provides a valuable set of tools for this task.

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DR CHRISTIAN WOLTER

Mr Wolter, in contrast to your colleagues, you have mainly been working on small urban water bodies – to be precise, Berlin's 400+ ponds, small lakes and ditches. What role do these systems play for the urban climate, local recreation and stormwater management? And what does this mean for future urban development?

Small urban water bodies are very diverse, ranging from well-maintained park ponds to virtually forgotten, fenced-in ponds. As such, some have a greater recreational use than others. Basically, water bodies always act as a magnet for walkers and people seeking recreation. Moreover, for many city dwellers, small urban water bodies are their first or even only encounter with nature. Inner-city small water bodies may not necessarily be hotspots of biodiversity, but they are very important places where residents can experience nature. And they have a positive effect on the urban climate – in combination with riparian vegetation, which may or may not be lush, they produce evaporative cooling, which reduces the local temperature. Water retention in the landscape is another key function of small water bodies that could be improved in Berlin. In many places, rainwater is discharged via the sewage system, and is then no longer available for freshwater systems. This is why many small water bodies in Berlin dried up completely or almost completely in the dry years from 2018 to 2020. Urban planning must therefore increasingly promote the removal of sealed surfaces in the catchment area, not only of small water bodies, as well as allowing roof drainage etc. to seep into the ground locally.

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PROFESSOR DR. HANS-PETER GROSSART

Mr Grossart, small water bodies are particularly affected by declining water levels due to sealing, drainage and drought. What happens when ponds intermittently run dry, and how resilient are they to weather extremes?

The United Nations predict that 1.1 billion more people will be living in urbanised areas in ten years from now. This will be accompanied by a sealing of the landscape and severe anthropogenic interferences with the hydrology of water bodies. This is problematic because small bodies of water in urban areas are already drying out more frequently as a result of higher temperatures and longer periods of drought. As BUND's Small Waterbody Report 2020/21 shows, 55.3 per cent of Berlin's water bodies have major deficiencies, for example because they are dry or very overgrown. Nearly 10 per cent of small water bodies were no longer recognisable as such. These dramatic figures show that many small water bodies are no longer just drying up temporarily, but are disappearing completely.

This is devastating for the biodiversity of these ecosystems, because population densities in urban habitats are generally often very low. Populations especially tied to these water bodies, e.g. amphibians, are much more endangered by local extinction events than populations in larger and better-connected water bodies. Thus, it is to be feared that species diversity will decline further. As water bodies dry out and species disappear from the urban landscape, ecosystem functions, such as cleaning water bodies, providing oxygen or remineralising carbon, also change. More frequent weather extremes put these important functions at even greater risk. Polluted, nutrient-rich waters produce significantly more of the harmful climate gases methane and carbon dioxide. These negative consequences must therefore be increasingly counteracted by taking sustainable measures, e.g. through better water retention in the landscape.

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> "As water bodies dry out and species disappear, ecosystem functions, such as cleaning water bodies, providing oxygen or remineralising carbon, also change."
>
> **Professor Dr Hans-Peter Grossart**

PHOTOS: DAVID AUSSERHOFER/IGB , LENA GIOVANAZZI (1)

Learn more:

- https://ponderful.eu
- www.urban-waters.org

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Rivers under pressure

Consequences of mining and industry

Contaminants from the extraction of fossil resources and industrial production pollute river systems all over the world. IGB scientists examine the sources and consequences of such pollution in studies and statements, one example being the River Spree: high levels of sulphate and trace organic compounds are problematic for the river and the ecosystems connected to it; they also pose a threat to the quality of drinking water in the metropolis of Berlin. The problem is likely to get worse, given that climate change will make the region, which already has some of the lowest rainfall in Germany, warmer and drier. With this in mind, IGB researchers also recommend a particularly careful approach and the guarantee of sustainable water management when large industrial projects are implemented, such as the electric car manufacturer Tesla in Grünheide.

Ever since the industrial age, human intervention in nature has posed environmental problems. The consequences of burning fossil fuels, such as acid rain, proved to be a cause for concern: large amounts of sulphur were released into the atmosphere. This led to sulphate contamination, which caused forest dieback and heavily polluted freshwater ecosystems. For this reason, power plants in North America and Europe were retrofitted with flue gas desulphurisation in the 1980s. In Germany, atmospheric sulphur inputs fell by 90 per cent.

Nevertheless, sulphate levels in freshwaters have changed little in recent decades, as highlighted by a study involving IGB researchers; in some regions, they have even increased. One such example is the Spree: in some sections of the river, sulphate concentrations exceed the drinking water limit of 250 milligrammes per litre at times. The River Spree is used as an indirect source of drinking water in Berlin, such as through bank filtration. Sulphate is not degraded during bank filtration and technical drinking water treatment. "This is why it is mixed, when necessary, with raw water from other well galeries to make sure that the limit is not exceeded," reported Jörg Lewandowski.

But what are the current causes of elevated sulphate levels in water? They result from various human activities: the drainage of wetlands, fertiliser leaching from agricultural soils, and agricultural and industrial wastewater all play a role. "Discharge from opencast mining is the most relevant cause in the Spree," stated Tobias Goldhammer. Lignite is still being mined in the catchment area of the river; on 15 per cent of the Spree's total length it flows through a groundwater drawdown funnel covering some 2,000 square kilometres, a relic of former opencast lignite mines south of the Spreewald. "Large quantities of sulphur are present in open tailings, which will continue to be oxidised slowly over the coming decades," the researcher remarked. This produces sulphate, which is leached and discharged into the Spree via groundwater discharge. Even after the cessation of lignite mining, sulphate will continue to be released into the Spree for decades.

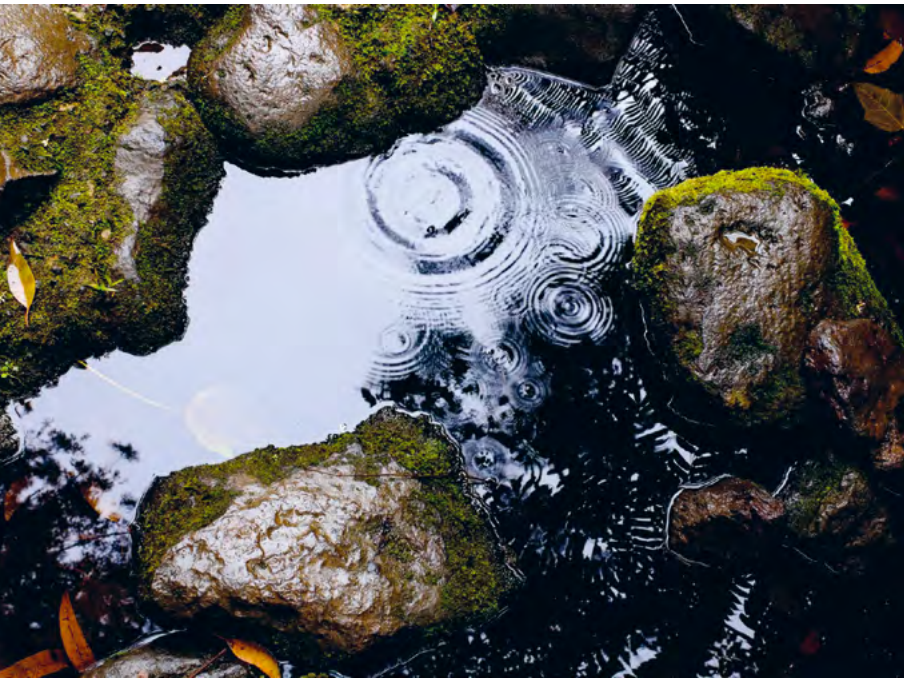
The River Spree at Spreewitz in the Lusatian lignite mining area: dissolved sulphate is not visible, but large quantities of barely soluble iron oxyhydroxides cause brownish-orange turbidity in river water.

PHOTO: TOBIAS GOLDHAMMER/IGB

SULPHATE RESIDUES IMPACT SEDIMENT CHEMISTRY

Sulphate not only impairs drinking water quality, it also affects the material cycles of carbon, nitrogen and phosphorus. Consequently, there is an increase in nutrient loads in water bodies, leading to an increase in plant and algal growth, which enhances the food supply for aquatic organisms. The result is a lack of oxygen in the water, which promotes the further release of phosphate from the sediment – a vicious cycle. Moreover, sulphate and its degradation products, especially sulphide, can have a toxic effect on aquatic life.

IGB scientists have also detected sulphate residues from opencast mining in sediments of the Spree, along with iron and trace metals such as nickel and cobalt – up to 90 kilometres downstream from the input source. "This can affect living organisms in the river," remarked doctoral candidate Giulia Kommana. While iron levels decrease along the flow course, sulphate can



Acid rain was a phenomenon of the 1980s. But even though atmospheric sulphur inputs have since decreased significantly, sulphate levels in freshwaters have changed little; in some regions, they have even increased. A sign that other pollution sources have gained in importance.

PHOTO: LUCA BRAVO ON UNSPLASH

be detected in bound form along the entire River Spree: "Under oxygen-deficient conditions, sulphate in the water can be converted to sulphide in the sediments, and precipitate as iron sulphide (FeS2). And since there continues to be a very large supply of sulphate in the water downstream to Berlin, this is precisely what happens," the junior scientist explained.

TESLA'S GIGAFACTORY AND THE RIVER SPREE

The Spree is likely to remain under increasing pressure in the future, as the new Tesla Gigafactory in Grünheide is located southeast of Berlin in the Spree catchment. Up to 500,000 electric cars are to be produced there annually with 12,000 employees, including associated battery production. Tesla has been promised 1.4 million cubic metres of water annually for its production. This equates to a more than 10 per cent increase in consumption across the region, i.e. a considerable amount for an area that is already short of water. In the first expansion stage, Tesla also plans to discharge 921,000 cubic metres of wastewater annually. Further expansion stages are planned, depending on how the market develops; one day, there may be as many as 40,000 staff working at the Gigafactory. "Much more wastewater will probably be discharged then, not only due to the presence of Tesla, but also because suppliers and numerous people will settle in the area," Jörg Lewandowski explained. It is not yet known where or how Tesla's wastewater will be treated in the future. The intention for the first 10 years is to discharge treated wastewater into the Erpe, a tributary of the Spree, via the Münchehofe wastewater treatment plant. After that, wastewater from the Gigafactory is to be purified via a new wastewater treatment plant. Freienbrink on the Müggelspree was originally earmarked as the site of the new plant, to be completed by end of 2029. But the Wasserverband Strausberg-Erkner, which was supposed to construct it, has withdrawn its tender. It is therefore not known where the factory's wastewater will be discharged in the long term, whether into the Müggelspree, the Oder-Spree-Canal or the Erpe.

