Newsletter

2/2022

CzechGlobe

Global Change Research Institute CAS

OUR FORECASTS HELP PREVENT CRISIS SITUATIONS

We are unlikely to look back on the past year, 2022, in a very fond way. The whole Europe has experienced so many bad events that it would have previously sufficed for at least a few years. It started with Russia's invasion of Ukraine replacing the receding pandemic at the end of winter. The war caused the exodus of several million Ukrainians mainly to neighboring countries, including the Czech Republic, and at the same time escalated an unprecedented energy crisis. It had been fomented since the summer of 2021 though, and it is a matter of opinion whether it was already directed by Russia at that time, or whether it was intended to be a "natural proof" against the EU's green policy to achieve carbon neutrality through gradual decarbonisation. It is certain that Russia already throttled gas supplies back then, thereby driving the price of gas and energy above barely acceptable levels. All that was needed to make things worse was for Germany to have insufficient wind in the summer of 2021 and for wind farms not to generate electricity. Consequently electricity produced from backup sources – in steam-gas power plants – ended up being many times more expensive. In any case, energy security was undermined.

In normal times of peace and with the expected growing share of renewable energy sources (RES), the so-called energy meteorology is supposed to serve to ensure energy security and the predictability of resource availability. For several years, this has been the domain of the Department of Climate Services from CzechGlobe, which "operates" it as part of the EnergoAdapt project and as part of contract research for the company E.ON. In today's issue, we talk about this, among other things, with Pavel Zahradníček.

2022 wasn't the happiest year for the planet Earth in terms of climate developments either. According to climatologists, it is already clear that the past year has once again set several alarming records and will be one of the hottest years. The weather in Europe, which experienced the hottest summer in the last 40 years, has played a significant part in this, and the month of October was the warmest October in the history of measurements, with even a tropical night recorded in Austria, for example. After all, heat and drought have been plaguing Europe, which is warming up the fastest of all the continents, since spring, and it has all culminated in drastic drought. In addition to the customary damage to farmers – this time mainly for the rice and tomato growers in the Po Valley and even olive growers in Spain – it also exacerbated the energy crisis. Shipping on the dried-up Rhine River was halted, making it difficult to supply coal-fired power plants, which had been restarted due to gas shortages. The drought in France, for its part, did not allow nuclear power plants to be started after technical shutdowns, because there was little water for cooling.

Forest fires raged across Europe this summer as well. We have become accustomed to the annual pattern of vegetation burning in the Mediterranean – most often in Greece, Spain and Portugal. This July, however, we experienced the largest forest fire in the modern history of the Czech Republic, which engulfed the Czech Switzerland National Park. It lasted 20 days and affected more than 1000 hectares of forest. According to ecological experts, however, this is a greater tragedy for people than for nature, because in the conditions of the no-intervention zones of the National Park, natural regeneration should occur relatively quickly. However, the fire showed how vital it is, even in our conditions, to have an early warning system that could prevent large fires. CzechGlobe is ready to be of assistance in this field as well, as we have been involved in fire weather and fire risk forecasting for some time now and run the FireRisk web application. According to FireRisk project coordinator prof. Trnka, a week before the fire, data from the measuring stations had already showed that it could happen. In order to make our forecasts even more precise, three of our colleagues took part in an internship at the Fire sciences laboratory in Missoula, Montana (USA) in the autumn, where they learned how to calibrate the FlamMap model (describing potential fire behavior under constant environmental conditions) and forest fuel types for the Czech Republic.

In November, the COP 27 climate conference was held in Sharm el-Sheikh, Egypt, which was expected to strengthen measures to gradually reduce greenhouse gas emissions and achieve the goal of keeping global warming to 1.5°C, as set by the Paris Agreement. Although the final declaration confirmed the goal as well as earlier commitments regarding the reduction of emissions and the reduction of coal burning, there was no significant progress compared to the previous conference in Glasgow. One can only speculate whether the record-breaking attendance of representatives of the fossil lobby at the summit contributed to this. The most significant result of the two-week conference was the agreement reached at its very end on the creation of a common fund for compensation of climate damage caused to poorer countries. Those countries that have been assessed as developing but are in fact already developed and are among the biggest polluters should newly perhaps also contribute to this fund. China is a typical example. -mš-

