Newsletter
1/2018

CzechGlobe
Global Change Research Institute CAS

LACK OF YOUNG SCIENTISTS IS BECOMING AN ISSUE

The year 2018 in CzechGlobe began with the concerns associated with the launch of the solution of the new SustES project, which we informed you about in the previous issue. In this connection, CzechGlobe got slightly reorganized and expanded again. According to the rules of the Operational Programme Research, Development and Education, a new section of Adaptation Strategies was formed and at the same time we greatly fortified our team with new foreign professors and experienced scientists.

However, we hit limits in terms of recruiting young workers and doctoral students. Apparently, the current problem that Czech economy particularly worries about - the lack of staff, has also affected the scientific environment. This is also why we took part in the event called Okno do praxe (Window into Practice), which is a meeting of potential employers and students of scientific disciplines of the Palacky University in Olomouc. Colleagues from the Department of Remote Sensing and the Department of Matters and Energy Fluxes pursued to attract and get on board prospective PhD candidates. For the same reason, the representatives of the Institute conducted two missions to Kiev in Ukraine and Yerevan in Armenia in order to present CzechGlobe activities at the local universities and the Academy of Sciences in order to acquire students for doctoral studies for which CzechGlobe is the holder of extended accreditation.

Fortunately, for the time being, the lack of younger years neither endangers the research itself nor related activities. At the beginning of May, CzechGlobe hosted the General Assembly of the C3surf project within the Copernicus Climate Change Services, where – thanks to the Department of Climate Modelling – we belong to a wider consortium that comprises of several national meteorological institutes and is shielded by the organization of European national meteorological services EUMETNET and the University of East Anglia. The workshop concentrated European climatology experts, specialists and administrators of climatological observation databases.

Coincidentally, this happened at a time when the whole of the Czech Republic was concerned with the topic of drought again, which, this time, was associated with unusually high temperatures for this season. After all, the month of April was the warmest since 1800!

In addition to the high temperatures and a lack of precipitation, the Czech Republic concurrently also suffered from the clouds of yellow pollen. Ubiquitous rapeseed was not to blame this time as it was mostly pollen from trees, particularly spruce and pine trees. This would not be so special if the seed years in coniferous trees did not use to average once in seven years. Nowadays this period is considerably shorter and some experts associate it with climate change. It is said, that we will have to get used to the large amount of pollen in the air also due to the fact that the climate change has nearly erased spring from our geographical latitudes and all kinds of trees are blooming practically at once. More pessimistic opinions suggest that more frequent blooming of conifers is the last chance for them to reproduce before they, due to drought and overpopulated bark beetles, in fact die.

Nevertheless, not to underestimate the effects of rapeseed at all, the experts, among others, also prof. Hruška of CzechGlobe, pointed out on the DVTV channel the devastating effects of intense rapeseed cultivation on the soil and the whole environment. Dead soil without soil microorganisms, missing insects with a consequent decline in biodiversity, polluted groundwater by chemicals from herbicide and pesticide sprays ... related to this, two to three weeks of pollen calamity and an unpleasant odor are absolutely incomparable.

With the upcoming summer, some of our colleagues will make themselves sweat – not only because of the persistent hot weather and terrain measurements that comprise the foundation of much of our research. In September, we are organizing a prestigious international conference “The 3rd ICOS Science Conference”, which will primarily focus on greenhouse gases, biogeochemical cycles and climate changes. The conference is organized by the ICOS-ERIC European Research Infrastructure based in Helsinki, with the expected participation of up to 350 scientists. We believe that the program of the conference, which also includes expert excursions at the Ecosystem Station in Třeboň and Atmosferic Station in Křešín near Pacov, will be attractive for all the participants. We will share the outcomes with you again in the Newsletter’s winter issue. -mš-