Berlin's drinking water supply could also be compromised. After all, the Gigafactory will emit

problematic substances that cannot be eliminated (completely) in the wastewater treatment plant, and these substances will be discharged into the Spree and end up in the capital city regardless of the discharge points currently under discussion. As a result, the Lake Müggelsee and the surrounding bank filtration wells could be subject to prolonged elevated exposure. "From a water management perspective, the pretty much least favourable site was chosen," remarked Jörg Lewandowski.

TRACE ORGANIC COMPOUNDS ARE A THREAT TO ECOSYSTEMS

A scientific assessment of the Gigafactory, published by IGB in the summer of 2021, explains why the expected aquatic pollution focuses on trace organic compounds. These chemical compounds produced by humans are contained in products such as pharmaceuticals, detergents, pesticides, anti-corrosion agents, paints and lacquers, and they are often very persistent. Even low concentrations of some trace substances can have potentially negative impacts on ecosystems or human health. Many of these substances are water-soluble, and can only be broken down partially, or not at all, in wastewater treatment plants. As a result, they are discharged into freshwater ecosystems via wastewater treatment plants, as well as via other sources such as rainwater runoff. From as early as 2009, when IGB started its research on this topic at the River Erpe, it has measured considerable levels of contamination of the surface water with trace organic compounds in the River Erpe, the river into which the Münchehofe wastewater treatment plant effluents are discharged. Even now, trace organic compounds from the Erpe can be detected in drinking water wells of Berliner Wasserbetriebe. The new wastewater treatment plant, the construction of which is uncertain as yet, could be equipped with a fourth treatment stage, which would largely remove most trace organic compounds. But even then, it would not be possible to completely eliminate undesirable water constituents.

It is thought that Tesla's wastewater discharge will contain different chemicals. Exactly which chemicals are involved has not been disclosed to the public. "The accessible official documents were blacked out in many places, citing trade secrecy," stated Jörg Lewandowski. It is therefore difficult for scientists to assess how problematic the effluents will be. What is known, however, gives cause for concern: benzotriazole, an anti-corrosion and anti-freeze agents are reportedly used, for example. Benzotriazole is a persistent trace organic compound that accumulates in the environment and has toxic effects on aquatic organisms such as fish and crustaceans. "Although there are no limit values for such substances, the precautionary principle should generally apply, i.e. the idea of keeping everything out of the water that does not belong in it," emphasised Jörg Lewandowski. Tesla will also have an impact on sulphate contamination. The company has applied for the discharge of sulphate via wastewater, which is likely to further increase sulphate levels in the River Spree and the Lake Müggelsee. According to IGB' scientific assessment, the extent to which the Tesla factory contaminates the Spree with its wastewater discharges will depend primarily on the substances used in the production process, the purification technology in the Gigafactory's in-house wastewater treatment plant, and the equipment of the municipal wastewater treatment plant, which is yet to be built. The most sensible thing would be to avoid emissions to the greatest extent possible. This could be achieved, for example, by imposing more stringent conditions that require the company to recycle more water. "Besides lowering the demand for water, less contaminated water would be discharged. But of course, such measures cost money," remarked Jörg Lewandowski.

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Learn more on www.igb-berlin.de/en:

- Acid rain is yesterday's news?
- The long arm of opencast mining
- The Berlin-Brandenburg region and the Tesla Gigafactory

Zak et al. (2021). Sulphate in freshwater ecosystems: a review of sources, biogeochemical cycles, ecotoxicological effects and bioremediation. Earth-Science Reviews, 212, Article 103446. https://doi.org/10.1016/j.earscirev.2020.103446

Secrets of an impressive fish

The South American arapaima (*Arapaima gigas*) is one of the largest freshwater fish. This extremely fast-growing species attracts great interest by aquaculture. However, the challenge of rearing and reproducing this primeval lung breather – one of the many megafauna species that are endangered in the wild – is great for scientists as well as sustainable aquaculturists. This is why several groups at IGB are exploring this extraordinary species: as part of international collaborative efforts, IGB researchers contributed to the sequencing of the genome and a molecular marker that enables the sex to be determined using DNA markers in the laboratory, an otherwise difficult approach. In a bid to optimise husbandry and reproduction, another team is using artificial intelligence to investigate the behaviour of adult and juvenile animals. In IGB's aquarium hall, controlled reproduction is currently examined. The commercial cooperation partner is the regional aquaculture company Manich Food Innovations, which specialises in farming this species.

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PHOTO: DAVID AUSSERHOFER/IGB

Insect decline due to excessive artificial light

The number and diversity of insects are in massive decline globally. In addition to the loss of these organisms, we may also lose important services they provide to ensure intact ecosystems. There are many causes of insect decline: the intensive use of pesticides, the dramatic decline in flowering plants, but also light pollution in and around settlements. Even aquatic insects are affected by excessive artificial light, as researchers have discovered. Several projects on this topic are currently underway at IGB: in AuBe and NaturLicht, for example, scientists are investigating which insects are attracted to which light source. In BELLVUE, researchers are working on the standardisation of light measurements in an effort to ensure more effective planning of lighting systems and better nature conservation. A review led by IGB shows which other questions are relevant to the impact of light pollution. It also provides a summary of the gaps in knowledge that need to be addressed, as well as an overview of the opportunities available and the challenges involved in achieving a more sustainable use of light.

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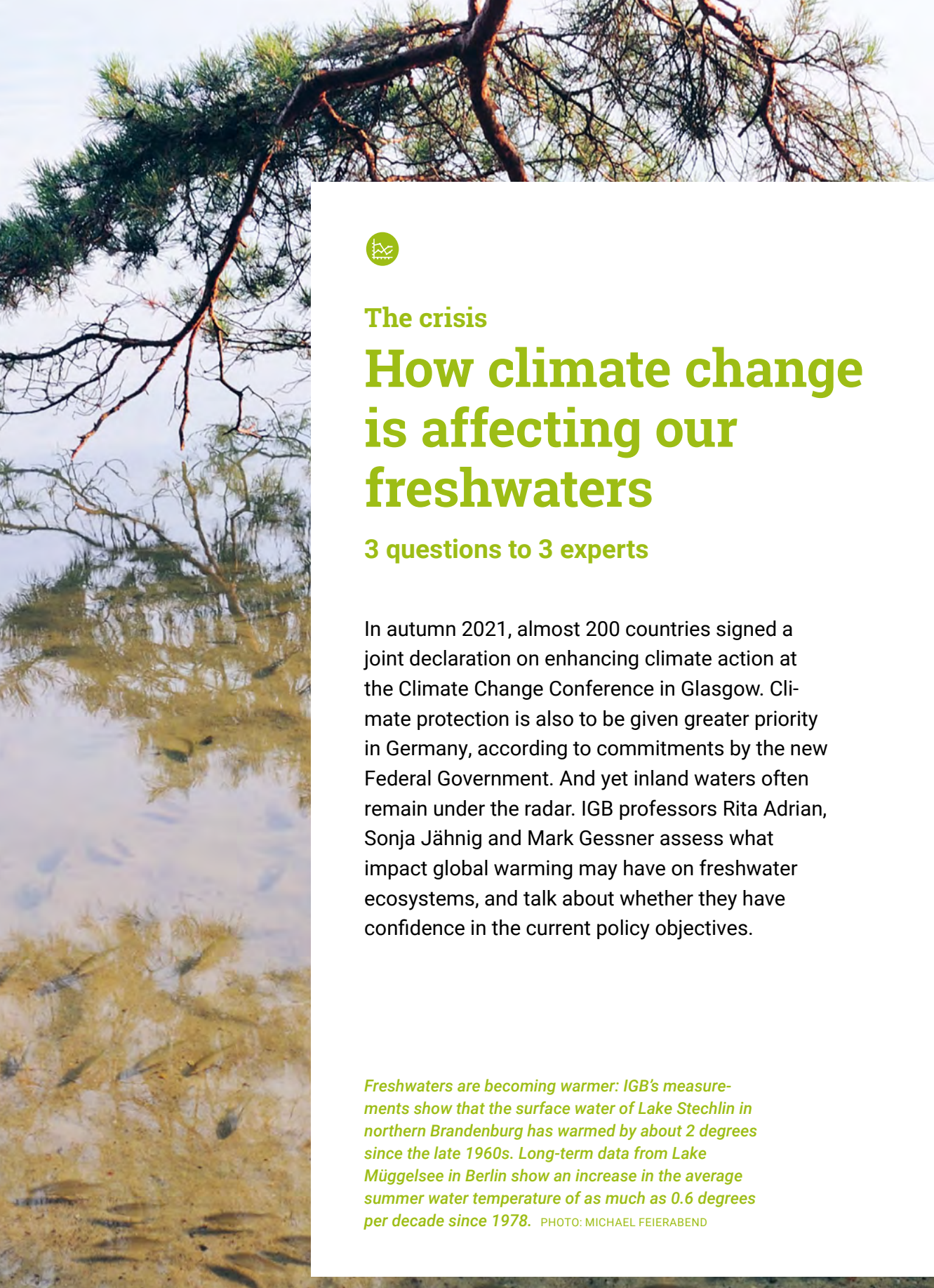
➔ www.igb-berlin.de/en/news/aquatic-insects-are-sensitive-light-pollution
➔ www.igb-berlin.de/en/news/snowglow-and-leafy-trees-winter

PHOTO: GREGOR KALINKAT/IGB



The crisis

How climate change is affecting our freshwaters

3 questions to 3 experts

In autumn 2021, almost 200 countries signed a joint declaration on enhancing climate action at the Climate Change Conference in Glasgow. Climate protection is also to be given greater priority in Germany, according to commitments by the new Federal Government. And yet inland waters often remain under the radar. IGB professors Rita Adrian, Sonja Jähnig and Mark Gessner assess what impact global warming may have on freshwater ecosystems, and talk about whether they have confidence in the current policy objectives.

Freshwaters are becoming warmer: IGB's measurements show that the surface water of Lake Stechlin in northern Brandenburg has warmed by about 2 degrees since the late 1960s. Long-term data from Lake Müggelsee in Berlin show an increase in the average summer water temperature of as much as 0.6 degrees per decade since 1978. PHOTO: MICHAEL FEIERABEND

PROFESSOR DR RITA ADRIAN

Ms Adrian, as a lead author of the IPCC Report, you are able to closely follow both the scientific and political discussions. What role do freshwaters play in the current debate?