Meet one of us

MGR. PAVEL ZAHRADNÍČEK, PH.D.

is a Brno native and has been loyal to this city for 41 years. He graduated in geography and history for teachers at the Faculty of Science of Masaryk University (FoS MU) in Brno. He completed his doctoral studies in the field of Physical Geography at the Department of Geography, FoS MU. Since 2007, he has worked as a meteorologist and climatologist at the Czech Hydrometeorological Institute in Brno. In 2011, he started working part-time at the Global Change Research Institute of the Czech Academy of Sciences – CzechGlobe, which later became his main employer. He deals with the analysis of climatological series, participates in drought monitoring for the needs of the Intersucho application and for early warning systems against forest fires (FireRisk) and against abiotic and biotic risks in agriculture (AgroRisk). As part of cooperation with energy companies, he is engaged in the final fine-tuning of special operational forecasts for energy companies. He is the author or co-author of 89 publications listed in WoS.

On the occasion of the COP 27 climate conference in Sharm el-Sheikh, Egypt, the World Meteorological Organization (WMO) released a report showing that Europe has been warming twice as fast as the rest of the continents over the last thirty years. Why Europe?

In general, the land warms faster than the oceans, hence the Northern Hemisphere, because there is more land. In addition, part of the Arctic also belongs to Europe geographically, and it is warming the fastest. Therefore, statistically, it is logical that Europe as a continent is warming the fastest. The global air temperature has risen by about 1.2°C compared to the pre-industrial period 1850–1900. In the Czech Republic, however, the air temperature has increased by 1.9 °C in the last 30 years (1991–2020) compared to the period 1851–1900. And the last decade was even warmer by 2.6°C. It was the warmest decade ever in the Czech Republic territory with temperatures on record significantly higher than in all previous periods. Moreover, the warming rate was twice as fast in these years.

According to the WMO report, warming is set to continue, and we probably won't be able to keep global warming below 1.5 degrees Celsius. What should we prepare for in Europe and in the Czech Republic?

Our department has prepared and regularly updates several sets of climate model outputs, which are specifically applied to the conditions of the Czech Republic. This allows us to more accurately predict the impacts of climate change in our region. By 2050, the Czech Republic is expected to warm by 1.4–1.9 °C compared to the period 1981–2010. Overall, the global temperature increase is not expected to remain below 1.5°C.

The expected impacts will generally be the same as we have already observed in recent years. First of all, we must state that weather extremes have always been here in the past, what is changing now is their intensity and frequency though. For example, if previously an extreme occurred once every ten years, in the current climate it is already three times a decade. With further warming, it may be every other year and it will basically become the new normal, which will no longer be an extreme, but will cause great damage and inconvenience. Typical extremes that belong to Central Europe are drought and floods. These have always been here in the past, but in the last 30 years we have experienced the worst drought in 2000 years and also the summer floods across Europe were the most frequent in 500 years. Although these are two completely different extremes, they simply occur more often. In April 2020, a huge drought peaked in the Czech Republic, and in the following summer months came floods, which unfortunately took a toll on several human lives and billions in property damage.

Other extremes that will occur more often in the Czech Republic will be heat waves, which significantly increase the health burden on the population and also have an adverse effect on nature. The number of tropical days with a maximum air temperature of 30°C or more has tripled over the past 60 years, and there have been 40-60% more of them than the models had predicted in the most pessimistic scenario.

At the other extreme are mild winters. They have been gradually warming up, but we haven't felt it too much, as the air temperatures have still often been below freezing point, so there was also enough snow. But in the last decade, the air temperatures have increasingly crossed the threshold in winter, and instead of snowing, it rains, and of course this is mainly in the middle and lower elevations. In the past decade, we have had only half the number of days with snow cover compared to the 1961-1990 normal, and the number of days with more than 10 cm of snow cover has fallen by two-thirds. Going forward, we expect snow to continue to decline, but it will still remain on our mountains, even though the winter seasons will be shorter.

