Biosphere Reserves and Climate Adaptation

Volume 2 – Climate Change Impacts and Adaptation Ivano Frankove, 2021

Roztochya Biosphere Reserve – Climate Change Impacts and Adaptation

Climate enables life – life influences climate

Man-made climate change poses a particular challenge for ecosystems and people living in them. In the worst-case scenario, sharp changes in temperature and precipitation patterns will necessitate a restructuring of the ecosystem as important flora and fauna species become extinct or replaced. This has happened several times in the history of the earth. However, such restructuring has often been accompanied by significant and abrupt losses in functionality. Furthermore, the current change is extremely rapid. Advantageously, ecosystems have important properties and functions which humans can use to adapt to climate change: they catch water, store and retain it in the landscape and thereby cool it, reduce wind speeds, and buffer extreme weather events of all kinds. Yet, if we continue to unsustainably utilise natural resources, e.g. solely for the production of biomass as in intensive agriculture or forestry, many of these properties will be lost. The ecosystem-based sustainable development approach aims at a balanced use of as many ecosystem services as possible without destroying the functional efficiency and self-healing powers of nature.

(1) Flood rescue and evacuation
(cc4.0) State Emergency Service of Ukraine

Ecosystem services (ES): Outputs, conditions, or processes of natural systems that directly or indirectly benefit humans or enhance social welfare. Citation: R.J. Johnston, Britannica

They can be subdivided into three categories:

Regulating: Air and water purification, soil formation, pollination, decomposition, erosion and flood control (e.g. through soil- and plant water retention), carbon storage, and climate regulation.

Provisioning: Goods (biomass and genetic materials) – e.g. food (fish, fruit and vegetables, etc.), seeds, clean air and water, timber (e.g. as construction material), and fuel materials (firewood).

Cultural: Aesthetic, spiritual, and cultural values; physical and intellectual interaction in education, research, and art. Also, space and conditions for recreational and sports activities.

Based on: Common Classification of Ecosystem Services (CICES) developed by Haines-Young & Potschin

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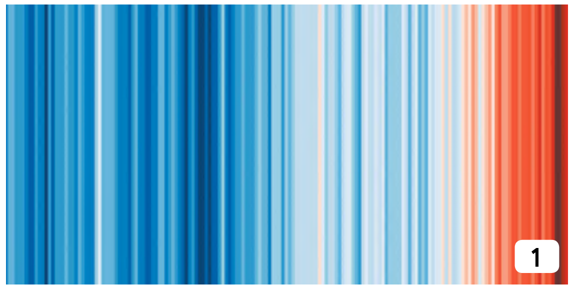
Climate Change
The biggest challenge for humanity

Global temperature change (1860–2019)



Climate change is not a scenario anymore. Humans are increasingly influencing the climate system by burning fossil fuels, cutting down forests, and practising increasingly intensive and large-scale agriculture. These harmful activities add enormous amounts of greenhouse gases to those naturally occurring in the atmosphere, leading, with a time lag, to global warming and other climate changes.

Planet Earth is unique. The interplay of its properties allows water to exist on its surface in liquid form, which is an essential condition for life. The globe of approximately 12,700 km thickness is surrounded by the biosphere as if it were a macroscopic biofilm. This fragmented and delicate film, which even in the areas of the mightiest forests corresponds to less than 0.0005% of the earth's diameter, contains all known forms of life, produces our food, and thus forms the basis of our existence. The composition of the atmosphere surrounding it and the global greenhouse effect are also significantly influenced by the biosphere.

The Great Acceleration

For several hundred thousand years, humans have been just some of the numerous actors in this delicate biosphere layer. But it is only in the last 150 years that technological and social developments have led to the incomparably rapid growth of a wide variety of factors, which have significantly changed the state of both the biosphere and atmosphere (the small graphs show examples of some of the most important exponential developments). It becomes clear that, in the history of humankind, the last 50 years have without a doubt seen the most rapid transformation of the human relationship with the natural world. This escalating trend of environmental problems, which has thus become a symbol of our world today, causes not only the climate but also the global change affecting a wide range of different levels and sectors.

The year 2019 was the second warmest year in the 140-year record, with global land surface temperature deviating from the average by +1.44°C. This value is 0.11°C less than the record-value of +1.55°C set in 2016 and only 0.01°C higher than the third-highest value set in 2017 and 2015 (1.43°C). The five warmest years in the 1880–2019 record have occurred since 2015, while nine of the 10 warmest years have occurred since 2005.

Citation: NOAA National Centers for Environmental Information, Climate at a Glance: Global Time Series, published June 2020, retrieved on June 30, 2020, from https://www.ncdc.noaa.gov/cag/https://www.ncdc.noaa.gov/cag/

Climate impacts are happening on all continents and in many sectors

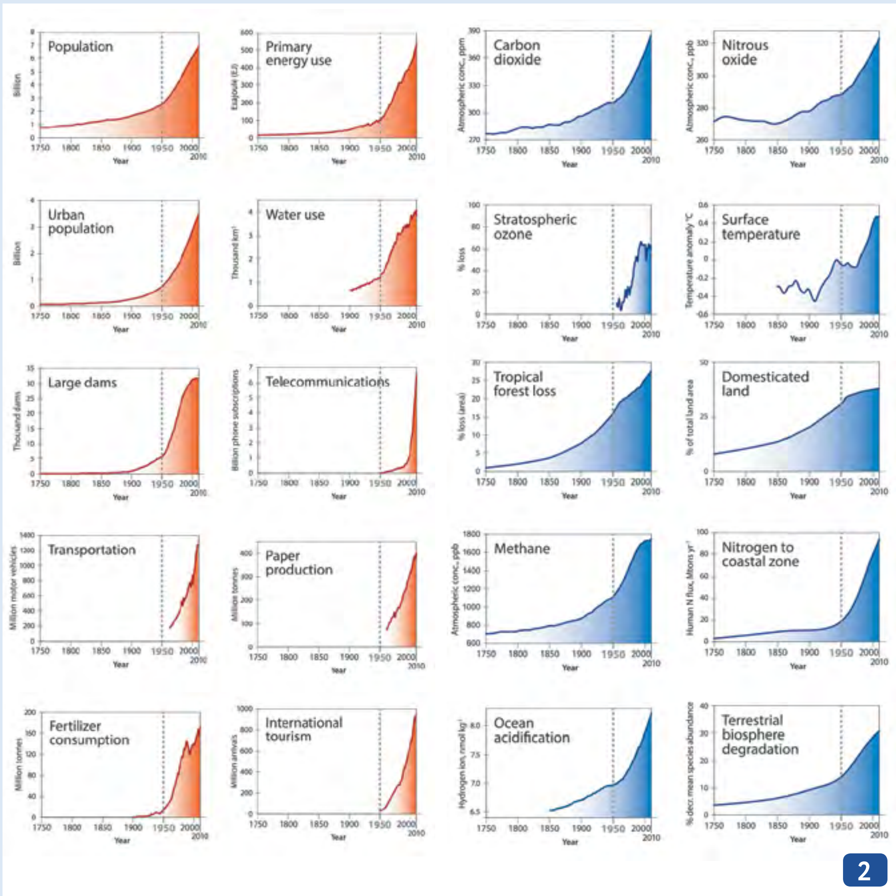
Research on future scenarios predicts that climate change will have a dramatic effect on natural environments, plants, and animals. **Direct impacts** include changes in phenology, species abundance and distribution, community composition, habitat structure, and ecosystem processes. Climate change is also leading to **indirect impacts** on biodiversity through land-use changes. The effects of these changes can be even more damaging than the direct impacts due to their scale, intensity, and speed. They include habitat fragmentation and loss, over-exploitation, pollution of air, water and soil, and the spread of invasive species. These impacts will further reduce the resilience of ecosystems to climate change as well as the capacity to deliver essential ecosystem services to humans.