Inland waters are rarely explicitly mentioned, and are typically assigned to land in global considerations. This was also the case at the COP26 conference. Of course, the diversity of all ecosystems cannot be taken into account in detail. However, explicitly considering inland waters – as major sources of freshwater and food and as ecosystems suffering from dramatic losses in biodiversity in the context of global warming – has been accomplished in the 2022 IPCC report. The average global temperature of lakes, has risen by more than 1 degree Celsius in the last few decades. This trend could increase to as much as 3 to 6 degrees under different climate scenarios. The consequences are grave: lakes loose oxygen, in nutrient-rich lakes, there is a greater risk of algal blooms, and in nutrient-poor lakes, the algal biomass is likely to decrease, which would have a negative effect on fish yield. Lakes lose their recreational value when the water quality deteriorates or the ice cover diminishes. But it is not only a question of quality but also of quantity: entire regions are affected by water shortages and declining groundwater levels. In other words, the societal relevance of freshwaters is enormous. Irrespective of this, freshwater ecosystems and freshwater biodiversity have an inherent value, which deserves protection.

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PROFESSOR DR SONJA JÄHNIG

Ms Jähnig, the biodiversity crisis is overshadowed by the climate crisis. Are these two environmental crises still considered in isolation? And how do they affect each other?

The two crises are indeed closely linked – but this is often neglected. This link is mentioned only once briefly in the outcome document of the COP26 conference. Habitats are lost due to climate change, for example, because water bodies temporarily dry up. This is the case for about half of all watercourses worldwide. And this trend will continue. In freshwaters, animals that only tolerate a narrow temperature range are forced to move to other regions, which is not always possible. Of course, the deterioration of water quality mentioned by Rita Adrian also plays a role. In addition, climate change may lead to the spread of invasive species that compete with their native counterparts or harm other species through predation or disease transmission. Climate protection and biodiversity conservation should go hand in hand. Rivers that are given more space, for example, significantly contribute to flood protection and at the same time support species-rich and diverse habitats. This is because refuges such as backwaters, pools or root structures are created, which facilitate recolonisation after periods of strongly fluctuating water levels. Another issue that I feel very strongly about is resolving the conflict that is sometimes perceived between the goals of climate and biodiversity protection in hydropower development. Despite being a renewable energy source, hydropower is not environmentally friendly. Small hydropower plants, in particular, make a negligible contribution to the energy transition, but have a significant impact on the ecological status of water bodies and their biodiversity.

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PROFESSOR DR MARK GESSNER

The COP26 framework decision recognises "that the impacts of climate change will be much lower at a temperature increase of 1.5 °C compared with 2 °C," and resolves to "pursue efforts to limit warming to 1.5 °C." Mr Gessner, from the perspective of a limnologist: What impacts are to be expected from a 1.5 or 2 degrees warming?

The strong commitment to clearly limit warming is a good outcome of the conference. Now it is important to take effective measures to achieve this goal. But for freshwaters we need to recognise that the 1.5 or 2 degrees threshold cannot be directly applied. As Ms Adrian said, many lakes have already exceeded these marks. Moreover, at least three factors in addition to long-term warming trends require attention. The first one is the mixing regime. As models of our lake physicists show, warming will prevent stratification during the winter in some of our larger lakes, which will hence undergo complete mixing during the cold season, leading to a fundamental change in the character of these lakes. A temperature increase of 1.5 to 2 degrees in winter makes a big difference in this case. Oxygen conditions in deep water layers of lakes are also affected. This is the second important aspect. A prolonged stratification in summer results in increased oxygen consumption, whereas prolonged mixing during the winter – and that is the good news – improves re-aeration of the lake water. This is important because the negative impacts on fish and other aquatic organisms are enormous when oxygen is depleted, and much greater than the direct effects of warming. What is more, when oxygen is depleted, nutrients are released from the sediment, which is a driver of lake eutrophication and all its negative consequences. Finally, we must not forget extreme weather events – the third aspect. They are expected to increase in frequency and intensity. Heat waves and storms can trigger mass developments of potentially toxic blue-green algae, as well as fish mortality. At Lake Stechlin, we have documented such observations, and have also been able to reproduce them in a large-scale enclosure experiment in the lake.

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> "For freshwaters we need to recognise that the 1.5 or 2 degrees threshold cannot be directly applied."
>
> **Professor Dr Mark Gessner**

PHOTOS: DAVID AUSSERHOFER/IGB

PHOTO: DAVID AUSSERHOFER/IGB

Rapid adaptation depending on both local and regional genetic variation

Whether plant and animal populations can rapidly adapt to changing environmental conditions strongly depends on the presence of sufficiently high levels of genetic variation. In a collaborative study involving researchers from IGB and the Universities of Birmingham (UK) and Leuven (Belgium), the evolution of a population of the water flea *Daphnia magna* that was temporarily exposed to high selection pressure by predation due to fish stocking was reconstructed through a detailed genome sequencing effort. The researchers hatched eggs from different time periods in the 1970s and 1980s that were archived in the sediments of a lake. This "resurrection ecology" approach also allows to reconstruct evolution of body size and other traits so that genomic changes could be linked to adaptive responses to the changes in fish predation. The results show that the rapid and adaptive evolution of predator-avoidance traits in the population involved pronounced changes at the level of the genome that are, however, entirely based on genetic variation that was already present prior to the fish stocking. Screening for genomic variation in other populations in the region revealed that all of them had similarly high levels of genetic variation. Strikingly, the researchers found that this high level of genetic variation can be seeded by just a handful of colonists. The study shows that the high amount of genetic variation that fuels rapid genetic adaptation may for many species critically depend on the fact that most populations in a region are genetically diverse. This implies that for safeguarding the capacity of populations to adapt to environmental change we need to protect genetic variation across regional populations and not just locally. Multiple and sufficiently large populations are crucial for the conservation of biodiversity, which poses a real challenge for larger-bodied and less widespread species, which are characterised by smaller population sizes.

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Chaturvedi et al. (2021). Extensive standing genetic variation from a small number of founders enables rapid adaptation in Daphnia. Nature Communications, 12, Article 4306. https://doi.org/10.1038/s41467-021-24581-z

The Eurasian beaver (*Castor fiber*) has experienced a sharp decline in its population and range in the past – to the point of extinction in many countries. But the species has now returned to many European regions. This success is due largely to conservation measures and reintroduction projects.

Diminishing habitats

Many freshwater species at risk

ILLUSTRATIONS: WWW.STUDIOADEN.BERLIN

Our planet is experiencing a dramatic decline in biodiversity. Freshwater plants and animals are particularly at risk. IGB scientists have helped conduct various studies that reveal where and why freshwater habitats are declining: there is increasing oxygen depletion in the deep layers of many lakes, water temperatures are rising, and many free-flowing waters are becoming increasingly fragmented or periodically dry up.

Stressful influences such as climate change and a growing population are putting freshwaters all over the world under extreme pressure. As a result, the habitats of many species that are dependent on certain conditions for survival are diminishing. By contrast, adaptable species, some of which are invasive, are capable of spreading to new areas. What developments have been observed in recent decades, and how will these trends pan out? Is it possible to counteract these developments, and what action is expedient? IGB researchers are tackling these issues from various perspectives in a number of current projects. One thing for sure is that we must act if we are to preserve freshwater biodiversity throughout the world. After all, human life is also dependent on it.

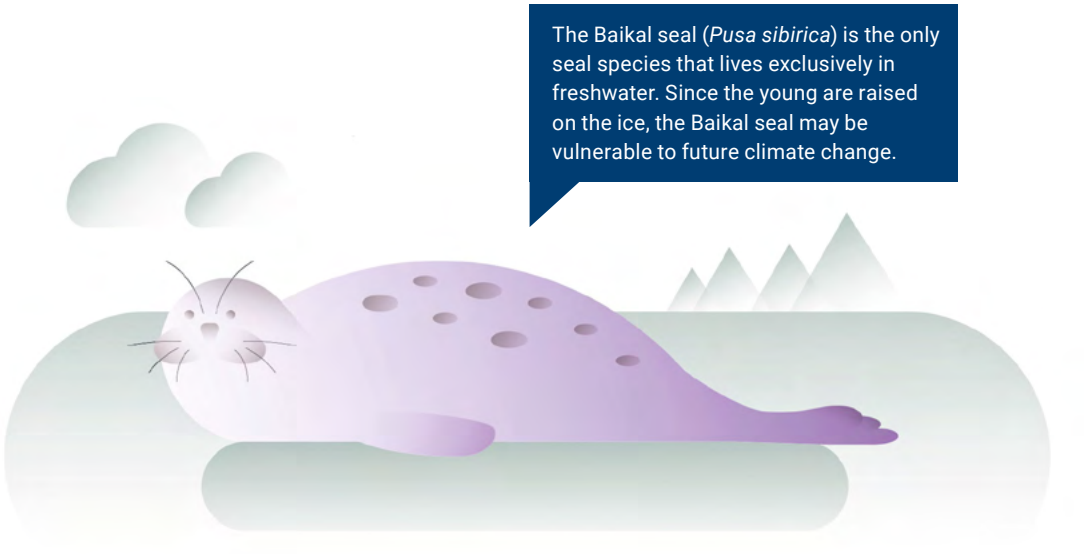
> "Dams block migration routes of freshwater megafauna and could lead to reduced reproduction and genetic isolation."
>
> **Professor Dr Sonja Jähnig**

THE LESS OXYGEN THERE IS, THE LESS DIVERSE LIFE ON EARTH GETS

Long-term data on aspects such as water temperature or nutrient dynamics show changes in the past decades; such time series exist for many lakes around the world. IGB researchers were part of a team that analysed data that has been collected from almost 400 lakes since 1941, generating more than 45,000 oxygen and temperature profiles. Most of the long-term data originate from the temperate zone. The analysis shows that since 1980, oxygen levels in the lakes studied have declined by an average of 6 per cent at the surface and 19 per cent in the deep zone of thermally stratified waters. This means that lakes are losing oxygen around three to nine times faster than oceans. The temperature profiles also revealed significant changes: in 68 per cent of the lakes studied, habitats for many cold-water species are declining.

Taking Lake Stechlin as an example: "The oxygen-free zone at the deepest point of the lake has been steadily increasing for about a decade. As a result, the lake no longer provides a habitat for animals such as the endemic Stechlin cisco (*Coregonus fontanae*) at a depth below 40 metres in late autumn," explained Hans-Peter Grossart. Other species native to Lake Stechlin are also suffering: fish need 60 to 70 per cent oxygen saturation in the water, and smaller aquatic organisms such as snails are also dependent on oxygen. At zero per cent, only microorganisms are able to survive in lakes.

Populations of the freshwater pearl mussel (*Margaritifera margaritifera*) have declined by more than 90 per cent since the 1930s. One of the main causes is considered to be the siltation of river beds: the Holarctic species, which may grow up to 16 cm, needs stable cobble and gravel substrates with only small quantities of fine material.



The Baikal seal (*Pusa sibirica*) is the only seal species that lives exclusively in freshwater. Since the young are raised on the ice, the Baikal seal may be vulnerable to future climate change.