We present a department of xylogenetics and biomass production

THE COMPOSITION OF WOOD SIGNIFICANTLY INFLUENCES THE PHYSIOLOGICAL RESPONSES OF WOODY PLANTS TO THE EFFECTS OF EXTERNAL FACTORS

says Prof. Dr. Ing. Petr Horáček, the Head of the Department of Xylogenesis and Biomass Allocation at the GCRI CAS. He graduated from Forest Engineering at Brno University of Technology (today's Mendel University), where he also defended his dissertation thesis in Applied and Landscape Ecology. After a short time at the North Moravian State Forests of Krnov, he worked at the Faculty of Forestry and Wood Technology at Mendel University in Brno in 1989–2016. Here, in 1995, he founded the Department of Wood Science, which he led until 2010. In 2006-2014 he was the Dean of the Faculty. He was appointed Professor in 2013 in the field of Wood Processing and Furniture Production Processes. Since 2016 he has been working at the GCRI CAS. As an academic, he is also active at the Faculty of Forestry and Wood Sciences of the Czech University of Life Sciences Prague and at the Institute of Forensic Engineering, Brno University of Technology. From 1997 to 2004, he was a member of the United Nations Economic Commission for Forests and the Forest Industry. At the national level, he worked as an adviser to the Ministry of Agriculture and the Ministry of Industry and Trade.

You came to CzechGlobe quite recently, didn't you? What was it like to relocate from the university environment to the CAS Institute?

When I came to CzechGlobe in 2016, it was a completely different world for me after years spent at the Mendel University. Compared to the competitiveness, stabs of envy and even mutual hostility at the university, here, from the very beginning, I have just encountered open and friendly community of people dealing with the central theme of the 21st century – the global ecological crisis. Unfortunately, the essence of ecological crisis remains unclear for the wider public also due to the current education. In order to understand the heart of ecological crisis well and to be able to successfully face it, we need the ability to adequately ask and answer questions related to the whole world. I.e. to look at one theme from different angles of view, combine approaches and primarily not to be narrow-minded. After the initial surprise that there are also sociologists working at the Institute, I realized that the possible core of ecological crisis is not the conflict between man and nature, as might seem at first glance, but the clash of human culture with nature. Instead of technological controlling of nature and the pragmatic fulfillment of man's short-term goals, which was what I devoted myself to at university, I began to think about the existential dependence of culture on nature. I began to think about biology-oriented education, whose essence is humility and respect for nature stemming from the understanding of its uniqueness and functioning. Humility and respect also applies to the promotion of new research directions. What was hardly conceivable for me at university was almost effortless at the CAS workplace. After designing, discussing and defending the new concept of the department, there was a qualitative leap towards the complexity of the research. It is a matter of course for us not only to share data, but even to subordinate the design of our own experiments to others in order for the result to benefit everyone.

Your joining the department and later assuming the leadership over it brought about quite a change. What kind of change was it?

I joined the Department of Water Management, Production and Allocation of Biomass. The objectives of the department were defined very broadly – to describe and quantify the water and carbon balance of selected types of stands of the given structure, to temporarily and spatially identify the production activity of forest tree species stands depending on the influence of environmental factors and to model the development of the whole ecosystem. The basis of the concept of the department was the ecophysiological study of the mass and energy balance of the tree production processes, focusing in particular on sequestration and carbon allocation in tree biomass. This concept turned out to be too ambitious and unrealistic because we lacked the basic knowledge of how changing environmental factors – due to global climate change (GCC) – modify tree growth. Adaptation to Climate Change (CC) and proposal of adaptation measures assumes an understanding of the effect of the length and intensity of environmental factors on the dynamics of tree growth. An example may be water deficit, which leads to reduced growth and also to the increased probability of withering and dying of forest stands.

In the course of 2017, we therefore revised the concept of the department and completely redesigned it. We found out that we are not able to study both the energy and mass balance of production processes equally intensively, so we decided to focus exclusively on the mass balance, where we focused on growth responses at a variety of levels. As a result of the rapid increase in temperature and concurrent increase of water deficit from the 1980s to the 1990s, the structure and properties of wood tissues are changing, including their ability to meet contradictory requirements to ensure their hydraulic and mechanical functions. The result is the modification of the tissue forming processes, while not only the external composition and the internal structure of the tree organs (morphology) is changing, but also the duration (phenology) and growth rate (physiology), which may be the manifestation of the tree's adaptations to the CC. Changes in the external composition and the internal structure of the tree organs, depending on the anticipated effect of the CC, are also reflected in their ability / inability to acclimate or adapt to changes in the environment. Following the change in focus of the department, we also changed the name of the department to the Department of Xylogenesis and Biomass Allocation. We also withdrew from studying entire ecosystems, or more precisely tree stands, and we started to focus on studying individual trees instead.