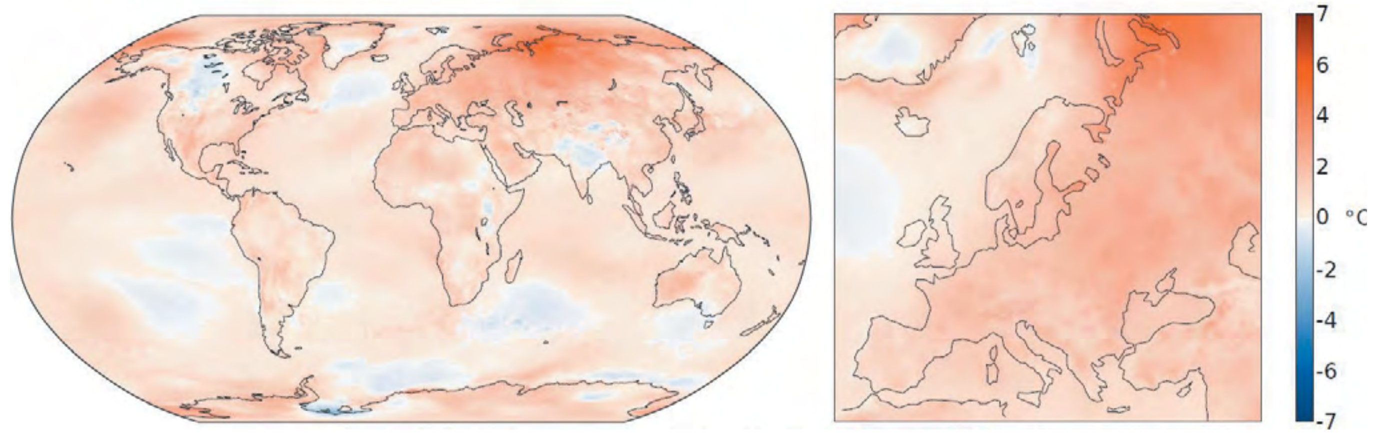
(1) **Warming stripes of the globe**
© Ed Hawkins (University of Reading).
Data: Berkeley Earth, NOAA, UK Met Office, MeteoSwiss, DWD, SMHI, UoR, Meteo France & ZAMG

(2) **The Great Acceleration Graphs**
Updated version by Will Steffen et al. "The trajectory of the Anthropocene: The Great Acceleration." The Anthropocene Review, March 2015

Greenhouse gases

CO_2 is the greenhouse gas most commonly produced by human activities and responsible for 64% of man-made global warming. Its concentration in the atmosphere is currently 40% higher than at the beginning of industrialisation. As populations, economies, and standards of living grow, so does the cumulative level of greenhouse gas emissions.



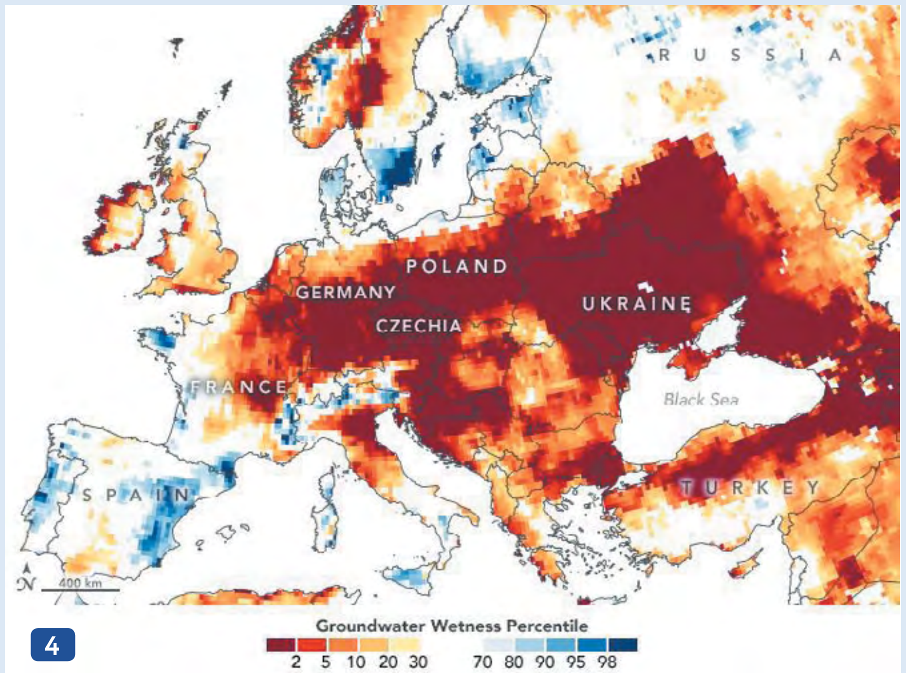


Surface air temperature anomaly for September 2019 to August 2020
(Reference period: 1981-2010)

3

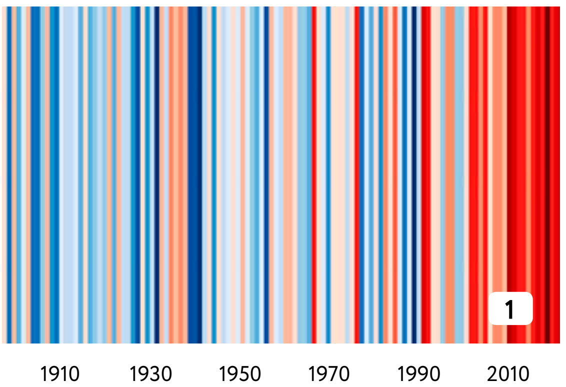
(3) **The map depicts global and European surface air temperature anomaly for September 2019 to August 2020 relative to the average for 1981-2010. It does not show absolute temperatures; instead, it shows how much warmer or cooler each region of the Earth was compared to that baseline average.**
Data source: ERA5. Credit: Copernicus Climate Change Service/ECMWF

(4) **Drought in European Groundwater**
The map shows shallow groundwater storage in Europe as of June 22, 2020, as measured by the Gravity Recovery and Climate Experiment Follow ON (GRACE-FO) satellites. The colours depict the wetness percentile; that is, how the levels of groundwater compare to long-term records for the month. Blue areas have more abundant water than usual, and orange and red areas have less. The darkest reds represent dry conditions that should occur only 2 percent of the time (about once every 50 years).
NASA Earth Observatory image by Lauren Dauphin, using GRACE data from the National Drought Mitigation Center.



Climate and its development in Roztochya Region

Temperature change in Ukraine since 1901



The Roztochya Biosphere Reserve represents the most western part of the broadleaved forest zone in Ukraine. The local climate is extensively influenced by westerlies, which bring about the highest annual precipitation across the entire plain part of the country. Therefore, Roztochya is a north-eastern frontier of natural beech forests in Ukraine. Variations in surface topography (both in elevation and morphology) cause the uneven distribution of solar radiation and precipitation establishing distinct patterns of microclimate in Roztochya. The summer season here is humid, often with thunderstorms, whilst winter tended to have a permanent snow cover until recent years.

"There is an increase in the number of hot, dry days per year and abnormally warm, snowless winters; the catastrophic spread and increase in the number of invasive species of flora and fauna have also been observed."