In oxygen-depleted freshwaters such as Lake Stechlin, the problem is usually caused by inadequate mixing: the stratification phase, when the upper, oxygen-richer layer of a lake does not mix with the oxygen-deficient lower layer, has become more prolonged. Thermal stratification now occurs some two weeks earlier in spring and ends two weeks later in autumn. Several times in recent years, the dimictic Lake Stechlin has undergone intermixing only once instead of twice a year, i.e. it is then monomictic. Both phenomena result in significantly higher oxygen consumption rates in deep water layers, averaged over the year.

Permanent oxygen depletion in the deep zone unleashes a spiral effect: the more oxygen-deficient the lake bottom is, the more iron-bound phosphorus (P) is remobilised and released into the water, acting as an important nutrient for phytoplankton growth in the sunlit surface water after lake mixing. "This is referred to as internal eutrophication, i.e. self-fertilisation of the lake," commented Hans-Peter Grossart.

The more prolonged oxygen-free phases are, the more phosphorus is released from the lake bottom; the amount released then increases almost exponentially from year to year. The phosphorus released then stimulates increased algal biomass production the following year. This biomass sinks to the bottom of the lake and is then converted ("consumed" in part) by microorganisms; this conversion leads to a higher consumption of oxygen, which is then no longer available to higher organisms in the lake.

There are two main reasons why the mechanisms described above are at work, the first being global warming. Besides having the effect of less lake mixing, global warming causes a loss of oxygen. This is because oxygen saturation – the amount of oxygen that water can absorb – decreases when temperatures rise. The second reason is the increasing eutrophication of freshwaters due to human activities that result in wastewater discharges, nutrients from farming or waste materials from settlements being discharged into lakes.

> "Overall, warm thermal habitats tend to increase while cold ones decrease."
>
> **Professor Dr Rita Adrian**

"Lakes can be restored by using iron or aluminium salts to induce the precipitation of phosphorus during the algal growth phase, while at the same time covering the lake bottom to ensure that no additional phosphorus can be released and become available for algal growth," stated Hans-Peter Grossart. But this is a complicated and expensive measure, especially when large lakes are involved. Researchers recognised the risk years ago, and issued warnings accordingly; in spring 2021, they additionally published their state of knowledge in an IGB Dossier.

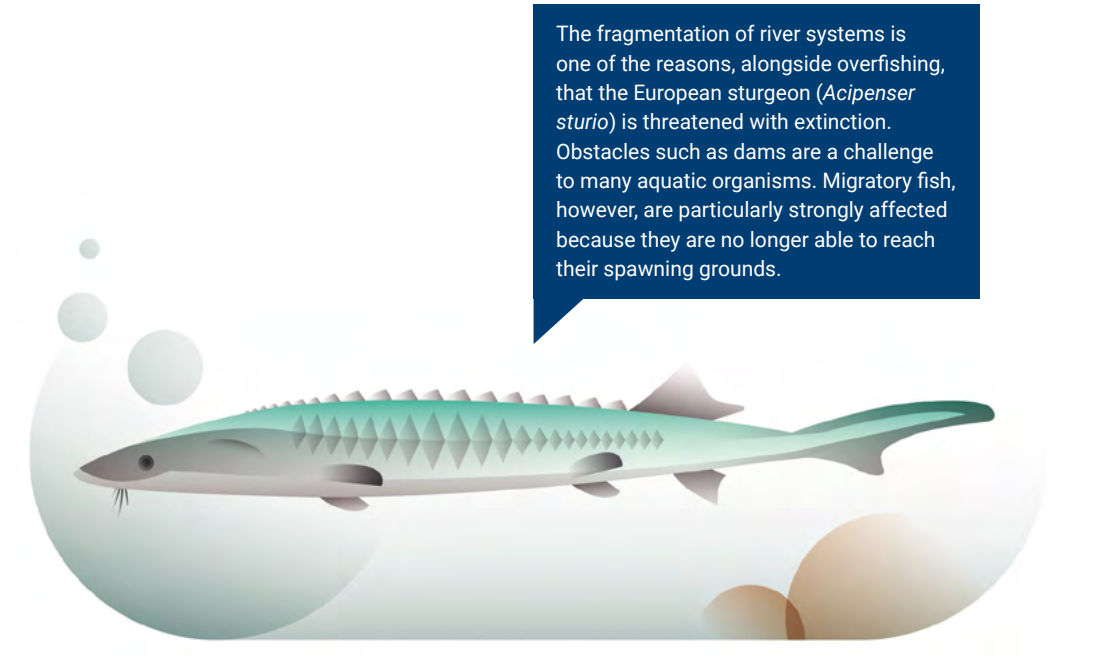
WARMER WATER IS PROBLEMATIC FOR COLD-WATER SPECIES

Another team led by Ben Kraemer and Rita Adrian has also analysed long-term data from lakes worldwide. They focused on the long-term temperature changes in water. The researchers analysed data from 32 million temperature measurements from a total of 139 lakes, representing about 69 per cent of the Earth's freshwater habitats by volume. They wanted to know how thermal habitats in lakes have already changed in response to climate change – whether they have shrunk or expanded. To this end, the researchers defined temperature habitat changes as the difference between current lake temperatures compared to before. Thermal habitat change was quantified as the percentage of thermal habitats that were lost or gained when comparing these two time periods.

They found that long-term temperature change resulted in an average 6 per cent difference between thermal habitats in the 1978-1995 and 1996-2013 periods. For selected species that are constrained by season and water depth, the thermal difference was as much as 19 per cent on average.

"Overall, warm thermal habitats tend to increase while cold ones decrease," stated Rita Adrian. Species can cope with temperature increases by shifting to different depths or adapting their seasonal occurrence. However, these responses may be constrained by ecological interactions, life histories or limited resources. For example, cold-water fish species may not be capable of

Populations of the Amazon river dolphin (*Inia geoffrensis*), which can grow up to a length of 250 cm, are dwindling, especially due to illegal hunting. This is compounded by fact that the animals get caught up in fishing nets, where they often die. Dams and other regulatory measures restrict their habitat.



The fragmentation of river systems is one of the reasons, alongside overfishing, that the European sturgeon (*Acipenser sturio*) is threatened with extinction. Obstacles such as dams are a challenge to many aquatic organisms. Migratory fish, however, are particularly strongly affected because they are no longer able to reach their spawning grounds.

occupying deeper parts of lakes any more as oxygen concentration become insufficient – but at the same time cannot elude to upper water layers, where water temperatures are too high for them. They experience a double jeopardy of temperature and oxygen constraints at the expense of high metabolic costs. As a consequence, the southern distribution range of cold-water fish species has already shifted northwards.

Lakes in the tropics are particularly affected by the shift in thermal habitats: tropical lakes exhibit less variability in water temperatures than temperate lakes. If tropical lakes become warmer at the same rate, their thermal habitats are subject to even greater shifts. This has a marked negative impact on the species living there, which are often endemic. At the same time, changes in thermal habitat can result in the spread of invasive species. The round goby is an example of an invasive species that thrives in a range of temperatures and has spread explosively in waters where it is not native. Besides being able to affect the food web, water quality and species composition of the colonised ecosystem, invasive species can also promote the spread of diseases – invasive crayfish, for instance, transmit crayfish plague without actually contracting the disease.

DAMS FRAGMENT RIVER HABITATS

Diminishing habitats for large aquatic animals is the topic of a study led by Sonja Jähnig. More than 3,400 large hydropower plants with over one megawatt design capacity are either planned or under construction. The researchers investigated the global patterns of river connectivity within distribution ranges of freshwater megafauna and analysed how these patterns could change in the future. They found that the habitats of freshwater megafauna are particularly under threat from these construction projects. If all of the proposed dams are built, over 600 currently free-flowing rivers longer than 100 kilometres will be fragmented. More than 260 new dams would then fragment 75 major rivers such as the Amazon, Congo, Salween and Irrawaddy. Across the globe, 19 per cent of rivers longer than 500 kilometres where megafauna occurs would lose their free-flowing status. And yet the river systems affected are currently home to the highest biodiversity of megafauna – more than in the

Freshwater Fact Cards

How do arapaima breathe? How fast are hippos? And how do water fleas reproduce? Answers to these and many other questions have been compiled by IGB and the Alliance for Freshwater Life. The #FreshwaterFact-Cards, used to create the images shown here, present 20 freshwater species that deserve our attention.

➔ www.igb-berlin.de/en/freshwater-fact-cards

Design by www.studioaden.berlin

IGB Policy Brief: freshwater biodiversity

The rapid decline in aquatic biodiversity not only endangers plants and animals, but also the foundations of human life. This has been pointed out by IGB in a Policy Brief published in 2021. On the occasion of the German federal elections, researchers formulated seven recommendations for action to set the course for a more sustainable water policy.

➔ www.igb-berlin.de/en/news/researchers-recommend-sustainable-water-policy

free-flowing rivers that would be left remaining or those that have already been fragmented.

Such dams block migration routes of freshwater megafauna and could lead to reduced reproduction and genetic isolation. Freshwater megafauna often have complex habitat requirements and life histories adapted to the natural flow regime; many must move between habitats to complete their life cycles. Large fish species also migrate long distances to reproduce.

“Potential impacts on biodiversity, and especially on endangered and vulnerable species, must be taken into account in the planning of hydropower plants,” urged Sonja Jähnig. In summer 2021, she and five other IGB scientists drew up specific recommendations for sustainable water management in a Policy Brief aimed at federal policy-makers. In this document, the researchers criticise the “considerable implementation deficit”, and call for aspects such as the avoidance, reduction and realistic pricing of aquatic pollution, as well as the prioritisation of aquatic biodiversity protection as an interministerial objective.