It is assumed that these expected phenomena will bring a whole range of negative consequences. How will deepening climate change affect the environment, the economy, e.g. in agriculture, and the health of the population?

Climate change already has a negative impact on the environment, the economy and the health of the population. Compared to other natural elements, heat waves claim the most human lives worldwide each year. In our country, the impacts of climate change most often affect agriculture. During the drought of 2011–2012, crop yields in some districts were lower than in the 1960s. In 2018, when there was drought for practically the entire growing season, crop yields fell by up to 40%. There is a risk that in the future, for example, growing wheat in our conditions will be unprofitable. On the other hand, we could be more successful in growing grapevine and, for example, its red varieties, which require sufficient heat, could improve significantly in quality.

Living in cities, where the majority of the population lives, is also becoming a major problem, and the proportion of urban dwellers will increase in the future. In the urban environment, two interacting effects combine, namely climate change and the urban heat island. The latter is created by the combination of three factors – the inappropriate structure of the city, the materials used and the generated waste heat. As a result, cities are warming faster than their surroundings. Paradoxically, the biggest problem of cities is not so much the daily maximum air temperatures during the hot summer, but the subsequent nights. During the day, for example, the agrarian areas around Prague can heat up to similar or even higher temperatures than the center of

Prague, but at night there is a radical change, when the landscape can cool down, but the city maintains a high air temperature due to poor ventilation and heat accumulation in materials. It is up to 7 °C higher in the city than in the surrounding areas. This results in generally very poor night-time living comfort in cities, i.e. heated apartments, subsequently poor sleep of the residents, etc. In the period 1961–1990, only 7 tropical nights were recorded in the center of Prague in 30 years, but since 1991 there have been more than 109, i.e. a fifteen-fold increase.

As one of the key players, it is Europe that takes the most responsibility to stop warming and has set the most ambitious goals in this regard (in addition to achieving carbon neutrality by 2050, it is also to reduce emissions by 55% by 2030 as part of the Fit for 55 climate package). Will this help us?

Europe has historically been the most responsible continent for the emissions that we emitted into the atmosphere in the past, and therefore the most responsible for the current warming. Therefore, the planned changes to reduce emissions are absolutely necessary and appropriate, and if this also means a technological shift, believe me, Europe will not be left alone and the rest of the world will join in very quickly, seeing this as an opportunity for new economic and hopefully sustainable growth.

One of the measures to mitigate warming is the replacement of conventional energy sources - mainly fossil fuels – with renewable energy sources (RES). Nevertheless they are still unstable due to their dependence on weather conditions. In your department, among other things, you deal with forecasts for energy companies, on the basis of which they can plan and manage the involvement of various energy sources, thus contributing to energy security. What can you tell us about this?

Measures to mitigate the amount of greenhouse gas emissions must be large and systemic. As the largest source of emissions in our country is the energy sector, it is clear that the transformation of this sector would solve a large part of the problem. However, the transformation of the energy sector must also take into account the security situation. Since 2012, our department has been cooperating with the company E.ON Energy, to which we supply special hourly forecasts to estimate the production of photovoltaic and wind power plants. By doing so, we are trying to reduce the instability of these sources and make them a safe and very efficient source of electrical energy. I think we are doing well because in 2020 we successfully went through a new tender and beat competition from Germany and Spain. Thanks to this, we will continue supplying these predictions for E.ON Energy in the years to come. As for our involvement in the energy sector, I would also like to mention the cooperation with the Amper group, which, among other things, deals with energy savings and has introduced the new CO2IN virtual currency (https://www.co2in.com/cs/). This allows the owners of a special mobile application to participate in the auction of emission allowances and, by buying them, prevent their use by the biggest polluters.

QUO VADITIS CONFERENCE

On 19th – 21st September 2022, the 2nd International Conference **"Quo vaditis agriculture, forestry and society under Global Change? From understanding past and present Earth's processes to adaptations for the future"** was held in Velké Karlovice in the Beskydy Mountains. Its scientific guarantor was the European center of excellence CzechGlobe. Thematically, the conference was devoted to comprehensive research on global change, thus following on from the conference of 2017. The proceedings took place in five expert sections, which highlighted the wide range of topics and possibilities that this field of research offers.