Our aim is therefore to evaluate changes in the external composition and internal structure of the tree organs, depending on the ecophysiological effect of environmental factors, especially the effects of drought in the period from 1961 until today. This will help us to discover and describe the generally applicable regulatory mechanisms of carbon allocation into the tissues of the tree, especially xylem, during the influence of stressors inducing water and temperature stress. We would like to analyze the different strategies of growth responses of woody species and, in particular, to compare the hydraulic and mechanical functions of the tissues. Based on the general model of growth response of woody species in the continuum soil – plant – atmosphere, we would also like to synthesize the growth with physiological reactions – photosynthesis, transpiration

DEPARTMENT OF XYLOGENESIS AND BIOMASS ALLOCATION

The Department is included in the Domain of Environmental Effects on Terrestrial Ecosystems. It deals with the assessment of changes in the external construction and internal structure of tree organs due to environmental factors. It also deals with the analysis of growth response strategies in trees, in particular using comparison between the hydraulic and mechanical functions of tissues, and with the understanding of the carbon cycle with an emphasis on the dynamics of carbon storage in aboveground and underground biomass.
The Department employs three scientists, five PhD students and three technicians.

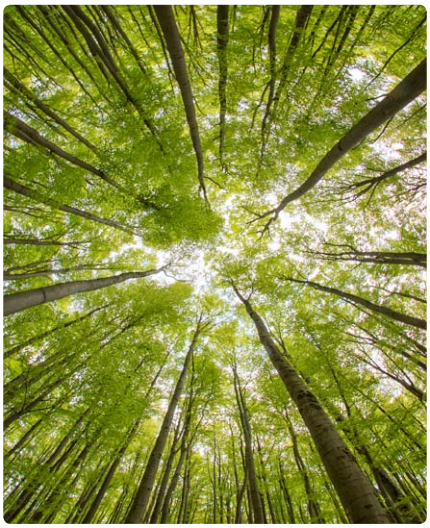
and respiration, in particular with the transport of water and non-structural carbohydrates. The ultimate goal is to decipher the carbon cycle, with an emphasis on the dynamics of carbon storage in the individual aboveground and underground tree organs. This is a superstructure for data provided by the Eddy-covariance system where we are accurately able to locate the place, time and amount of carbon stored using our carbon allocation estimation methods.

Can you explain the term 'Xylogenesis' in the name of the department?

The term 'Xylogenesis' in the name of the department expresses part of the processes related to wood formation. By wood formation, we mean secondary radial growth due to the division activities of secondary meristems - cambium and phellogen. Wood formation has two dimensions - xylogenesis and morphogenesis. Xylogenesis describes the process of differentiation of xylem elements (wood) and includes all cell cycle phases - embryonic (division of the cambial initials and maternal cells of the wood), prolongation (transversal and longitudinal cell growth) and differentiation (lignification and cell wall thickening). As part of xylogenesis, we study the initiation and termination of division activities of the cambium and the influence of growth factors, the mechanism of differentiation and the influence of environmental factors, the relationship between the formation of wood and phloem, the duration and the rate of the cell cycle phases. Morphogenesis, on the other hand, describes changes in the shape of the cell - its dimensions. We study the resulting dimensions of cells formed through xylogenesis. We are interested in their variability during cell development within one year, variability among individual organs (root, trunk, branch), but also variability within one organ. By combining both approaches (xylogenesis and morphogenesis), we are able to determine when, where and how much biomass was stored in wood at the level of cells, tissues, organs and individuals.

Does climate change affect wood formation as well then?

Yes, it does, the example is a connection with the water regime in spruce. Spruce physically, like any other plant, essentially only bridges the difference in water content in soil and air. And to such difference it responses passively - the bigger the difference between the water content in the soil and the air, the more water it transpires. The driving force of water movement in the plant is the difference in water potential in soil and air. The water potential of the air depends mainly on the air temperature and humidity. Wind also contributes to the evaporation of water. Often we speak about dry winds blowing out moisture from the air over the forests to the countryside without trees. Generally, the drier the air, the faster the output of water out of the woody plant. The greater the output of water out of the tree, the higher the need for creating pathways that lead the water from the roots to the leaves. Logically, the growth rate of wood increases with increasing water output. However, substances and energy needed for defense reactions, for example against bark beetles, are exhausted. With longer drought stress accompanied by high temperatures cells get gradually smaller and smaller with an increasingly thin cell wall. Conductivity of wood for water movement decreases and water stress increases. As the transverse dimensions of the cells change, so does their bulk density, which paradoxically increases. Changes in dimensions also result in less ability to cope with the internal tension of transpired water, and smaller cell of spring-wood with thinner cell walls begin to be prone to failures due to mechanical stress. Based on the knowledge of the boundary dimensions of individual cells, it is possible to determine how long water stress affected the spruce at the site in the past and how long the spruce will be able to withstand water stress. Wood composition has a significant impact on