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Learn more on www.igb-berlin.de/en:

- ➔ Lake habitats are disappearing as the climate changes
- ➔ Global warming: lakes lose too much oxygen
- ➔ Large aquatic animals are at risk due to the loss of free-flowing rivers
- ➔ Giving freshwater biodiversity a seat at the table
- ➔ Species loss in freshwaters not yet in the political discourse

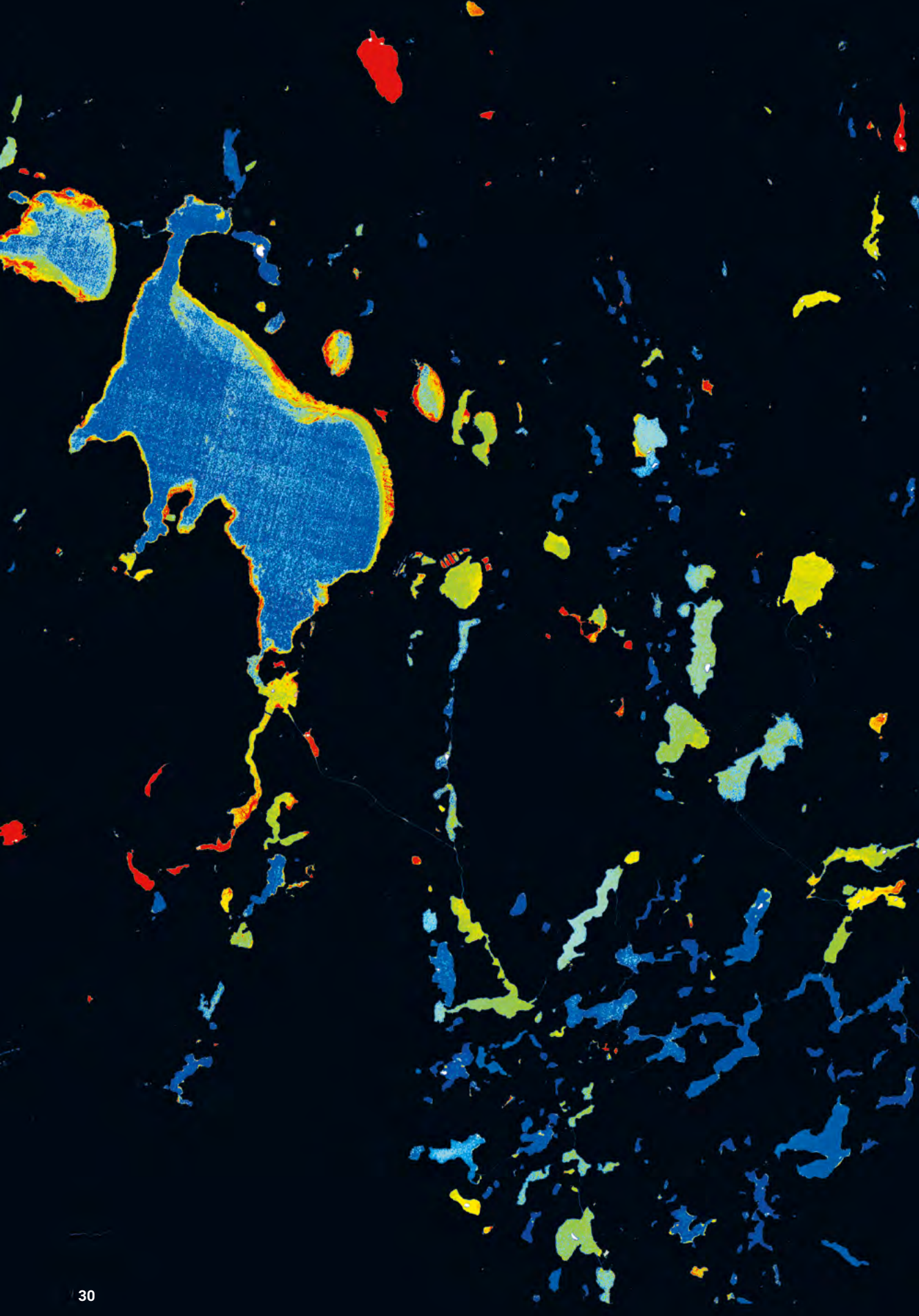

PHOTO: SENTINEL-2A

Water monitoring from space

How do river-connected lakes respond to eutrophication and to local extreme weather events? This is investigated by aquatic and landscape ecologists, and experts in remote sensing in the CONNECT project. Their study area includes lakes in the North German Lowlands, some of which are connected to the Upper Havel river system. The researchers combine large-scale remote sensing data with sensor-based temporally highly resolved in-situ measurements of the water bodies. With the help of satellite images and bio-optical modelling, they determine the chlorophyll-*a* content in the water, which enables an indirect estimation of the trophic level. Initial results show that remote sensing data are suitable for quickly identifying short-term events and thus support inland water monitoring – especially since the installation of the Multi Spectral Instruments (MSI) on the two satellites Sentinel-2A and -2B, which pass the study area two times per week.

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➔ www.igb-berlin.de/en/projekt/connect

Ogashawara et al. (2021). The use of Sentinel-2 for Chlorophyll-a spatial dynamics assessment: a comparative study on different lakes in Northern Germany. Remote Sensing, 13(8), Article 1542. https://doi.org/10.3390/rs13081542

The value

What role does biodiversity play?

4 questions to 4 experts

Anyone discussing the importance of biodiversity soon ends up in a debate about values shaped by ethics and economics. Four IGB scientists draw attention to aspects that continue to be overlooked. They research genetic diversity, interactions between different species, biological invasions, and the smallest and most diverse organisms that colonise freshwaters.

PHOTO: SOLVIN ZANKL

PD DR MATTHIAS STÖCK

An inherent aspect of biodiversity is genetic diversity, which is often overlooked. Mr Stöck, your research includes how it changes through interactions between species and populations. In your opinion, what is a good indication of the importance of high genetic diversity for evolution?

The destruction of the biosphere by our species – also called the "sixth mass extinction" – obviously leads to a loss of species. What is less obvious is that there is also a loss of genetic diversity within species, resulting in less and less genetic variation in populations and subpopulations. This generally reduces the evolvability of species – their ability to adapt genetically to environmental changes. This threatens the "buffering capacity" of living organisms and ecosystems against biotic and abiotic changes. While the loss of species makes ecosystems more vulnerable, depauperation of genetic diversity will most probably decrease the adaptive capacity of species – and make both organisms and ecosystems even less resilient to anthropogenic change. Conservation of genetic diversity therefore ensures evolvability and strongly contributes to ecosystem resilience.

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DR LYNN GOVAERT

Ms Govaert, you investigate how ecological and evolutionary processes influence species communities and their response to environmental change. Does biodiversity make the world more resilient to future changes?

When the environment changes, species have three response options: die, move or adapt. For those that survive, depending on the speed of environmental change, we find a combination of species expanding their native range and showing an adaptive response. Research into these ecological and evolutionary responses of species to environmental change is currently shifting from a population-level to a community-level focus, taking into account species diversity and species interactions. Little is yet known about how species respond within a biodiverse community consisting of many other species, all responding simultaneously to a changing environment. Theoretical studies have shown that the presence of other species can both accelerate and inhibit the evolutionary response to environmental change. Empirical work also demonstrates that interactions between species can indeed alter evolutionary responses to environmental change. Moreover, evidence suggests that there is a link between the ability of species to adapt to environmental change and ecosystem resilience. For example, the adaptive evolution of macrophytes in a shallow lake can increase ecosystem resilience by delaying the transition from clear water to turbid water. However, such evolution also leads to a slower recovery of the system after the turbid state has occurred.

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PROFESSOR DR HANS-PETER GROSSART

Mr Grossart, you study microbes in water that play an important role in matter cycling. You also focus on aquatic fungi, which very few people outside the world of science know anything about. Why are these small organisms so fascinating and important? And does diversity also play a role in their case?

The smallest organisms are often difficult to see with the naked eye, and even under the microscope they usually all look the same. And yet bacteria and fungi make up the majority of biodiversity in all ecosystems; with millions of species still waiting to be described. More importantly, microorganisms are at the base of all food webs, and contribute to an essential ecosystem function by remineralising organic matter, keeping nutrients and other compounds in the production loop. In addition, as parasites they can influence both phytoplankton and zooplankton and other organismic secondary producers – and thus the flow of organic matter and energy in the food web. In microorganisms, phylogenetic biodiversity is particularly linked to functional diversity. This can be illustrated by the following example: Humans have about 15,000 functional genes, while the bacteria associated with humans – on our skin or in our bodies – contain a total of up to 1.5 million functional genes. This shows the enormous range of functions driven and maintained by microbes. Although microbes are so critical to ecosystem functioning and our health, little is known about whether we will lose key species as a result of global change, and how this might affect the functioning and therefore the health of our natural environment. For fungi, in any case, there is evidence that current environmental changes are leading to the loss of key species and thus ecosystem functions. We therefore urgently need a Red List for microorganisms to ensure continued environmental and human health.

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> "Evidence suggests that there is a link between the ability of species to adapt to environmental change and ecosystem resilience."
>
> **Dr Lynn Govaert**

PROFESSOR DR JONATHAN JESCHKE

Mr Jeschke, one of your research areas is invasive species, i.e. species that move into new areas, where they come into contact with native species. The way in which we deal with these species is a subject of dispute, and the damage they cause is often quantified in monetary terms. Put in rather banal terms, however: do they not increase biodiversity, and are we perhaps applying double standards?

My simple answer is no, but this is a complex issue, also because there are different meanings of key terms in this context, which can lead to misunderstandings and sometimes very heated discussions. It is therefore helpful to agree on a terminology, or at least understand each other's terminology, especially in multi-stakeholder discussions. For example, "alien species" can be defined as species that have been intentionally or unintentionally introduced by human action into areas beyond their native range. "Invasive species" can be understood as a subset of alien species: while many alien species do not have a negative impact on their new environment, some do – these species are invasive. Despite also being living organisms, they pose a serious threat to biodiversity. This particular situation sometimes leads to a dilemma when dealing with invasive species: to protect biodiversity, action must sometimes be taken against living organisms. In such a situation, it is not easy to decide whether and which management measures should be taken. Management decisions should therefore be made for each individual case, and after careful consideration of the relevant aspects and perspectives.

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> "Bacteria and fungi make up the majority of biodiversity in all ecosystems."
>
> **Professor Dr Hans-Peter Grossart**

PHOTOS: DAVID AUSSERHOFER/IGB (3), PRIVATE (1)

Learn more:

Govaert et al. (2021). Competition alters species' plastic and genetic response to environmental change. Scientific Reports, 11, Article 23518. https://doi.org/10.1038/s41598-021-02841-8

Chaparro Pedraza et al. (2021). Adaptive evolution can both prevent ecosystem collapse and delay ecosystem recovery. The American Naturalist, 198, e185-e197. https://doi.org/10.1086/716929

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Heger et al. (2021). Some reflections on current invasion science, and perspectives for an exciting future. NeoBiota, 68, 79-100. https://doi.org/10.3897/neobiota.68.68997

The great drought

Rethinking integrated water and landscape management

Cities of the future must adapt to two challenges: they face an increasing demand for water while the natural supply of this resource is increasingly limited. Besides affecting the use of water by humans, water distribution conflicts also have an impact on blue and green infrastructure, given that urban water bodies and green spaces need water. Using Berlin as an example, Professor Dörthe Tetzlaff's research group at IGB is investigating urban water flows. The team focused on the extreme drought of the summers of 2018, 2019 and 2020.

Large cities with plenty of green spaces: urban vegetation has an impact on water consumption and water balance. Shrubs were found to be particularly beneficial in the studies conducted by IGB.

PHOTO: ALEKSANDAR RISTOV ON UNSPLASH

The term "brl" comes from Old Polabian – a Slavic language that was widely spoken in northeastern Germany until the 12th century, but never written down. And yet some words have survived to this day, in city names such as Berlin. Brl stands for swamp or morass, indicative of the fact that Berlin is built on sandy soil and groundwater levels are high in many districts.