The section **From understanding past and present Earth's processes to adaptations for the future** featured contributions on how air pollution and other stressors affect the health and stability of forests, how climate change affects the urban environment and the water balance of watersheds. There was also a paper on the possibilities of adapting the Czech agricultural landscape to climate change, including the identification of social and cultural barriers.

The section **From molecules to landscape: experimental and observatory studies for the future climate change** included, among others, papers on the effects of nitrogen fertilization on carbon sequestration in boreal pine forests, on the effects of "covid" lockdowns on the amount of emissions and aerosols in the air. Several keynotes were devoted to natural emissions of methane and nitrous oxide, and an interesting topic was also an overview of the possibilities of widespread use of remote sensing techniques in assessing the condition of forest ecosystems.

Contributions in the section **Climate change impacts on terrestrial ecosystems, and the possible ways for their adaptation and climate change mitigation** focused on the role of interactions of multiple factors and on the nonlinearities of responses to combined environmental influences. Papers were devoted to adaptations from the level of molecular mechanisms in wheat to the dynamics of forest condition and natural processes of forest ecosystems under the influence of climate change.

Within the section **Creating the transformation: Policy, Practice and Progress**, researchers reflected on how research contributes to creating transformational changes to mitigate and adapt to climate change and biodiversity loss. The papers presented dealt with the pathways to transformational change in agriculture and the role of institutional changes in shaping and constraining the transformation, the role of sustainability education in shaping the knowledge and activities of younger generations, questions on how ecosystem managers perceive and act on the threats of global change as well as tools and techniques to support decision-makers in creating transformational change in ecosystem management.

Contributions in the section **New approaches and technologies for climate adaptation and mitigation solutions** covered global change research at a wide range from remote sensing imaging of land and a perspective from within the anthroposphere, up to processes occurring at the molecular level of plants. Papers on newly developed tools offering effective non-invasive detection of important indicators or nature-based solutions for reducing environmental pollution dominated. Other interesting topics were alternative biotechnological solutions to existing industrial activities, methods of obtaining biomass, valuable substances and new materials that do not endanger natural resources and are based on the principle of circular economy.

The conference, which was attended by a hundred participants, confirmed that science has an irreplaceable role also in addressing mitigation and adaptation to climate change, in meeting international climate change commitments as well as the objectives of the EU Strategy on Climate Change Adaptation.

PROTECTED FORESTS SLOW DOWN WARMING

GOT OUR ATTENTION

Continued warming pushes many species beyond the limits of their thermal tolerance and increases the risk of their local extinction in the future. In some cases, this process has already begun. In a new study, a team of Chinese and Belgian scientists explored the possibilities of increasing the resilience and chances of survival of individual species and entire ecosystems at the local level. The function of forests as CO_2 "sinks" is very well known and studied in detail. The ability of woody plants to cool the surroundings through evapotranspiration is also well known. A study led by Xiyan Xu, published in the journal *Science Advances*, showed that protecting forest ecosystems can also significantly slow down the rate of warming compared to similar ecosystems that are not protected.

In the study, the authors compared the surface temperature and the rate of warming in protected and unprotected areas in the five major biomes of the planet - in boreal, temperate and tropical forests, and in grassland ecosystems and savannas. In 60% of officially protected areas, the rate of warming was slower than in unprotected areas of the same biomes. One of the reasons for the statistically significantly slower warming is the presence of more lush and structured vegetation that provides more shading. At the same time, this "cooler" vegetation provides favorable conditions for the preservation of biodiversity, as up to 80% of all plant species, including temperate forests, are found in the shade of trees.

According to the results of the study, the cooling effect is most significant in the protected areas of the boreal zone in the northern hemisphere, which is also the largest one and makes up 27% of the global forest area. In this biome, the rate of warming was up to 20% lower than in the surrounding unprotected areas (Fig. 1).