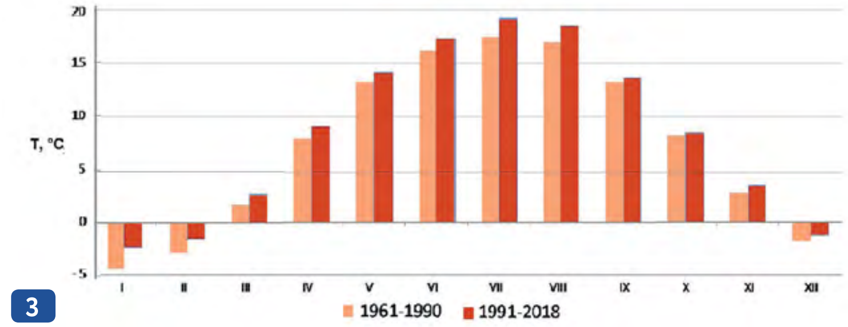
Ihor Khomyn, Senior Researcher at Roztochya Biosphere Reserve

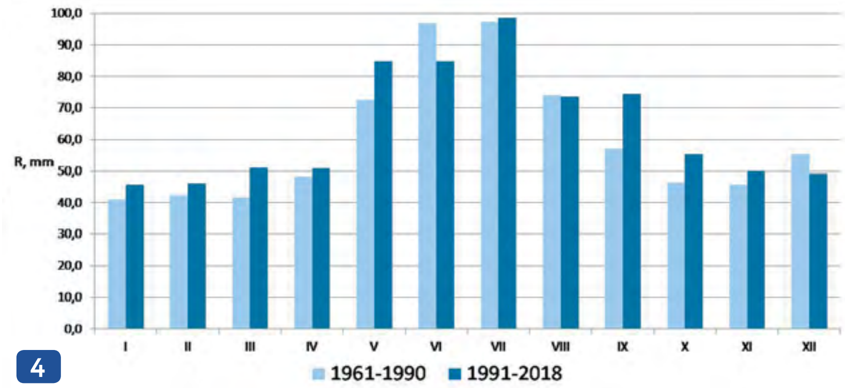
(1) Warming stripes of Ukraine
© Ed Hawkins (University of Reading) Data: Berkeley Earth, NOAA, UK Met Office, MeteoSwiss, DWD, SMHI, UoR, Meteo France & ZAMG

(2) Evaporation and cooling function of a forest after rainfall
© P. Ibisch

(3) Monthly means of air temperature for the current period (1991-2018) vs. the period of climatological normal (1961-1990) in the Roztochya BR (three weather stations' average)
© A. Smaliychuk

(4) Average sum of monthly precipitation for the current period (1991-2018) vs. the period of climatological normal (1961-1990) in the Roztochya BR (two weather stations' average)
© A. Smaliychuk





There are fixed facilities for the collection of climatological data within the Biosphere Reserve, in the town of Ivano-Frankove. But since they were installed only in the late 1980s and could not provide a long-term dataset, we used the data from three weather stations of the Ukrainian Hydrometeorological Service situated nearby, namely, those of Lviv, Yavoriv, and Rava-Ruska stations. They are located to the east, south, and north, respectively, and at a distance no more than 15 km from the Reserve's edge.

Air temperature

During the normal climatic period between 1961 and 1990 (standard reference), the average annual air temperature was about 7.4°C. It reached the maximum of 9.0°C (Rava-Ruska) and 9.1°C (Yavoriv) in 1989. In the last 28 years (1991-2018) the mean annual temperature increased to 8.4°C, i.e. by 1.0°C. It has been particularly high since 2014, with a peak of 10.0°C in 2015 in Yavoriv. The mean monthly temperature of the coldest and hottest months (i.e., January and July) in the periods of 1961-1990 and 1991-2018 were -4.4 vs. -2.4°C and 17.5 vs. 19.2°C, respectively.
The highest increase in mean monthly temperatures in comparison to a climatic normal was observed in winter (January & February) and summer months (July & August) (see graph 1). Moreover, this trend has accelerated in the recent five years (2014-2018), when the highest temperature rise detected was more than 2.5°C in December, August, and February. It was particularly hot in August 2015 and July of 2014, when the average air temperature reached 21.5 and 20.5°C, respectively, which corresponds to the past long-term average of Central-Eastern Ukraine within the steppe zone. In 2018, the summer days (with a maximum daily temperature exceeding 25°C) were observed as early as April, this being additional evidence of the recent climate change in the region.

Precipitation

The average annual amount of precipitation in the region of the Biosphere Reserve compared to the reference period and the last three decades increased by almost 6 % – from 719 to 765 mm. However, eight out of ten years between 2009 and 2018 had the amount of precipitation close to the long-term average of 1961-1990. Most precipitation still falls during the summer season, but there are some changes in its volume throughout the year (see graph 2). Between 1991 and 2018, a noticeable decrease in the amount of rainwater was recorded in June and December, while in September, May, and March, a substantial surplus of water, as compared to the climatic normal, was recorded. July and August showed the lowest changes in the precipitation pattern.

During the last five years, the average duration of a dry period was 9 days per month, with the longest consecutive period of 35 days having been observed in August - September 2015. The highest one-day precipitation usually falls in May - July and September - October with an average amount of 20-30 mm over 24 hours. Its absolute maximum was recorded in October 2016 with 69 mm/day, which constituted 146% of the long-term average for that month. In the Roztochya BR, an average number of days with extremely heavy rains (R>20 mm) is the highest amongst other reserves and equals six. Due to the air temperature developments, last winter seasons were marked by the absence of stable snow cover while most of the precipitation fell as rain rather than snow.

Projection for the future

According to the most probable climate development scenarios for the Roztochya region (B1 and A2 scenarios of IPCC), the mean annual temperature is expected to increase by 2.1 and 4.6°C, respectively, by the end of the 21st century in comparison to the 2000-2010 average. They also indicate an increasing variability of the amount of precipitation, which might be challenging for the development of sustainable and adapted agriculture and forestry in the region.

Climate change and land-use impacts on the biosphere and its people

(1) **Open, vulnerable area after clear-cut – heating and drying more rapidly**
© Roztochya Biosphere Reserve

(2) **Drained artificial, large-scale fishing pond**
© J. Kloiber

(3) **Uncontrolled urban sprawl and surface sealing**
© A. Schick

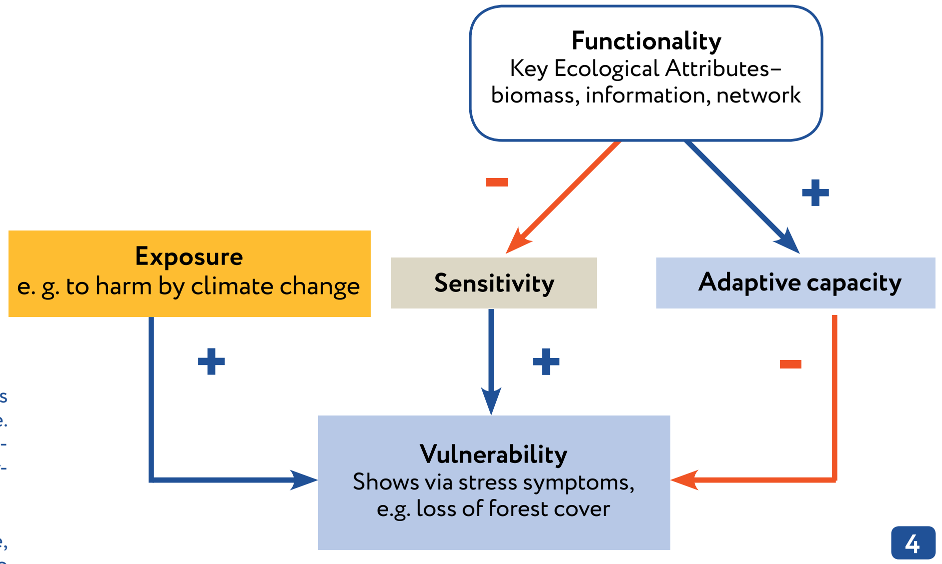
(4) **Conceptual model – vulnerability**
Illustration © K. Mack

The ecosystems and, in consequence, the people of the Roztochya Biosphere Reserve are affected by multiple stresses, i.e. disrupted or destroyed ecological attributes. Dysfunctional ecosystems are more vulnerable and provide diminished quality and quantity of ecosystem services, thus affecting human wellbeing – health, nutrition, income, and livelihood. Climate change is particularly dangerous where ecosystems are exposed and cannot function properly due to overuse, modification, destruction, and fragmentation.