Despite having an abundance of water bodies, Berlin is water scarce: as the city's demand for this resource grows, it faces an increasing shortage of water. IGB researchers explore which adaptations are required.
PHOTO: MICHAL BEDNAREK

A "MORASS CITY" WITH LITTLE RAINFALL

In contrast, the Berlin-Brandenburg region is one of the areas in Germany with the lowest precipitation. This problem will be exacerbated in the wake of climate change. "It seems to be a rather paradoxical situation. Despite being marshy in places due to high groundwater levels, and despite being home to many water bodies, Berlin and Brandenburg are struggling with water shortages," remarked Dörthe Tetzlaff. A comparison of cities shows that Munich has a long-term annual average of 944 mm precipitation, Cologne 839 mm and Hamburg 793 mm, while Berlin has only 591 mm. In fact, Berlin had a mere 312 mm precipitation in 2018, an all-time low.

IGB researchers examined various components of the water balance in Berlin during the dry years from 2018 to 2020. They used stable water isotopes to study water fluxes from the atmosphere, vegetation, groundwater, soil water and surface water at high spatial and temporal resolution. This approach enabled the team to precisely determine the water's "fingerprint", i.e. its origin, age and fate in the landscape.

THE "GREEN-SPACE MOSAIC": SHRUBS STABILISE GROUNDWATER, TREES PROVIDE EVAPORATIVE COOLING

Plants play an important role in the water cycle – also and particularly in cities. In Berlin, green spaces account for a whole 30 per cent of the city. The team investigated which type of vegetation promotes the retention of water in the soil, stabilising the groundwater level. "Of course, trees play an important role in the urban climate – they provide shade, produce oxygen and have a cooling effect in summer due to water evaporating via the leaf surface. A key aspect is that evaporation and groundwater recharge interact closely: large trees often transpire more water, hence the significant cooling effect. However, less water is then available for groundwater recharge. We were able to show that a "green mosaic" of shrubs – which help retain water in the soil better in dry periods – and trees is the best way to withstand extreme drought," explained Dörthe Tetzlaff.

The studies also showed that large trees released more moisture via their leaves and drew more water from deep soil layers, meaning that precipitation created very little new groundwater recharge in those areas. Green areas with shrubs transpired around 17 per cent less moisture to the atmosphere via their leaves. And since their roots are shallower, they drew no water from deeper soil layers. About the same amount of water evaporated from lawns as from trees, despite having a shallower root depth and lower leaf mass.

The data collected in Brandenburg is consistent with general observations: parched soils, dried up streams, depleted wells and lower crop yields are clear signs that there is insufficient water accumulation to support groundwater recharge and plant water uptake.

PHOTO: HAUKE DÄMPFLING/IGB

The research also showed that Berlin's green spaces have limited exchange with surface waters and groundwater during dry periods. Interaction between sealed surfaces and green spaces could therefore become important in the future: as modelling showed, evaporation from trees increases by about 50 per cent when water from an adjacent sealed area runs off towards them. Such runoff also leads to the recharge of groundwater – even during the vegetation growth period. These aspects must be taken into account in sustainable water and land use planning in order to preserve urban green spaces while conserving water resources.

SMALLER URBAN STREAMS MAINLY CARRY TREATED WASTEWATER DURING DRY PERIODS

Groundwater is hugely important for Berlin. After all, most of the water for public water supplies and much of the city's utility water is obtained from groundwater. Berlin's rivers also feed on groundwater – but not always, as IGB early career researcher Lena-Marie Kuhlemann has discovered. The doctoral candidate investigated the role of groundwater, precipitation, treated wastewater and urban runoff in the 220-square-kilometre catchment area of the

small river Erpe for the dry years of 2018 and 2019. Primarily fed by groundwater in winter, the Erpe mainly carries treated wastewater from the discharge of two municipal wastewater treatment plants during dry periods in summer. Water from precipitation and urban water inputs accounted for less than 10 per cent of the Erpe's discharge, despite the fact that around 20 per cent of the catchment area is urban. Since the high proportion of treated wastewater can have an impact on environmental quality and ecosystem services, it is also an important aspect for the management of municipal wastewater. "When treated wastewater is discharged into a surface water body, trace substances and nutrients may enter the freshwater system. These pollutants affect the water quality, especially if little 'natural water' enters the water body at the same time," explained Lena-Marie Kuhlemann.

> "We would need at least four years of average rainfall, for groundwater levels to recover to pre-drought levels."
>
> **Professor Dr Dörthe Tetzlaff**

Similar results were obtained for the River Panke by Christian Marx, also an early career researcher in Dörthe Tetzlaff's team. The Panke is the third longest river in Berlin's urban area, after the Spree and the Havel. Around 75 per cent of the upper part of the catchment area is fed by groundwater from gravel aquifers. After heavy rainfall, this is the main source of water for the Panke. Overall, however, water from precipitation accounts for only 10 to 15 per cent of the annual water flow. Downstream, the river is influenced by several tributaries. However, inputs from a waste water treatment plant account for 90 per cent of the water flow in the lower catchment, where the effects of urbanisation are strongest. The associated increase in sealed surfaces downstream also reduces the relative contribution of groundwater.

The European Commission carried out a consultation on the revision of the EU Urban Wastewater Treatment Directive (UWWTD) in 2021, in which IGB was also involved. Besides completing the official questionnaire of the online consultation, IGB researchers Stephanie Spahr, Markus Venohr and Jörg Lewandowski compiled additional information on micropollutants, stormwater overflow, surface runoff and leaking sewer systems. They emphasised that water pollution from settlements threatens groundwater, aquatic ecosystems and their biodiversity, and ecosystem services for humans. Dörthe Tetzlaff agrees: "The increasing proportion of treated wastewater in surface waters due to drought and sealing is an important aspect for the adaptation of this EU Directive," she concluded.

SPREE, DAHME, HAVEL: EVAPORATION LOSSES IN UPSTREAM CATCHMENTS

In the case of Berlin's three major rivers – Spree, Dahme and Havel – it is not so much the proportion of treated wastewater that causes problems. These rivers face other challenges: even before their water reaches the urban area of Berlin, a lot of their flow has already evaporated, as isotope analyses have shown. Particularly in view of the cessation of opencast mining in Lusatia in the upper catchment area of the Spree and in the wake of climate change, it will be important to understand and quantify the water balance of upstream catchment areas in order to minimise water losses through sustainable water use strategies and to maintain the inflow of water from the Spree in Berlin. "Simple measurement programmes using isotopes can help us to better quantify evaporation losses at larger scales in the future," stated Dörthe Tetzlaff.

BRANDENBURG REVEALS "DROUGHT MEMORY EFFECTS"

The team also operates a field observatory in the Demnitzer Mühlenfließ in eastern Brandenburg. In the drought year of 2018, 30

per cent less precipitation fell there compared to the long-term average. In the two subsequent years, 2019 and 2020, which were also dry, there was 10 to 15 per cent less rainfall than the long-term average. Even in the first half of 2021, there was too little rain. And yet how do such dry spells affect water resources? And how much precipitation would be needed to compensate for the shortage? The measured data show that groundwater recharge occurs with a time lag. After the drought summer of 2018, for example, groundwater reached its lowest level in 2020. It was more than 20 per cent, i.e. 40 centimetres, less than the normal groundwater level.
Even now, in early 2022, there is still too little groundwater, in spite of increased precipitation in recent weeks. The situation is similar for the moisture content of topsoil: recent rainfalls have not led to an adequate replenishment of soil water at depths of 25 centimetres. Moisture is still around 15 per cent lower than the average over the last 13 years.

"Our integrated measurements and modelling show that we would need at least four years of average rainfall, i.e. about 600 millimetres per year in this region, for groundwater levels to recover to pre-drought levels; it would take a year to replenish the soil water reservoirs," predicted Dörthe Tetzlaff. The increasing occurrence of extreme events such as droughts therefore requires strategies in and around the city that are adapted to water availability and that increase the resilience of the region's blue and green infrastructure to climate change.

PROFESSOR DR DÖRTHE TETZLAFF
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DR CHRISTIAN MARX
christian.marx@igb-berlin.de

Learn more on www.igb-berlin.de/en:

- Rainy summer, dry soils
- Meeting the water needs of urban green spaces in a sustainable way
- Urban water pollution is a major threat to groundwater and freshwater ecosystems

Kuhlemann et al. (2021). Spatio-temporal variations in stable isotopes in peri-urban catchments: a preliminary assessment of potential and challenges in assessing streamflow sources. Journal of Hydrology, 600, Article 126685. https://doi.org/10.1016/j.jhydrol.2021.126685

Marx et al. (2021). Isotope hydrology and water sources in a heavily urbanized stream. Hydrological Processes, 35(10), Article e14377. https://doi.org/10.1002/hyp.14377

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Kleine et al. (2021). Modelling ecohydrological feedbacks in forest and grassland plots under a prolonged drought anomaly in Central Europe 2018–2020. Hydrological Processes, 35(8), Article e14325. https://doi.org/10.1002/hyp.14325

Kuhlemann et al. (2021). Using soil water isotopes to infer the influence of contrasting urban green space on ecohydrological partitioning. Hydrology and Earth System Sciences, 25(2), 927–943. https://doi.org/10.5194/hess-25-927-2021

Gillefalk et al. (2022). Estimates of water partitioning in complex urban landscapes with isotope-aided ecohydrological modelling. Hydrological Processes, 36(3), Article e14532. https://doi.org/10.1002/hyp.14532

Tracking fish movements in the wild

Acoustic telemetry can be used to track how fish move in the wild. This method involves a transmitter placed on the fish that emits sound waves. In marine environments, only rough recordings have been possible so far. A team led by IGB researcher Robert Arlinghaus and Josep Alós from the Instituto Mediterráneo de Estudios Avanzados (IMEDEA) has succeeded in developing a new high-resolution telemetry system for use in coastal areas. This novel system enables the positions and movements of hundreds of tagged fish to be determined to the nearest metre. Besides functioning in coastal waters, the system can also be used in inland waters: IGB researchers have equipped a lake in Brandenburg with a whole-lake fish detection system that is unique in Germany. Depending on the transmitter type and battery runtime, the system can operate for several years, recording numerous fish species simultaneously. The research lake has thus been transformed into an aquarium that provided insights into the world of fish around the clock.