the physiological responses of trees to the effects of factors, much more than we were willing to admit in the past.

What methods do you work with?

The influence of GC on tree growth is examined both by theoretical and field methods. As for the theoretical methods we deal with mechanistic modeling focused on the morphological and physiological parameters of growth in given environmental conditions. The models allow us to identify factors that limit growth under the CC pressure. In terms of field methods, we use studies comparing the impact of CC on woody-plants growth from one given site at different times. Here we can enjoy the network of forest ecosystem stations in Lanžhot (floodplain forest), Rájec-Němčice (spruce forests at medium altitudes), Štítná nad Vláří (beech forest of higher altitudes) and Bílý Kříž (spruce forest of mountain altitudes). Further, we use studies that monitor phenotypic changes, phenological changes or morphological changes in woody plants over time at various sites under the influence of CC. At ecosystem sites we compare the reactions among model trees (spruce, beech, oak, ash, hornbeam) to one another. For manipulative experiments we also use spheres at Bílý Kříž.

Woody-plants growth strategies are studied through direct and indirect methods used to quantify growth over time based on periodic measurements. We use periodic sampling of tissue samples from micro-boreholes from trunk, coarse roots and skeletal branches. We analyze the anatomical dimensions of elements of xylem and phloem in the transverse and longitudinal directions. We determine the hydraulic conductivity, buckling strength, density, speed and duration of growth, as well as one-shot sampling from trunk boreholes, coarse roots and skeletal branches to determine the relative position of the cells in the ring, the proportion of spring and summer wood, the change in ring size and wood density over time. We further monitor the radial growth of trunk, coarse roots and skeletal branches using band dendrometers, long growth of fine root by a root scanner, responses at a leaf-level, we measure trunk profiles, and we perform overall phenological observations.

What projects are you currently working on?

At present, we are engaged in projects focusing on application outputs (e.g. Technology agency of the Czech Republic - Determination of Norway Spruce Stress using Direct Methods). The aim is to determine such woody-plant properties that would allow us to identify debilitated stressed spruce individuals by monitoring the initial ecophysiological changes. These can be manifested in a change in the morphology of whole organs, tissue or individual cells, but also in the rate of growth. In the case of changes in cell morphology, what seems promising is the assessment of the degree of drought stress based on the cell diameter and cell wall thickness ratio. It turns out that cell dimensions are key properties determining the trees' ability to acclimate.

LIMITATION OF WARMING SAVES THE GLOBAL ECONOMY BILLIONS

GOT OUR ATTENTION

In the context of proposed climate change solutions, the topic that is often discussed is the financial costs associated with reducing the consumption of fossil fuels. A new study, however, evaluated the other side of the same coin and looked at the money saved. In other words, for the first time, scientists have tried to globally quantify what economic losses could potentially be avoided if warming by more than 1.5 °C was prevented.

Initial hopes for a possible reversal in the global carbon dioxide (CO_2) emission trend were dashed by the data on a record-breaking high value in 2017. This trend is expected to continue this year as well. Therefore, it is already clear that to limit global warming to the threshold defined by the Paris Agreement (PA) will by no means be an easy and inexpensive matter. Fulfillment of the current commitments of individual states stemming from the PA would mean global warming by 2.5 up to 3 °C by the end of this century. However, since individual countries have not yet adopted a trajectory aiming to reduce emissions, the expected warming is to be around 3.5 °C or more by the end of the century. That's why it's important to have an idea of how much damage could potentially be avoided if the continuation of warming was prevented.