At risk are essential supporting ecological functions like water cycling (water retention, evaporation, etc.), productivity and procreation (photosynthesis, primary production, etc.), physical work (shading, wind speed reduction, filtration of air and water, etc.), nutrient cycling (decay, humus, and soil formation), and the corresponding ecosystem services.
Both the ecosystems´ current capacity to perform and future ability to cope with disruption is hampered. In the Roztochya BR, this is a result of past and present human land-use practices such as large scale monoculture forestry, clear-cutting and overharvest, land conversion (for agriculture, infrastructure, and urban development, etc.), surface sealing, land melioration practices and drainage, pollution, mining activities, excessive use of pesticides and herbicides, and pressure from uncontrolled recreation.
In recent years, in addition to a shift of seasons and changing wind directions, the area is facing increasing average temperatures, number of hot days, new maximum temperatures, heatwaves, and droughts. Sealed surfaces, biomass- and diversity-poor, managed agricultural, forest, and urban ecosystems greatly contribute to the heating of the land surface.
This creates both constant and periodical stresses for flora and fauna in multiple ways: Apart from direct heat and dry stresses, these events and changing conditions drive evaporation and transpiration rates of water-bodies, soils, and plants, leading to landscape dehydration. Combined with changes in quantity and timing of precipitation, higher runoff rates, and unsustainable water use by agriculture and private households, the water balance is additionally under pressure. Numerous drainage systems and the flooding of past sulfur mines also have a relevant impact.
The combination of dryer conditions due to climate change and unsustainable water use by humans increases the risk and occurrence of forest-, peat bog-, swamp-, field- and meadow fires. Especially in spring, the current conditions favour fires in peat bogs and meadows. The risk of forest fires has risen over the past years, even though they still rarely occur. Often, irresponsible and ill-advised humans trigger these types of fires, e.g. by burning agricultural residues and waste, or during recreational activities.
Climate change and land use drive alterations in habitats, wildlife, plant and animal populations and species. A decrease in native plant and animal species due to a variety of morbidity

The functionality of a system largely determines how sensitive and how adaptable it is to change. Consequently, preserving and restoring a system's ability to function can reduce its vulnerability.

Vulnerability describes the level of exposure, sensitivity, and adaptive capacity of a system to external influences, such as climate change.



Key impacts:

- Decreased levels of surface and groundwater are becoming evident in the shallowing and drying of the Desna River, its tributaries, lakes, ponds, and wells
- Changed flood regime patterns
- Polluted surface- and groundwater
- Dehydration and desiccation of flora and fauna

Humans at risk – heat and drought:

- More frequent heat waves endanger the health of people, especially of sensitive groups. Not only humans but also plants and animals are stressed by heat, weaken, or die
- Respiratory and cardiovascular diseases can result from heat or thermal stresses
- Higher risk of fire
- Waterborne diseases
- Diminishing quality and quantity of drinking water
- Water supply shortages

Humans at risk – fires and air pollution:

- Drying of peat bogs, forest, and arable land entailing frequent fires can spur the amount of allergic and asthmatic diseases in the region
- Air pollution due to particles released into the atmosphere during fires can cause cardiovascular and pulmonary diseases and death
- Wildfires increase the risk of a direct loss of lives and damages to infrastructure

Humans at risk – alien species and species loss:

- Diarrhea and infectious diseases, in which the pathogens are transmitted, e.g by mosquitoes or ticks (tick-borne borreliosis – Lyme disease, and encephalitis), are two disease patterns that can occur more frequently as the temperature gradually rises
- Forest produce and crop damage and loss
- Increasing cases of allergies and allergic shocks

Humans at risk – extreme weather events:

- Direct damage to physical and mental well-being: e.g. flooding can cause mould or dampness provoking cough, phlegm, respiratory problems, and allergic reactions
- Damage to infrastructure, houses, and private property
- Damages to crops and harvest
- Power supply shortages
- Other negative consequences

(5) **Flooded post-sulfur mining site with sealed shorelines**
© J. Kloiber

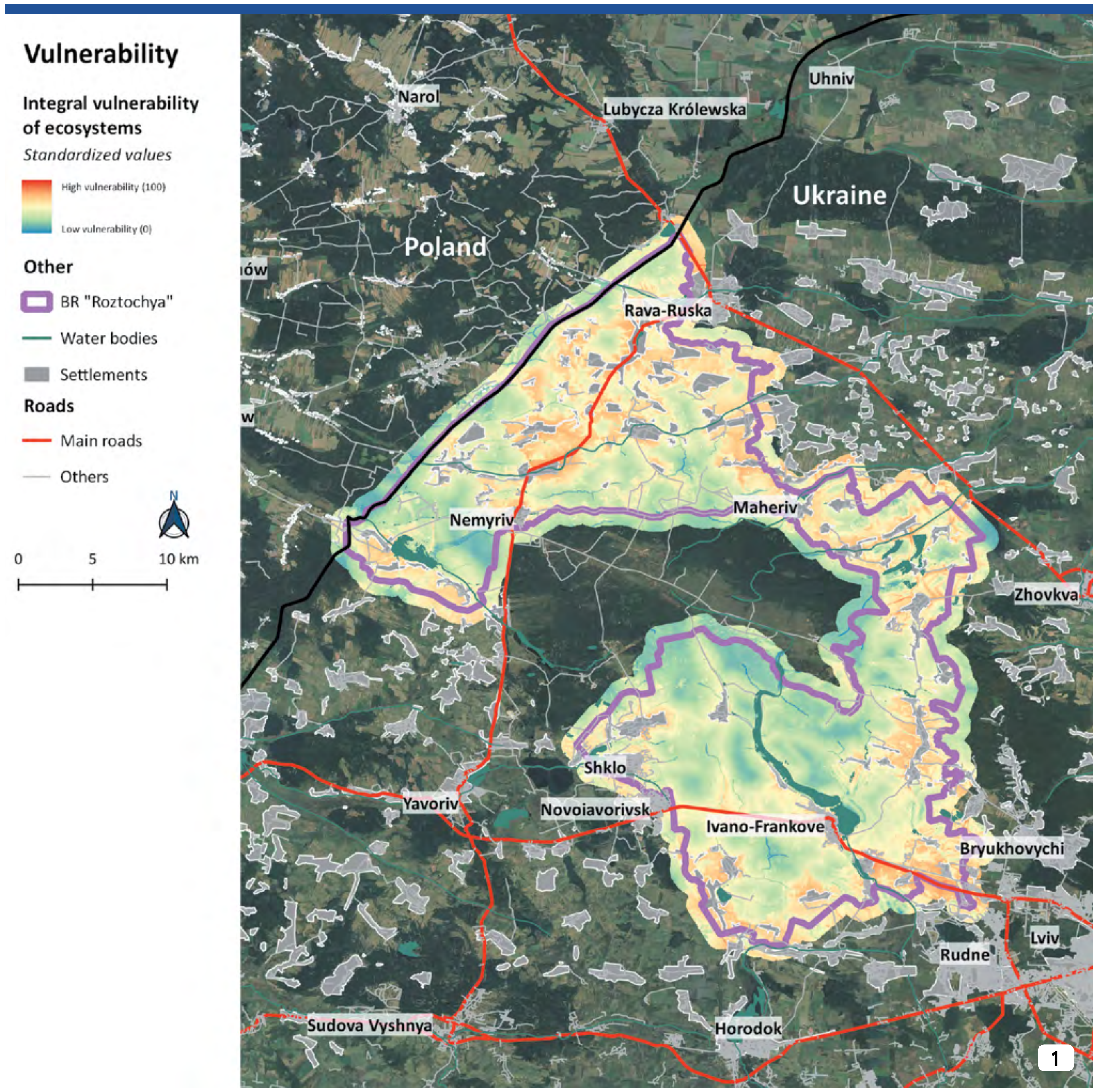
(6) **Shallowing water reservoir**
© J. Kloiber