PROFESSOR DR ROBERT ARLINGHAUS
robert.arlinghaus@igb-berlin.de

- www.igb-berlin.de/en/news/tracking-fish-ocean
- www.igb-berlin.de/en/news/we-are-looking-you-fish
- www.igb-berlin.de/en/news/large-predatory-fish-have-difficulties
- https://youtu.be/KtOH0Fr3KUk
- https://youtu.be/mXHHnKD8nZs

PHOTO: SOLVIN ZANKL

People

Awards and new faces

Justyna Wolinska given tenured professorship in Aquatic Evolutionary Ecology

Justyna Wolinska has been studying evolutionary and ecological processes mediated by parasitism in aquatic ecosystems for almost two decades now. Parasites are ubiquitous and impose strong selection on their hosts to evolve resistance, while themselves being under strong selection to undermine host defences. For this reason, Wolinska is interested in questions such as how parasitism contributes to the maintenance of genetic diversity, and how it influences interactions between host and non-host species. Another field of research that Justyna Wolinska focuses on is how future environmental change will affect the occurrence of disease and its underlying ecological effects. The IGB researcher successfully passed the six-year tenure track phase in 2021, and has now been jointly appointed to a permanent professorship for Aquatic Evolutionary Ecology by IGB and Freie Universität Berlin.

PROFESSOR DR JUSTYNA WOLINSKA
justyna.wolinska@igb-berlin.de

www.igb-berlin.de/en/news/wolinska-appointed-permanent-professor

PHOTOS: DAVID AUSSERHOFER/IGB

IGB welcomes two new research group leaders

Lynn Govaert is heading the Eco-Evolutionary Dynamics research group since February 2021. The Belgian-born scientist is particularly interested in the dynamical interplay between evolutionary and ecological processes and how they shape characteristics of species. She investigates issues such as how trait changes and trait variation affect the community structure and functioning of ecosystems in time and space. To this end, she works with protists – single to few-celled eukaryotes that are invisible to the naked eye. The qualified mathematician, who originally wanted to be a teacher but then decided to pursue a PhD in Evolutionary Ecology, previously conducted research at the University of Zurich as a post-doctoral fellow. At IGB, she now looks forward to identifying points of connection to other organisms and research questions.

DR LYNN GOVAERT
lynn.govaert@igb-berlin.de

www.igb-berlin.de/en/news/new-research-group-leader-eco-evolutionary-dynamics

Stephanie Spahr is heading the Organic Contaminants research group at IGB since May 2021. Before joining IGB, the qualified geoecologist with a PhD in Environmental Chemistry conducted research at the University of Tübingen's Center for Applied Geoscience. At IGB, she addresses applied issues – such as the causes of water pollution and how we could bring about a lasting improvement to water quality. Stephanie Spahr places a special focus on stormwater runoff, given that rain transports many pollutants to freshwater ecosystems. The researcher is also convinced that stormwater is a much-underestimated resource.

DR STEPHANIE SPAHR
stephanie.spahr@igb-berlin.de

www.igb-berlin.de/en/news/stormwater-risk-resource

We also congratulate:

Dr Elias Ehrlich won 1st place in the Schwoerbel–Benndorf Young Scientist Award of the German Society for Limnology (DGL) for his doctoral thesis at the University of Potsdam on the role of trade-offs in phytoplankton.

Dr Darshan Neubauer took 3rd place in the same award for his study on the microbial degradation of zooplankton.

Professor Dr Dörthe Tetzlaff was elected to the Executive Board of the German Hydrological Society (DHG). The hydrologist is also a new advisory board member of the Royal Society of Chemistry's Environmental Sciences: Advances journal.

Professor Dr Rainer Koschel, former Head of Department at IGB in Neuglobsow, was made a new honorary member of the German Society for Limnology (DGL) for his long-standing commitment to freshwater research.

Dr Döris Düthmann was selected for the Leibniz Mentoring Programme.

Dr Thomas Mehner was awarded the 2020/2021 Prize for Good Academic Teaching for his course in the Master's programme in Fish Biology, Fisheries and Aquaculture by HU Berlin's Faculty of Life Sciences.

Professor Dr Hans-Peter Grossart and his co-authors received the Toxins 2020 Best Paper Award for a publication on cyanotoxins. Their article provides insights into how environmental changes determine the production and distribution of cyanobacterial toxins.

Master's student Philipp Czapla took 1st place in the Best Poster Award at the Deutscher Fischereitag. His topic was the hook avoidance behaviour of carp (*Cyprinus carpio*) – long-term memory and the importance of social learning.

Review of the year 2021

INTERNAL MATTERS

Colloquium on equal opportunities

JANUARY To what extent is equality embraced in science? This question also concerns IGB. In a colloquium, expert Dr Lina Vollmer presented the mechanisms that exclude women and certain groups of society from science. The event was organised by our Diversity and Inclusion Group.

PROFESSOR DR JUSTYNA WOLINSKA

Strong against harassment

NOVEMBER In November, the IGB policy against sexual harassment was approved. It defines clear rules and aims to prevent or stop cases of sexual harassment, and to protect those affected by and witnesses of sexual harassment. We have also launched a sexual harassment complaints office, which can be turned to for confidential consultations and in the case of making a formal complaint.

DR KIRSTEN POHLMANN

PROJECT LAUNCH

Water-ForCE

JANUARY Freely accessible satellite data holds enormous potential for monitoring and assessing water bodies. Together with the space sector, the research community, policymakers, industry and the third sector, the Water-ForCE project is therefore creating a roadmap for the development of the next phase of the Copernicus Inland Water Services. Among other things, it will specify the technical requirements for the future Copernicus sensors so that the data can be optimally used for monitoring.

DR IGOR OGASHAWARA
DR JENS NEJSTGAARD
Twitter @H2020WaterForCE

RESIST

JANUARY The DFG Collaborative Research Centre RESIST, initiated by the University of Duisburg-Essen, investigates how various pressures affect the biodiversity and functions of flowing waters, and how previously stressed ecosystems can recover. Teams from the universities of Bochum, Cologne, Kiel and Koblenz Landau as well as the UFZ Halle-Leipzig are involved. IGB is also participating with two working groups that address litter decomposition by fungi and the improvement of the predictive ability of species-area models.

PROFESSOR DR MARK GESSNER
PROFESSOR DR SONJA JÄHNIG

Conservation planning in Cuba


PHOTO: YUSDIEL TORRES-CAMBAS

FEBRUARY In this project, funded by the Alexander von Humboldt Foundation, the IGB junior research group *Global Freshwater Biodiversity* is investigating, as an example, the extent to which Cuba's national protected areas support the conservation of aquatic biodiversity and the provision of freshwater ecosystem services, and what scenarios can be expected in the wake of climate and land use changes.

DR YUSDIEL TORRES-CAMBAS
DR SAMI DOMISCH

CURT

APRIL The CURT network on urban ecology brings together researchers from Berlin and Melbourne (Australia) to develop ideas for liveable, sustainable and resilient cities and communities. CURT is funded in part by the Berlin University Alliance, and stands for Comparative Urban ecology Research Training. IGB is involved as a partner.

PROFESSOR DR JONATHAN JESCHKE
https://curt4future.com

Vertical Wetlands

APRIL The project, funded by the European Regional Development Fund and the Federal State of Berlin as part of the Berlin Programme for Sustainable Development (BENE), is investigating the potential of sheet pile greening through vertical wetlands on inner-city stretches of water. Researchers are developing and testing specially developed modules from the implementation partner WITE Company and evaluating their ecological and microclimatic effectiveness.

DR CHRISTIAN WOLTER
ROSANNA WIEBE
https://urban-waters.org/en

IceTMP


PHOTO: TOM SHATWELL

JUNE The new German-Chinese cooperation project deals with ice-covered lakes of the Tibetan and Mongolian plateaus and their response to climate change. The aim is to establish an international research network to fill the knowledge gap on ice-covered lakes as an important but largely unstudied components of the hydrological and climatic system.

DR GEORGIY KIRILLIN

PROJECT LAUNCH

hi knowledge
dive into science

enKORE

SEPTEMBER Biological invasions can have negative consequences for ecosystems, economies and human health. To counteract these effects, researchers are developing an interactive and freely accessible atlas of invasion biology. To this end, they are also using modern visualisation techniques, artificial intelligence and novel methods for knowledge synthesis.

PROFESSOR DR JONATHAN JESCHKE
https://hi-knowledge.org

INAS

SEPTEMBER In this project, researchers are developing an interactive argumentation support for invasion biology. With this, they aim to facilitate access to and the development and refinement of hypotheses in this research field. The DFG-funded project is embedded in the Hi Knowledge initiative.

DR TINA HEGER
PROFESSOR DR JONATHAN JESCHKE
https://inas-argumentation.github.io

ADVICE

For binding restoration targets


PHOTO: LUBOS HOUSKA ON PIXABAY

MARCH The European Commission has consulted on several important biodiversity initiatives, such as the Biodiversity Strategy. IGB researchers provided detailed feedback, arguing in particular for more binding EU restoration targets.

PROFESSOR DR SONJA JÄHNIG
PROFESSOR DR JONATHAN JESCHKE
PD DR MARTIN PUSCH

IGB Dossier on Lake Stechlin

MARCH IGB has published a dossier on “The ecological degradation of Lake Stechlin – state of knowledge and options for action”. The clearwater lake is impaired by dramatically increasing phosphorus concentrations. The document provides an overview of the data situation, possible causes and potential countermeasures.

PROFESSOR DR MARK GESSNER

Healthy soils

APRIL Policymakers should take better account of the link between terrestrial and aquatic ecosystems, is the IGB recommendation in its feedback on the new EU Soil Strategy. Healthy soils cannot exist without healthy inland waters, and vice versa. Both systems therefore require appropriate and coordinated management.

DR MARKUS VENOHR

Waterway expansion that comes with risks

MAY IGB has participated in an EU consultation on the planned revision of the guidelines for the Trans-European Transport Network (TEN-T). The researchers suggest that inland navigation and its infrastructure should not generally be considered a sustainable solution, and that the negative impacts it has on inland waters, their ecosystems and the ecosystem services they provide to society should also be taken into account.

PD DR MARTIN PUSCH
DR CHRISTIAN WOLTER
DR JÖRN GESSNER

PHOTO: BERNSWAELZ ON PIXABAY

PHOTO: MICHAL JARMOLUK ON PIXABAY

Risks of urban wastewater

JULY IGB has provided feedback on the revision of the EU Urban Wastewater Treatment Directive (UWWTD). The researchers call for improved EU policy, especially with regard to EU environmental objectives. In addition to answering the official questionnaire, they also provided further information, for example on micropollutants, stormwater overflow, surface runoff and leaking sewer systems.

DR STEPHANIE SPAHR
DR MARKUS VENOHR
DR JÖRG LEWANDOWSKI

Scientific assessment of the Tesla construction project

AUGUST Tesla's Gigafactory construction in Grünheide and its potential impact on the environment are being hotly debated. For this reason, IGB published a scientific assessment on the siting of large-scale industrial projects in comparatively water-scarce regions.