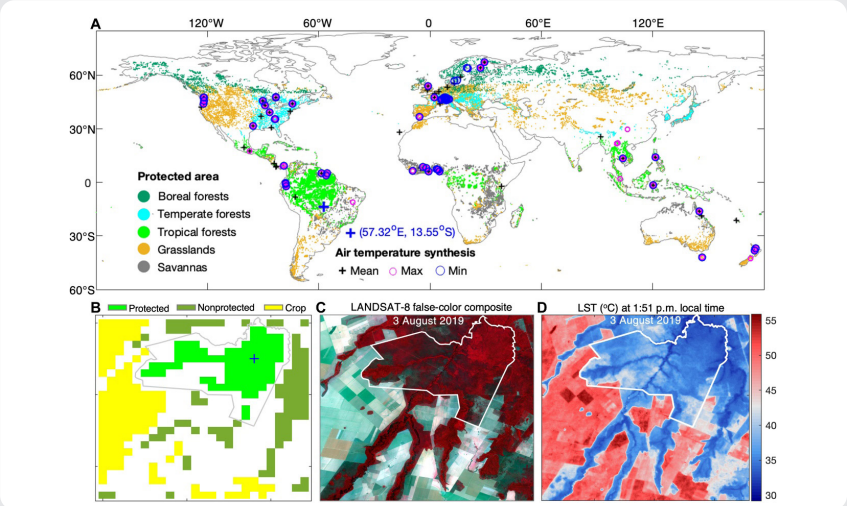

Fig. 1: *Classification of individual biomes according to the MODIS satellite (a). Example comparison of a protected tropical forest site (light green), an unprotected site (dark green) and an agricultural area (yellow) with a pixel resolution of 1 km and a dimension of 0.25° (b). The same location shown in LANDSAT-8 false colors at 30 meter resolution (c) and surface temperature map at 13:51 local time (d). The border shows the edges of the protected area.*

Protected areas have a higher 60% probability of lower maximum temperature and higher minimum temperature compared to unprotected areas, and up to 95% probability compared to agricultural ecosystems. Protected forests in the tropical zone had a lower maximum temperature of up to 0.5 °C on average, and in the case of temperate forests this difference was up to 0.57 °C. Even this seemingly small difference is very important from the biodiversity conservation point of view, since an increase in the maximum daily temperature by 2.86 °C already puts up to 35% of species at risk of local extinction, even if they had the opportunity to move to more suitable habitats. However, this is especially true for species in the tropical zone, which have a lower tolerance to warming and fewer adaptation options.

The paper provides further evidence of the importance of comprehensive protection of forest ecosystems for sustainable management in the landscape. It is indisputable that continued warming will contribute to an increase in both abiotic and biotic disturbances in forests and will represent a significant limit to their management. However, if managed successfully, it may provide the key space that will be needed before carbon neutrality can be achieved at the global level. -aa-

Reference:

Xu X. et al. Protected areas provide thermal buffer against climate change. Science Advances, 2022: https://www.science.org/doi/10.1126/sciadv.abo0119

WHAT´S NEW

Ceremonial book release event

On 7 July 2022, the book "Climate change - causes, impacts and adaptation", which is the result of the work of a team of scientists from the Global Change Research Institute of the Czech Academy of Sciences – CzechGlobe, was ceremonially launched in Prague premises of the Academy of Sciences in the presence of the Minister of the Environment, Anna Hubáčková. The book, published by the Academia publishing house, is devoted to the consequences of global change for both global and Czech society, the historical and current climate in the Czech Republic, as well as scenarios of climate development in the Czech Republic for the 21st century. Other chapters focus, for example, on the impacts of climate change on landscapes, ecosystems, biodiversity and cities, or on mitigation and adaptation measures to reduce the impact of global change.

Week of the Czech Academy of Sciences in CzechGlobe

On 2 November 2022, as part of the Week of the Czech Academy of Sciences, CzechGlobe held an Open Day event at the Brno workplace. Through guided tours and visual demonstrations, visitors could learn about isotopic analyzes and their use, about the identification and quantification of plant metabolism products in the laboratory of metabolomics, learn about the symbiotic coexistence of fungi with the roots of higher plants - mycorrhizae, and learn about remote sensing of the Earth and what can be detected from satellite and aerial data. The set of three popularization lectures offered the topics of the climate crisis, aerosols in the atmosphere and the meaning and function of urban greenery.