(7) **Autumn blossoming of a chestnut tree due to extreme heatwave**
© Roztochya Biosphere Reserve

(8) **Burning biomass in an urban area**
© A. Schick

Climate change and land-use impacts on the biosphere and its people

> "There is a higher number of dry days, strong winds, storms, reduced snow cover, lack of moisture in the soil, and heavy rains."
>
> **Maria Havalko,** Director of Lozynska School (grades I-II)



(1) Map of ecosystem vulnerability in the region of the Roztochya Biosphere Reserve (area of the BR + 1 km buffer)

Sources: Data processing and analysis by I. Kruhlov; Base map: Google Satellite 2016; Roads, settlements, waterbodies: OSM 2020; Produced by A. Dichte

Continued from p. 7

causes is observed while alien and invasive species are appearing. New and more frequent pests, diseases, insect calamities, and allergens are found, especially in forest and agricultural ecosystems. Overall, a reduction in biodiversity is occurring which is further accelerated by pressure from human land-use.

Climate change also drives an increase in the number of dangerous weather phenomena, such as storms, heatwaves, torrential rain and flooding, thunder-, hail- and sandstorms, frosts, and icing in late spring. The ecosystems and humans, forming part of them, are affected at different levels, space, and time by the manifold consequences of such events.

To obtain a spatial overview of stress impact distribution in ecosystems of the Biosphere Reserve, an assessment was carried out. The range of vulnerability is based on a set of stress indicators including management intensity, neighborhood impact, logging intensity, road impact, soil water conditions, artificial drainage, and human population density. All values were standardized on a 0-100 scale to enable integration into the vulnerability map, where highly (red-yellow) to lowly vulnerable (green-blue) areas are indicated.

The level of vulnerability also indicates where land- and natural resource use are stressing ecosystems and, thus, where regulating functions necessary to buffer climate change impacts and secure ecosystem services for human well-being are reduced. Blue and dark green areas particularly need ecosystem-based conservation efforts, while light green, yellow, and red areas, in addition to conservation, strongly require restoration efforts and reduction of human-induced stresses.

Forestry sector

The forestry sector within the Biosphere Reserve faces several challenges driven by climatic changes such as higher average temperatures, altered precipitation patterns, a shift of season, droughts, and extreme events such as heavy storms, flooding, and heatwaves. The vulnerability is increased by unsustainable practices like monoculture forestry, clear-cutting, and overharvest. This combination of factors drives a variety of stresses. Not only the highly managed pine monocultures are vulnerable, but also the more natural and ancient forests have already suffered from these changing conditions.

Agricultural sector

The already mentioned factors also result in water deficiency for agriculture and significantly impact the sector. Most of the residents live in rural areas (ca. 70%) and maintain a traditional system of self-sustaining households with small fields and allotment gardens for growing their produce. The dry autumn of 2019, for example, was problematic for the sowing of winter crops. Natural disasters such as heatwaves, droughts, storms, and flooding cause direct damage to crops, farming infrastructure, and put farmers themselves in danger.

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Fishery and tourism sector

The Vereshchytsya river valley holds over 6 square kilometers of ponds that were created for cultivated fish farms. They become increasingly threatened by deteriorating hydrological conditions, water availability, and chemical composition.

The Roztochya area is also a relevant tourism destination, located close to the metropolis of Lviv. The diverse ecosystem services include activities such as health-, recreational-, cultural- and religious-, as well as sport- tourism. These sectors are threatened by the above-described impacts of climate change and by the overall increased vulnerability of ecosystems and the people of the region.

Key impacts – forests and forestry:

- Impaired forest recovery in monocultures
- Drying of trees and forest dieback
- Increased frequency and risk of wildfire
- Disappearing of species (both flora and fauna)
- Damaging of local trees species by new insects
- Decreased growth rates and yield

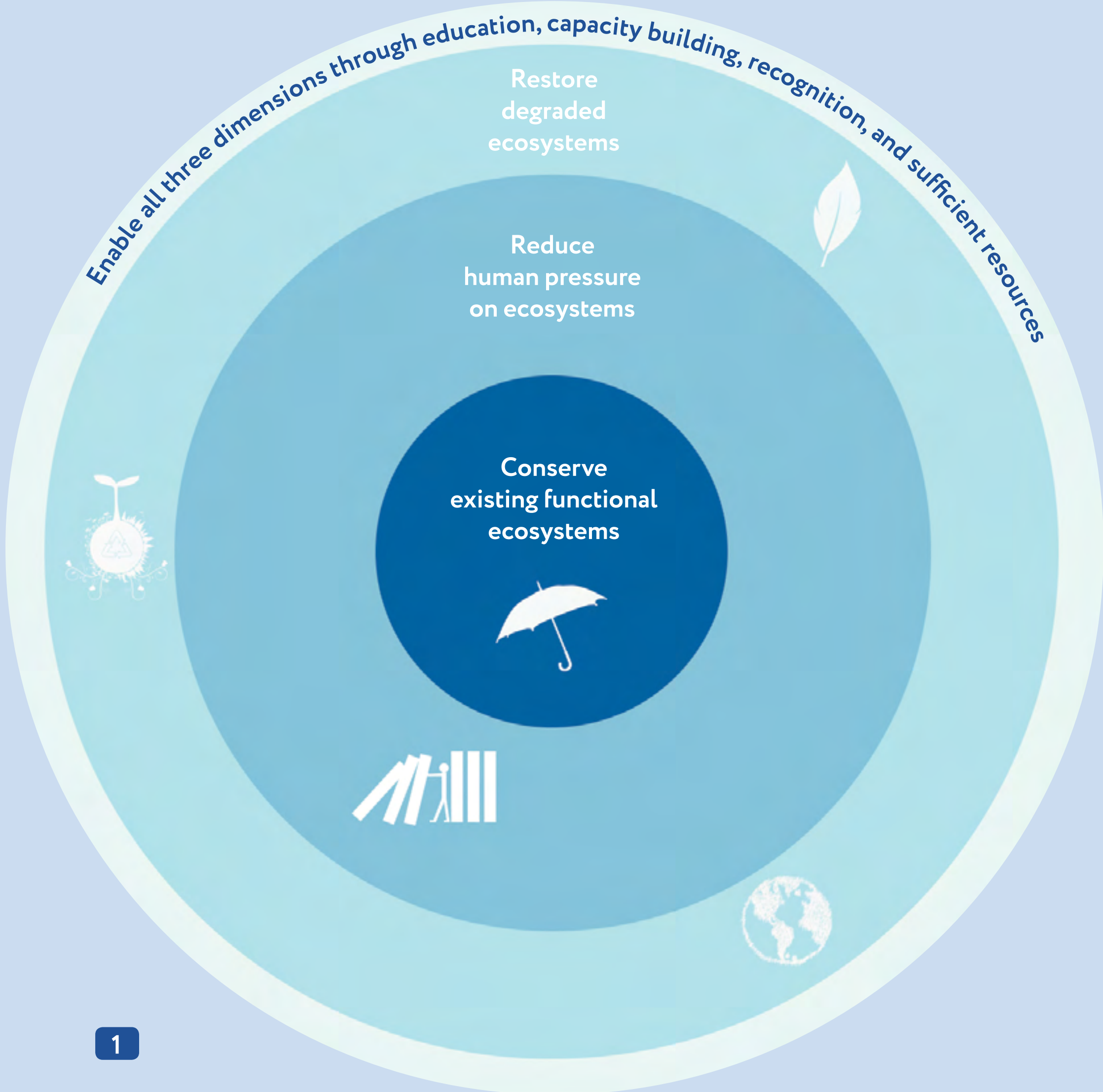
Key impacts – soil and agriculture:

- Increased risk from drought
- Increased frequency and risk of wildfire
- Shifting production zones
- Soil degradation
- Soil erosion
- Compacted soil (land-use related)
- Diminished soil productivity
- Decreased yield and growth rates

Ecosystem-based Adaptation to Climate Change

Ecosystem-based adaptation to climate change must become a central pillar of nature conservation and holistic ecosystem management. Absolute priority must be given to such measures as water retention, cooling and buffering of microclimatic fluctuations, and slowing down or stopping drying winds. These measures will lead to success if they are accompanied by an increase of biomass in near-natural vegetation in the landscape, soil care, and humus formation.