DR JÖRG LEWANDOWSKI

www.igb-berlin.de/en/news/berlin-brandenburg-region-and-tesla-gigafactory

IGB Policy Brief on freshwater biodiversity

PHOTO: MICHEL ROGGO

SEPTEMBER On the occasion of the 2021 federal elections, IGB scientists recommended that policymakers take urgent action against the massive decline in aquatic biodiversity in a bid to safeguard the many important ecosystem services that inland waters provide for humans. These include sufficient and clean drinking water, natural flood protection, pollutant retention and recreational spaces.

PROFESSOR DR SONJA JÄHNIG
DR CHRISTIAN WOLTER

Water pollution in Europe

NOVEMBER IGB researchers provided feedback on the possible revision of the EU list of pollutants affecting surface and groundwater. In addition to responding to the online public consultation and the expert survey, they provided additional information on the potential effects of anthropogenic substances and made recommendations for sustainable policy-making and monitoring.

DR STEPHANIE SPAHR
DR TOBIAS GOLDHAMMER

Memorandum on the energy transition

NOVEMBER In a scientific memorandum, 65 scientists from 30 institutions have recommended ending the subsidisation of inefficient small hydropower plants. They list 7 environmental policy initiatives to harmonise the use of hydropower with the legal goals of water protection and biodiversity conservation in the future.

PD DR MARTIN PUSCH

www.igb-berlin.de/en/news/energy-transition-scientists-recommend-subsidy-stop-inefficient-small-hydropower

PHOTO: ODINZ/SHUTTERSTOCK

EVENTS

Kick-off for ACTION

JANUARY The ACTION project started the second phase of its accelerator, supporting six citizen science pilot projects. The kick-off meeting shared ideas on scientific research methods, online citizen engagement and motivation, diversity and inclusion, open data, data quality and data lifecycle, impact assessment and policy implications.

DR KAT AUSTEN

https://actionproject.eu/accelerator

Less light for more insects

MARCH This was the theme of the 2021 International Dark Sky Week. IGB colleagues researching the topic used the occasion to prepare tips on how to deal with artificial light outdoors. They also invited people to a public online lecture on light pollution and insect protection.

JOHANNA REINHARD

www.igb-berlin.de/en/news/less-light-more-insects

PHOTO: SOPHIA DEHN, IGB

Virtual Girls' Day

APRIL 30 girls aged 12 to 16 from all over Germany visited IGB virtually. They learnt about the causes and effects of salinisation and urban influences, and experienced samples being taken at Lake Müggelsee and analysed in the laboratory via live video. IGB will also take part in Girls' Day in 2022.

NADJA NEUMANN

Soapbox Science

JUNE On 26 June, Berlin's Washingtonplatz was transformed into a place of shared learning and discussion as female scientists from around the world presented their research standing on soapboxes. The event, supported by IGB, is not only meant to be fun, but also promotes gender equality and diversity in science. Among the speakers was IGB doctoral candidate Anna-Lena Kronsbein, who spoke about freshwater mussels and drug residues.

ANNA-LENA KRONSBEIN
MARTA M. ALIRANGUES NUÑEZ

Twitter @berlin_soapbox

KOSMOS reading

AUGUST At the square in front of Berlin's Red City Hall, Robert Arlinghaus spoke about what city life has to do with sustainable fisheries. The event was part of the Wissensstadt Berlin 2021 festival, which offered a wide range of virtual and open-air events throughout the summer.

PROFESSOR DR ROBERT ARLINGHAUS

Treffpunkt StadtNatur

SEPTEMBER Personal exchange about our favourite research object: water bodies as a resource, habitat and recreational space. Together with partners from science, environmental education and nature conservation, IGB presented interesting facts about nature in the city on the Long Day of Urban Nature and discussed how to make a success of adaptation to global warming, urbanisation and land use change.

NADJA NEUMANN
ANGELINA TITTMANN

➔ www.igb-berlin.de/en/news/exploring-blue-and-green-urban-spaces

Topping-out ceremony for new biodiversity building

SEPTEMBER Berlin is getting a new science building in which IGB and Freie Universität will jointly research biodiversity in aquatic and terrestrial systems. About 70 participants and guests witnessed and celebrated the raising of the topping-out wreath on 17 September.

PROFESSOR DR LUC DE MEESTER

Awareness week: Attention Biodiversity!

OCTOBER On the occasion of the nationwide awareness week, the IGB project "Species Protection through Environmentally Friendly Lighting" (AuBe) showcased its insect collection – insects that had perished because of street lamps. Interested visitors discovered how many different species a street light attracts in just one night, and how to distinguish different species.

DR SIBYLLE SCHROER

9th Dialogue at Lake Müggelsee

OCTOBER IGB researchers and stakeholders from politics, authorities, user and environmental associations as well as planning offices discussed opportunities, challenges, open questions and options for action for sustainable aquatic plant management from different perspectives.

PD DR SABINE HILT
DR JAN KÖHLER

Berlin Science Week

NOVEMBER IGB participated in the Berlin Science Week with several contributions, including the panel discussion on diversity instead of uniformity with IGB Director Luc De Meester, and the Blumen! science show. IGB was also involved in the Leibniz Association's Book a Scientist event, as well as giving lectures and presenting information on the central campus at Berlin's Museum of Natural History.

VISITORS

Delegation in Neuglobsow


PHOTO: ANGELINA TITTMANN

AUGUST In August, a special delegation visited IGB at its Stechlin site. In addition to municipal and regional representatives, the (former) Parliamentary State Secretaries Uwe Feiler (BMEL) and Dr Michael Meister (BMBF) as well as Brandenburg's Minister of the Environment Axel Vogel (MLUK) were also guests seeking to learn first-hand about the status of Lake Stechlin.

PROFESSOR DR MARK GESSNER

Jugend forscht at IGB

SEPTEMBER Three winners of the nationwide "Jugend forscht" competition came to IGB to do a research internship. For a fortnight, they accompanied researchers at work and conducted their own swarm experiment, among other things.

NADJA NEUMANN

Schools of Sustainability

SEPTEMBER Art meets school meets science: as part of the "S.O.S. – Schools of Sustainability" project run by the Haus der Kulturen der Welt (HKW), 8th graders from Berlin's Gerhart Hauptmann Gymnasium visited IGB on a field trip. The topic they addressed was sustainable water management.

NADJA NEUMANN

Joint stocking in Lebus


PHOTO: ANGELINA TITTMANN

OKTOBER Brandenburg's Environment Minister Axel Vogel and primary school children from Lebus helped to release about 500 juveniles of Baltic sturgeon into the Oder River. The stocking was part of the reintroduction programme coordinated by IGB.

DR JÖRN GESSNER

www.wanderfisch.info/en

2021 in numbers

Overall budget	**€21,716,505**
Proportion of external funding	**32 %**
Institutional funding from the federal government	**€14,697,000**
of which core budget	€14,284,000
of which Leibniz Competition levy	€413,000
of which for major construction projects	€0
External grants*, including externally managed funds	**€7,019,505**
of which from the federal government	€1,897,215
of which from the federal states	€897,375
of which from the DFG	€2,080,604
of which from the Leibniz Competition	€430,768
of which from other public funding	€129,185
of which from non-public funding	€6,542
of which from the EU/international	€1,236,447
of which from foundations	€341,369

* on an expenditure basis (status as of 31 December 2021)

EMPLOYEES AT IGB IN 2021

149
scientists

including 46 postdoctoral scientists

including 39 doctoral candidates

89
science supporting staff

1
apprentice

36
assistants and temporary staff

115
guests

390
in total

SHARE BY SEX

Science:

43%
women

57%
men

0%
diverse

Science supporting staff:

62%
women

38%
men

0%
diverse

EMPLOYEES BROKEN DOWN BY FUNDING

(w/o guests, assistants and temporary staff)

140
funded from core budget

112
externally funded

To find out more about working at IGB, take a look at our website

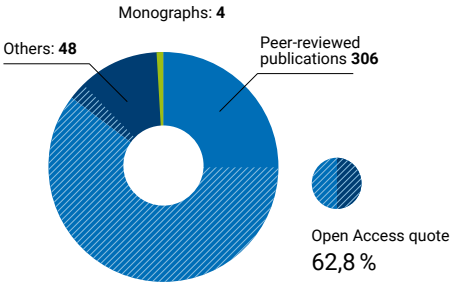
➔ www.igb-berlin.de/en/career

In 2021, IGB scientists contributed to a total of **358 publications**, including **306 articles in peer-reviewed journals**. All IGB publications are indexed and searchable in our library's online catalogue (OPAC): www.igb-lib.igb-berlin.de

The percentage of IGB articles published open access increased significantly, from 52.9 per cent in 2020 to 62.8 per cent in 2021. 225 of the Institute's publications appeared in open access, 213 of them in peer-reviewed journals. IGB participates in several open access transformative agreements. The library successfully applied for external funding from the DFG's Open Access Publication Funding programme for 2022-24.

DR THOMAS GERDES AND CAROLINE SCHMUNCK

Publications



library@igb-berlin.de

www.igb-berlin.de/en/library

The most cited article from 2020/2021 was

Bizic et al. (2020). Aquatic and terrestrial cyanobacteria produce methane. Science Advances, 6(3), Article eaax5343. https://doi.org/10.1126/sciadv.aax5343

Source: Web of Science (23 March 2022), articles with IGB corresponding authorship

DOCTORAL EDUCATION

39
employed doctoral students

15
doctoral candidates with external scholarships

1
other externally funded doctoral student

7
other doctoral candidates supervised by IGB

62
in total

ORIGIN OF DOCTORAL CANDIDATES

23
Germany

20
Europe (w/o Germany)

3
North America

1
South and Latin America

4
Africa

11
Asia

DEGREES & CO.

12
Bachelor theses

21
Diplom and Master's theses

6
dissertations

0
habilitations

~

1
offer of professorship to IGB

11
joint professorships with universities

STATUS AS OF 31 DECEMBER 2021

Organisation

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STATUS AS OF 15 MARCH 2022

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Gwendolyn Billig

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Thomas Gerdes

Information Technology
Christian Baal

Technical Services
Bernd Schubert

Research departments

1 Ecohydrology and Biogeochemistry
Dörthe Tetzlaff

2 Community and Ecosystem Ecology
Sonja Jähnig

3 Plankton and Microbial Ecology
Mark Gessner

4 Fish Biology, Fisheries and Aquaculture
Jens Krause
Werner Kloas

5 Evolutionary and Integrative Ecology
Jonathan Jeschke

Cross-cutting research domains

1 Aquatic Biodiversity	Hans-Peter Grossart
2 Aquatic Fluxes under Global Change	Tobias Goldhammer (a.i.), Sabine Hilt (a.i.)
3 Human-Aquatic Ecosystem Interactions	Christian Wolter

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Imprint

The annual research report of IGB gives you an insight into the research work and structure of our Institute. For more information, please visit our website or contact us directly at:

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