Visit of the Danish ambassador

On 1 December 2022, the Ambassador of the Kingdom of Denmark, Søren Kelstrup, visited GCRI. The aim of the visit was to support the deepening of research cooperation within the framework of Czech-Danish intergovernmental relations. Currently, GCRI cooperates with the University of Copenhagen or the Technical University of Denmark through basic research projects. The meeting also highlighted the cooperation with Danish companies in applied research, namely with the biotechnology company Hansen, and in the field of water management with the company DHI, which was directly represented at the meeting by Ing. Pryl.

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The appendix of Newsletter 2/2022 presents a selection of interesting publications by CzechGlobe researchers published in 2022.

Pohanková, E., **Hlavinka, P.**, **Kersebaum, K. C.**, Rodriguez, A., **Balek, J.**, **Bednařík, M.**, **Dubrovský, M.**, Gobin, A., Hoogenboom, G., Moriondo, M., **Nendel, C.**, **Olesen, J. E.**, Roetter, R.P., Ruiz-Ramos, M., Shelia, V., Stella, T., Hoffmann, M.P., Takáč, J., Eitzinger, J., Dibari, C., Ferrise, R., **Bláhová, M.**, **Trnka, M.** Expected effects of climate change on the production and water use of crop rotation management reproduced by crop model ensemble for Czech Republic sites. *European Journal of Agronomy* 2022, 134(Jan), 126446. ISSN 1161-0301. E-ISSN 1873-7331.

Crop rotation, fertilization and residue management affect the water balance and crop production and can lead to different sensitivities to climate change. To assess the impacts of climate change on crop rotations, the crop model ensemble (APSIM, AQUACROP, CROPSYST, DAISY, DSSAT, HERMES, MONICA) to simulate crop yields and water balance of two crop rotations with the same set of field crops (winter wheat, silage maize, spring barley and winter oil seed rape) in a continuous transient run from 1961 to 2080 was used. The main difference between included crop rotations was cover crops and organic fertilizers cattle manure inclusion. Simulations were performed using two contrast soil types (Chernozem, Cambisol) within three sites in the Czech Republic (Lednice, Věrovany, Domanínek), which represent temperature and precipitation gradients for target crops in central Europe. For the description of possible future climatic condition seven representative climate change scenarios were selected. For majority of scenarios used ensemble expect higher average yields for C3 crops in crop rotation containing catch crops and manure application. In the case of silage maize it depends on locality and if the available hybrids will be able to cope with warmer and drier conditions in the future. Generally higher actual yearly evapotranspiration could be expected in the future especially for good soil conditions.

Brázdil, R., Zahradník, P., Szabó, P., **Chromá, K.**, **Dobrovolný, P.**, **Dolák, L.**, **Trnka, M.**, Řehoř, J., Suchánková, S. Meteorological and climatological triggers of notable past and present bark beetle outbreaks in the Czech Republic. *Clim. Past.* 2022, 18, 2155–2180.

Bark beetle outbreaks have recently caused great damage to Norway spruce forests across Europe, including the Czech Republic. This study aims to answer two main questions. The first one, does recent climate change alter the conditions of bark beetle outbreak occurrences? And the second one, how significant is this last (current) outbreak in the context of preceding bark beetle outbreaks? Based on documentary evidence (e.g. from the project of forest history research describing in detail the history of forest units in the Czech Republic), a chronology of bark beetle outbreaks of the 1781–1963 period, continuing from 1964 to2021 by bark beetle salvage felling. The most important bark beetle calamities were identified in 1834–1839, 1870–1875, 1945–1954, 1982–1987, 1992–1995, 2007–2010 a 2015–2021. Each of these notable calamities was analyzed in detail with respect to the spatial extent of bark beetle within the Czech Republic, the volume of damaged wood (only for events after 1980) and their meteorological patterns including air temperature, precipitation and drought index expressed as anomalies from the 1961–1990 reference period, and complemented by the influence of windstorms and prevailing atmospheric circulation. The analysis showed that in the 19th century extreme windstorms were the main trigger of bark beetle calamities, when it was not possible to remove blowdown wood from forests relatively fast. It created good conditions for subsequent bark beetle infestation. Devastating effects might have been intensified by drought episodes following after the windstorm. Bark beetle calamities after the 1980s can be attributed to recent climate change. They are a result of strongly increasing air temperatures combined with relatively stable precipitation totals, finally leading to more frequent and severe droughts. This means, that environmental conditions for spruce worsened at many stands, making trees more susceptible to different types of damage including bark beetle infestation. Damaging windstorms may subsequently worsen the situation. The last bark beetle calamity since 2015 has no historical analogue neither in extent (in 58-year long series, more than 60% of total bark beetle salvage felling occurred in the last seven years) nor in devastating effects on spruce forests in the Czech Republic. Thus, Czech forests have changed from absorber to source of atmospheric CO_2 since 2018, contributing to increasing GHG concentrations.