(1) The three dimensions of Ecosystem-based Adaptation plus the enabling conditions – the core has the highest priority, meaning that you should protect by any means what still is healthy. If that is ensured reduce the pressure on degraded lands and regenerate healthy and functional ecosystems!



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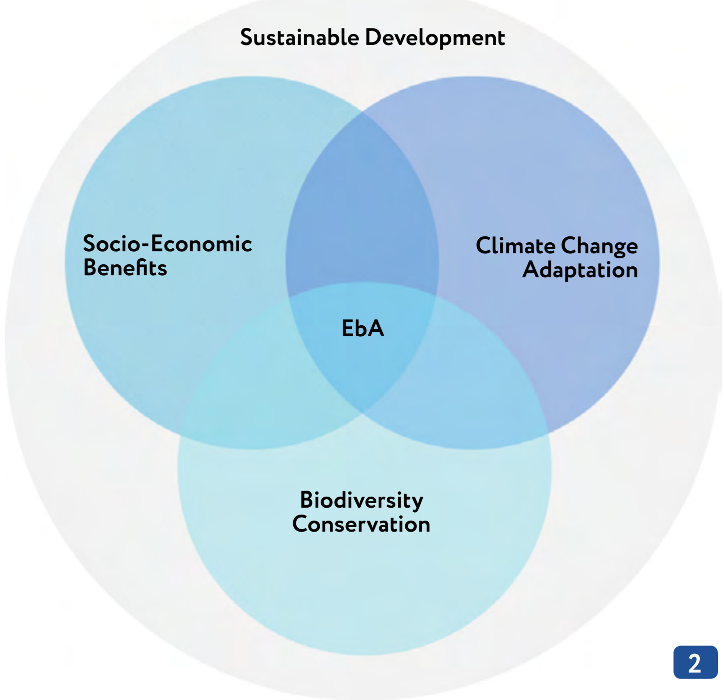
(2) Ecosystem-based Adaptation (EbA) in the context of sustainable development as a cross-cutting approach among several (adapted from Midgley et al. 2012. Biodiversity, Climate Change and Sustainable Development – Harnessing Synergies and Celebrating Successes)

(3) Water buffalo husbandry as an alternative form of land use for wetlands instead of drainage or after rewetting

(4) Reed use, e.g. as insulation material, needs functional wetlands

(5) Structure-rich, regenerative agriculture builds healthy soils, keeps water in the landscape, and provides nutrient-rich food

Sources: All 3 images are copyright-free provided by pixabay.com



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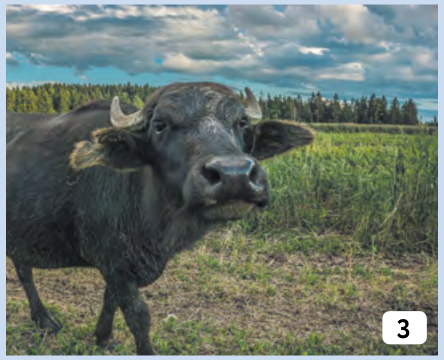

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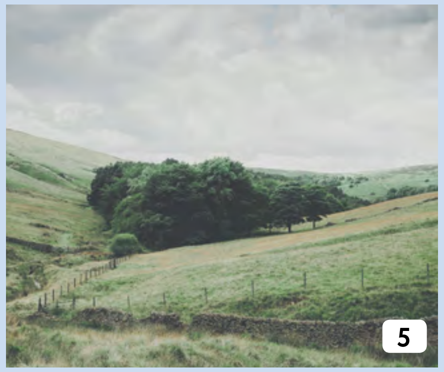

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Our solutions are in nature

When climate change and its effects are discussed, the aim is usually to prevent changes, such as temperature rising or an increase in the number of extreme weather events, from becoming excessively great. The main measures to achieve this include a reduced release of greenhouse gases into the atmosphere and the binding of more CO_2 from the atmosphere into vegetation. Also, geoengineering technologies, which intervene with the earth's biogeochemical cycles and thus mitigate climate change, are being discussed despite the manifold risks.
However, humanity has not yet succeeded in changing its economic and lifestyle patterns in such a way so that the above-mentioned goals (less emission / more absorption of CO_2) could even be partially achieved. In the last decade it has become increasingly obvious that the goal of preventing climate change is no longer sufficient. Instead, it is clear that we have already been deeply involved in the process of experiencing climate change and that we need to adapt. Thus, both objectives – climate change mitigation and adaptation – should simultaneously be pursued.

Adaptation is the process of adjusting to a current or expected changed condition, e.g. climate and its effects. People and nature have been adapting to the variability of climate for millions of years, but current rapid changes seem to outpace their coping mechanisms.
The creation of protective structures, such as dikes (to ward off excessive amounts of water) or water collection basins (to retain water for dry periods) may at first seem plausible. However, these "hard" or "grey" measures often involve excessively high financial and ecological costs. An ecosystem-based "green" approach, on the other hand, uses the natural properties and processes of ecosystems by protecting, sustainably managing, or restoring them. These measures are significantly less expensive and, in the best case, more effective than "grey" measures, since strengthening ecosystems simultaneously promotes a greater number of ecosystem services.
Part of the ecosystem approach is promoting the no-regret measures, which provide a useful way of dealing with uncertainties. They are worth implementing, no matter the actual developments, because the resulting improvements still bring benefits or at least do no harm.

Examples of EbA measures

The interest of local stakeholders in adaptation to climate change is primarily due to the growing intensity and frequency of the negative effects of these changes in the region. The process of finding and implementing adaptive solutions began in Roztochya in autumn 2015. Back then, the workshop entitled "Climate change in Roztochya: research and adaptation opportunities for local communities of Yavoriv region" was held in the premises of the ecological and educational centre of the "Roztochya" Biosphere Reserve. This event was organized by the staff of the Reserve in cooperation with several non-governmental public organizations, such as the National Ecological Center of Ukraine, the Public Institute of Nature Protection, and the environmental association "Nature of Roztochya".

"We have to change our thinking: On the one hand, we have to preserve all wetlands that are still in their natural states. On the other hand, we have to rewet drained peatlands and establish alternative land-use practices to secure the diverse functions of wetlands for humankind and nature."

Prof. em. Dr. Michael Succow, Laureate of the Right Livelihood Award, Succow Foundation, Greifswald, Germany

The workshop took place within the framework of the project "How to adapt to climate change for sustainable development of local communities: an action plan in an area with high environmental status", which was a part of a larger project – "Adaptation to climate change in Ukraine" funded by the European Commission and Austrian Development Agency (ADA) through the "Climate Forum East II" project.

The workshop aimed to unite the efforts of local communities and all stakeholders as well as to create an action plan to improve the effectiveness of territorial governance to adapt to climate change, which threatens sustainable environmental management in the area of high conservation importance. As a result, an action plan was prepared by a group of local environmentalists and scientists. In western Ukraine, this document is the first example of a comprehensive analysis of climate change and identification of priority areas for adaptation to its negative consequences regarding the large natural region of Roztochya.