According to a study led by Marshall Burke of Stanford University, published by Nature magazine, global warming by 4 °C by the end of

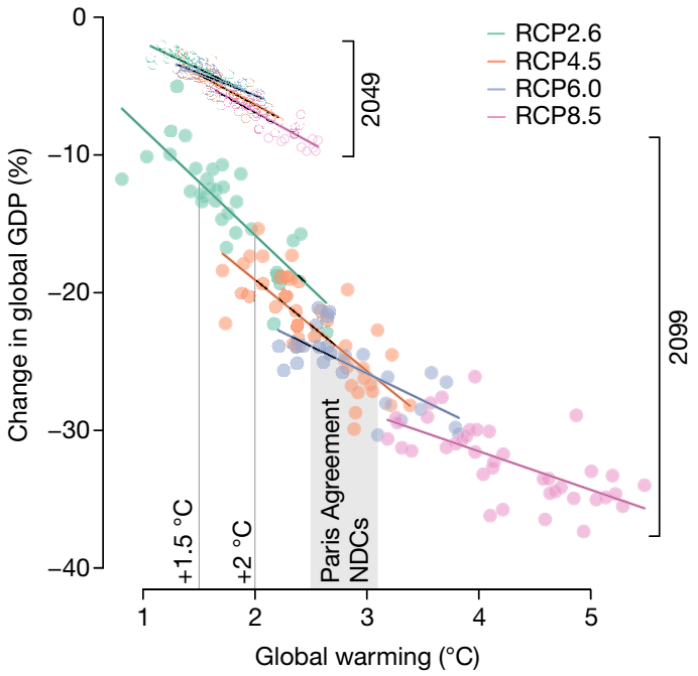


Fig. 1: Forecast of the decline in average global GDP (Gross Domestic Product) by the middle and the end of this century according to greenhouse gases concentrations trajectories (so-called representative emission scenarios - Representative Concentration Pathways - RCP).

the century would mean an average reduction in gross domestic product (GDP) per capita by more than 30% compared to a scenario that expects no further warming (Figure 1). If warming was limited to the threshold of 1.5 °C compared to the 2 °C threshold, it would bring about a potential economic benefit of about $ 20 trillion, which would affect up to 90% of the world's population. It is approximately 30 times the estimated economic costs associated with climate change mitigation to a warming level of 1.5 °C.

As a starting point for this analysis, authors used the data on the relationship between GDP and the average temperature over the last 50 years. Relatively the greatest benefit would be enjoyed by the countries in areas where it is hot already today. For people in these areas, any further warming means more significant limitation of their economic activity compared to cooler areas. The economic benefits of limited warming could be even more pronounced if ocean levels rose faster than expected today, or if extreme weather exceeded the limits of historical observations. -aa-

Reference: Burke et al., Nature, 2018: https://www.nature.com/articles/s41586-018-0071-9

WHAT´S NEW

Prof. Marek was awarded the City of Brno Prize

On 30th January 2018 the Director of the Global Change Research Institute CAS – CzechGlobe, prof. Michal Marek, accepted the City of Brno Prize that was presented by the First Deputy Mayor Petr Hladík. As the founder of the European Center of Excellence – CzechGlobe – he received the prize in the field of natural sciences.

Co-organizing a workshop in Zambia

On 18th April 2018 CzechGlobe co-organized a workshop in Lusaka (Zambia) within the SEACRIFOG project. The workshop was part of the conference called SASSCAL Science Symposium 2018. It was intended for the representatives of the academic sector, governmental and non-governmental institutions in South Africa countries and it addressed issues of the changes in land use and implications for food security, greenhouse gas monitoring, mitigation and capacity building in the mentioned areas. The workshop included panel discussions focusing on identifying user needs and knowledge requirements for the development of a research infrastructure. The main panelists included our colleagues E. Krkoška Lorencová and M. Acosta.

Visit of the Ambassador of the State of Israel

On 11th June 2018 Mr. Daniel Meron, the Ambassador of the State of Israel in the Czech Republic, visited GCRI. He met with the management of the Institute and with the representatives of the scientists who introduced CzechGlobe, its scientific activities and its interconnection with international research projects. The aim of the visit to the South Moravian Region and CzechGlobe, organized by the Czech-Israeli Mixed Chamber of Commerce, was to support the deeper cooperation of Israeli and Czech institutions in research and development.

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