Oulehle, F., Tahovská, K., **Ač, A.**, **Kolář, T.**, **Rybníček, M.**, Čermák, P., **Štěpánek, P.**, **Trnka, M.**, **Urban, O.**, **Hruška, J.** Changes in forest nitrogen cycling across deposition gradient revealed by $\delta^{15}N$ in tree rings. *Environmental Pollution*. 2022, 304(Jul), 119104. ISSN 0269-7491. E-ISSN 1873-6424.

The carbon and water balance of terrestrial ecosystems are influenced by climate change and global anthropogenic emissions of nitrogen. The biosphere is naturally low in specific elements, generally known as limiting nutrients, such as nitrogen and phosphorus. Due to fossil fuel combustion and intensified agriculture, Earth's ecosystems became enriched by nitrogen, and natural ecosystems, like forests, became more productive. With accelerated productivity, more carbon can be stored in living biomass. Nevertheless, the capacity of forests is temporarily limited, and nutrient-enriched ecosystems usually support less plant diversity. Our research focused on the long-term (>100 years) development of nitrogen isotope signal (^{14}N and ^{15}N) in tree rings along a pollution gradient. We sampled five sites and three tree species (spruce, fir and beech) spanning from less nitrogen-polluted Novohradské hory up to polluted Orlické hory. We found that phosphorus availability controlled nitrogen cycling. Sites with high phosphorus availability were connected to higher nitrogen utilization from deposition. We show that phosphorus availability likely influences nitrogen retention; thus, low phosphorus availability might be accompanied by higher N losses causing surface water eutrophication and N_2O emissions. Species-specific effect on nitrogen cycling was demonstrated through specific phosphorus content in tree litterfall (leaves vs needles). Beech forests were usually more phosphorus-rich, thus efficiently utilizing nitrogen from the atmosphere. We demonstrated that information on nitrogen isotopes in the tree-ring archive provided valuable insight into past nutrient cycling and provided the necessary information for future predictions.

Lembrechts, J. J., Van den Hoogen, J., Aalto, J., Kopecký, M., Altman, J., Brůna, J., Doležal, J., **Dušek, J.**, Hederová, L., Kašpar, V., Macek, M., Man, M., **Pavelka, M.**, Petit Bon, M., Wild, J. Global maps of soil temperature. *Global Change Biology* 2022, 28(9), 3110-3144. ISSN 1354-1013. E-ISSN 1365-2486.