Furthermore, two practical projects on adaptation to climate change were implemented in Roztochya within the framework of the international project "Climate Forum East II". The first project "Implementation of environmental protection measures to adapt the local communities to climate change in Roztochya" aimed to unite the stakeholders of the local community of Yavoriv district to effectively address the issues closely related to the ability of adaptation to climate change. Before proceeding to the practical phase, public hearings with representatives of the local community of Ivano-Frankove had been conducted. During these hearings held in August 2016, the action plan for adaptation to climate change in the Yavoriv region was discussed. Local deputies, teachers, government officials, agricultural and forestry workers, researchers, entrepreneurs, representatives of the energy sector and state nature reserve facilities, as well as volunteers from non-governmental organizations, participated in the public discussion. Stakeholders have identified a number of important issues and main areas of the life of the local community, which are affected by global and local manifestations of climate change.

Within the framework of this project, several tasks included in the local adaptation plan have been fulfilled; for example, practical environmental measures were implemented on the territory of the peat bog in the protected area of "Zalyvky". This specific project pursued the following goals:

- renaturalization of the peat bog by the local community, aimed at restoring the natural hydrological regime;
- restoration of natural functions of the largest peat bog located on the territory of the local community;
- fire prevention in peatlands and local forests;
- taking control over (limiting) the spread of alien, especially invasive, species of flora and fauna, which enter local ecosystems and disrupt sustainable food chains;

(1) Meeting with local citizens of Ivano-Frankove to discuss the Action plan and adaptation measures for Yavoriv district developed in the course of "Climate Forum East II" project
© I. Khomyn

- restoration of local populations of biota, which maintains the ecological balance of the natural environment.

As a result of the project implementation, the ability of local ecosystems to provide valuable services, such as climate regulation, has improved and contributed to the adaptive capacity of the local community concerning climate change.

The implementation of the project required a certain amount of fieldwork, which had to be carried out manually in certain locations due to a high groundwater level, which made them inaccessible for construction equipment. For example, this was the case for the installation of pipes in the upper part of the Zalyvky protected area, through which the territory of the swamp received water from the Stavchanka River. To ensure a balanced distribution of water within the territory of the drained bog, a system of old drainage ditches was used, which once served for the drainage of water from the bog. Furthermore, four additional barriers were built on one of the central canals, thus allowing to increase the water level by 20-40 cm and to slow down the speed of the water flow. Due to the re-flooding of the swamp, it became possible to restore conditions for the return of local fauna species, including beavers, improve air quality for thousands of locals by reducing the risk of fires in this area, and gain valuable practical experience in implementing the adaptation measures.

(2) Geodetic survey before the start of rewetting the drained peatland of "Zalyvky" in the Roztochya BR
© I. Khomyn

"Adaptation becomes an integral part of our life, and new nature-based approaches to adaptation, including ecosystem-based, are now in high demand in Ukraine. An important task of our project is showing people in the biosphere reserves and beyond, by the implementation of pilot adaptation projects in agriculture, forestry, urban environment, and wetland management, a more sustainable way of adaptation in the long run by using an ecosystem approach."

Ph.D. Anatoliy Smaliychuk, EbA-Ukraine project coordinator, Michael Succow Foundation / Lviv University

Multilevel Governance for Adaptation

The previous sections have shown that the impacts of climate change can already be observed in Ukraine. Extensive data collection and analysis draw a clear picture of large-scale changes which need to be addressed by simultaneous mitigation and adaptation measures.
However, efficient measures require implementation on different levels of governance, namely on the national, regional, and municipal levels. In this context and along with other policies, the principle of subsidiarity needs to be applied to advance successful multilevel governance of climate change adaptation in Ukraine.

This principle implies that action should be taken at the closest possible level to the ultimate receivers of the policy.

Respective measures ideally comprise a wide range of activities on each level, namely:

- creation of working groups with sectoral experts;
- development of strategies, programmes, and projects for adaptation to climate change;
- adoption of specific legal acts;
- stakeholder involvement, with particular regard for the local population;
- implementation and monitoring activities.

The project "Ecosystem-based Adaptation (EbA) to Climate Change and Regional Development by Empowerment of Ukrainian Biosphere Reserves" (EbA Ukraine) addresses all three levels of governance through various activities.

On the national level, the project closely cooperates with the Ministry of Ecology and Natural Resources (MENR). One of its main purposes is to contribute to the development of the Ukrainian Strategy for Adaptation to Climate Change until 2030. This strategy primarily aims to include indicators of a situation analysis and to define a suitable format for cooperation with the regions of Ukraine to perform sectoral risk and vulnerability analyses and to elaborate respective action plans in the field of climate change adaptation.

The MENR reinstated the working group on the Strategy in October 2020 after having completed its internal restructuring process.

Members of the EbA Ukraine project – Anatoliy Smaliychuk (Michael Succow Foundation/Ivan Franko National University Lviv), Galina Stryamets (Roztochya Biosphere Reserve), Serhii Kubrakov (Desnianskyi Biosphere Reserve) and Vitaliy Turych (Shatskyi Biosphere Reserve) are part of the working group. Due to their presence in the group, they are able not only to contribute their research findings and lessons learned from the project,

(1) Project kick-off hosted by the Ministry of Ecology and Natural Resources of Ukraine in 2018.
© Anna Kovbasniuk

"Ukraine's legal and political framework offers a solid basis for biosphere reserves to bring in their experience and vision on adaptation to climate change. But they still need to increase their visibility and further emphasize their roles as drivers of change"

Iryna Holovko, board member of the NGO Ecoaction, Ukraine

but also to enhance the visibility of Ukrainian biosphere reserves and their crucial role in the adaptation to climate change on the national level.

On the regional level, all Ukrainian regions work out their respective Regional (Sustainable) Development Strategies, which include detailed Action Plans. For the partner biosphere reserves, four Regional Development Strategies with respective Action Plans are applicable.

These Regional Strategies and Action Plans cover a wide range of different sectors and strategic actions, e.g. identification of trends and challenges of socio-economic development, assessment of the nature reserve fund, and SWOT-analysis of the region and its financial and innovation potential. The strategies include the Environmental Report, which is subject to public hearings and thus allows all interested persons to bring in their comments and suggestions, including those on the projects, which may have potentially negative effects on the environment.

While strategies define overarching development goals, action plans are instruments for realisation of the strategies in a medium-term perspective (3 to 4 years). They usually include specific tasks (projects), responsible persons, implementation periods, financing instruments and conditions as well as efficiency indicators. Overall, regional strategies and action plans are, in terms of their territorial scope and regulatory subject, efficient instruments to implement ecosystem-based adaptation to climate change in the regions and biosphere reserves.

The majority of the four above-mentioned Strategies and Action Plans make references to climate change (except the Draft Strategy of Sumy oblast). Various projects which are included in the respective Action Plans can potentially contribute to ecosystem-based adaptation to climate change. The examples of these projects are as follows:

- Creation of an ecological framework and sustainable development of the natural complex in the Lviv region (project 4.3.1.1)
- Working out of management plans for the sub-basin of the Desna River and the sub-basin of the Dnieper River within the borders of the Sumy region (project 3.2.1)