Research in global change ecology relies heavily on global climatic grids derived from estimates of air temperature in open areas at around 2 m above the ground. These climatic grids do not reflect conditions below vegetation canopies and near the ground surface, where critical ecosystem functions occur and most terrestrial species reside. Here, we provide global maps of soil temperature and bioclimatic variables at a 1-km^2 resolution for 0–5 and 5–15 cm soil depth. These maps were created by calculating the difference between in situ soil temperature measurements, based on time series from over 1200 1-km^2 pixels (summarized from 8519 unique temperature sensors) across all the world's major terrestrial biomes, and coarse-grained air temperature estimates from ERA5-Land (an atmospheric reanalysis by the European Centre for Medium-Range Weather Forecasts). We show that mean annual soil temperature differs markedly from the corresponding gridded air temperature, by up to 10°C (mean = 3.0 ± 2.1°C), with substantial variation across biomes and seasons. Over the year, soils in cold and/or dry biomes are substantially warmer (+3.6 ± 2.3°C) than gridded air temperature, whereas soils in warm and humid environments are on average slightly cooler (–0.7 ± 2.3°C). The observed substantial and biome-specific offsets emphasize the fact that the projected impacts of climate and climate change on near-surface biodiversity and ecosystem functioning are inaccurately assessed when air rather than soil temperature is used, especially in cold environments. The global soil-related bioclimatic variables provided here are an important step forward for any application in ecology and related disciplines. Nevertheless, we highlight the need to fill remaining geographic gaps by collecting more in situ measurements of microclimate conditions to further enhance the spatiotemporal resolution of global soil temperature products for ecological applications

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Kroel-Dulay, G., Mojzes, A., Szitar, K., Bahn, M., Batáry, P., Beier, C., Bilton, M., De Boeck, H. J., Dukes, J., Estiarte, M., **Holub, P.**, Jentsch, A., Schmidt, I., Kreyling, J., Reinsch, S., Larsen, K. S., Sternberg, M., Tielboerger, K., Tietema, A., Vicca, S., Penuelas, J. Field experiments underestimate aboveground biomass response to drought. *Nature Ecology & Evolution* 2022, 6(5), 540-545. ISSN 2397-334X. E-ISSN 2397-334X.

Researchers use both experiments and observations to study the impacts of climate change on ecosystems, but results from these contrasting approaches have not been systematically compared for droughts. Using a meta-analysis and accounting for potential confounding factors, we demonstrate that aboveground biomass responded only about half as much to experimentally imposed drought events as to natural droughts. Our findings indicate that experimental results may underestimate climate change impacts and highlight the need to integrate results across approaches. We conclude that while ecosystem experiments are an invaluable tool for studying the impacts of climate change, especially to distinguish among the effects of factors that change simultaneously and to unravel the mechanisms of ecosystem responses, they may underestimate the magnitude of the effects of climate change. Thus, innovative new work that integrates experimental and observational datasets could more reliably quantify the effects of climate change on terrestrial ecosystems.

Urban, J., & Kohlová, M. B. The COVID-19 crisis does not diminish environmental motivation: Evidence from two panel studies of decision making and self-reported pro-environmental behavior. *Journal of Environmental Psychology* 2022, 101761. https://doi.org/10.1016/j.jenvp.2022.101761

The Covid waves that took place in 2020 and 2021 had a dramatic impact on the daily lives of people around the world. The Covid crisis has virtually halted the daily rhythm of our lives and exposed the fragility of our existence. Some authors have therefore hypothesized that they might have changed our motivation to protect the environment and confront the climate crisis.

In our paper, we look at whether the Covid crisis and the associated restrictions on movement and everyday activities (referred to summarily as "lock downs") have indeed led to changes in individual behavior related to environmental and climate protection, and whether they have changed people's motivation to protect the environment and climate. In this paper we have drawn on a theory of environmental attitudes known as the Campbell paradigm. This theory allows for the assessment of environmental motivation using statistical measurement models and for the examination of motivation change relative to behavior change.

We conducted two pre-registered studies on random samples of the Czech population (N = 206 and N = 260), in which we recorded how people protected nature and climate before and after the first Covid wave in the spring 2020 and before and after the second Covid wave in the autumn 2020.

The first study was a repeated cross-sectional study conducted on similar samples of different participants, while the second study was a panel study conducted repeatedly on the same participants.

Our studies showed quite consistently that there were changes in people's everyday behavior during the Covid waves, but these changes were both pro- and anti-environmental. For example, there was a reduction in air travel but at the same time, there was also an increase in car use for commuting. Our studies showed that Covid waves did not affect people's motivation to protect the environment and climate. The results of our study, together with other studies, show quite convincingly that the Covid crisis has – unfortunately - not led to a change in pro-environmental behavior and motivation, at least not in the short term.