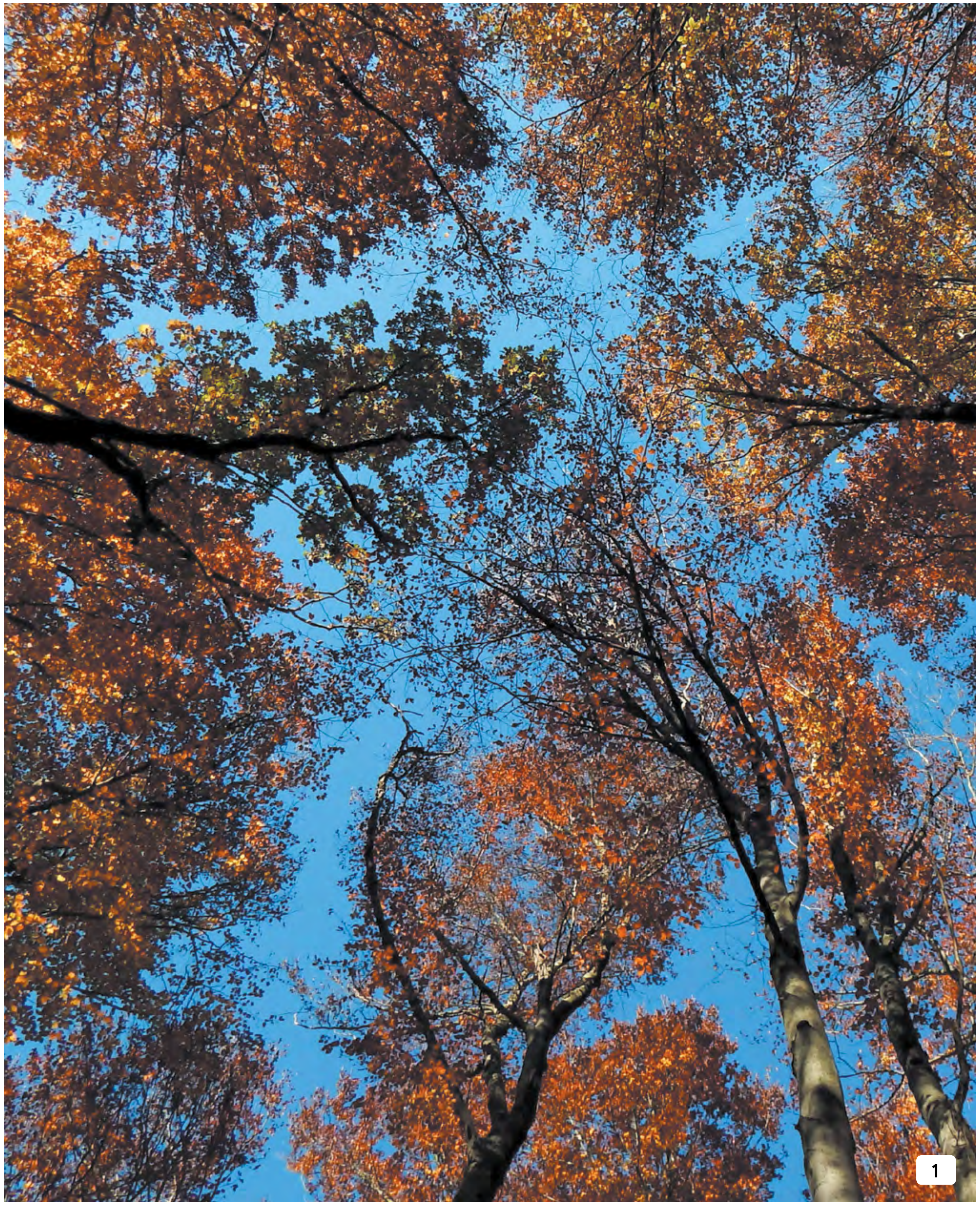
(2) Galina Stryamets (Roztochya Biosphere Reserve) presenting at a working group meeting in Kyiv
© EbA Ukraine

Biosphere Reserve "Roztochya"
- Development Strategy for Lviv Region (2021-2027)

Desnianskyi Biosphere Reserve
- Sustainable Development Strategy for Chernihiv Region (until 2027)
- Regional Development Strategy for Sumy Region (until 2027, Draft)

Shatskyi Biosphere Reserve
- Development Strategy for Volyn Region (until 2027)

Multilevel Governance for Adaptation



"Changing conditions of the biota and the need to change the way we do agriculture are the two things that I am concerned about with climate change. There is still time and opportunity to adapt to climate change in a way that will benefit both nature and agriculture. It's worth considering the worst-case scenarios and, as long as climatic conditions allow – the best choices for nature will be the most advantageous for people in the long term."

Ph.D. Olesia Petrovych, Chief specialist, Department of Protected Areas, Ministry of Environmental Protection and Natural Resources of Ukraine

Continued from p. 15

- Design of projects for re-naturalisation of meliorated hydromorphological soils and degraded areas in the Volyn region (project 5.3.3.1)
- Support of organic farming in Chernihiv region with consideration of the connection between land use and climate change (project 4.2)

Still, there is a high need to introduce an ecosystem-based approach to adaptation to climate change into these strategic documents and to consider the crucial role of biosphere reserves for its implementation. As of now, only the Lviv Regional Strategy mentions the Biosphere Reserve Roztochya located on its territory. Other biosphere reserves still need to raise visibility and to be recognised for their activities and importance for the region.

Moreover, adaptation to climate change is not clearly defined as a goal in any of the regional Strategies or Action Plans analysed within this project. It is worth again emphasizing that biosphere reserves can and should be strong drivers of change contributing knowledge and practical experience to the field.

On **the level of Ukrainian municipalities,** the main framework for adaptation actions is the European Union initiative "Covenant of Mayors for Energy and Climate". The platform/initiative brings together local governments to voluntarily commit to setting and achieving climate change mitigation goals. At the same time, it also includes climate change resilience assessment and adaptation measures. When officially joining the Covenant of Mayors, signatories commit to developing a Sustainable Energy (and Climate) Action Plan (SECAP) within two years. Local municipalities joining the Covenant include not only cities and towns but also rural amalgamated communities. In 2018, 16 communities in Ukraine had SECAPs in place, while in 2020 there were already 156 with 83 of them addressing adaptation to climate change in their SECAPs.

The example of the town Shostka, located close to the Desnianskyi Biosphere Reserve, demonstrates that approaches to climate change adaptation often include organizational, architectural, and engineering measures as well as information campaigns. An ecosystem-based approach, however, is still missing in these documents and remains an important task for the future.

Another promising instrument for applying EbA on the local level has been recently introduced by the EU. The Ukraine Local Empowerment, Accountability and Development Programme (U-LEAD) supports Ukrainian municipalities on their way towards integrated spatial planning. This approach aims at the comprehensive consideration of different interests within a particular area. In the municipality of Shatsk, integrated spatial planning has been already exercised in a pilot project. The importance of healthy ecosystems and the necessity of their conservation in the region have already been reflected in the proposed plan. It will serve as a good basis for ensuring an efficient connection between natural ecosystems and climate change adaptation during further steps.

As demonstrated in this section, there are various strategic processes and initiatives on all three governance levels in Ukraine with the potential for biosphere reserves to actively participate. For successful contributions to policy-making, however, they need to strengthen and consolidate their crucial role as drivers of change.

(1) Ancient beech forest of the Biosphere Reserve, providing manifold ecological functions, including, shading, water retention, and cooling of the landscape
© Roztochya Biosphere Reserve

Ukrainian–German Cooperation

Ecosystem-based Adaptation Training Week in Eberswalde, Germany

On 9-13 December 2019, 15 representatives of five Ukrainian UNESCO Biosphere Reserves met in Eberswalde and initiated a dialogue to mutually support the understanding of Ecosystem-based Adaptation to climate change. The training was organized and conducted by the Centre for Econics and Ecosystem Management with the support of the Michael Succow Foundation.
The participants and organizers set out to mutually explore, discuss, and understand practical options for the implementation of corresponding measures. The training week comprised diverse formats – from lectures and excursions to workshop-like group work, the elaboration of a common statement paper, and the co-creation of own criteria for effective ecosystem-based measures in biosphere reserves.

Idea Contest: "How to adapt to climate change with the help of natural ecosystems"

From 1st March until 24th April 2020, the three biosphere reserves Roztochya, Shatskyi, and Desnianskyi had a chance to participate in an idea contest on the topic "How to adapt to climate change with the help of natural ecosystems." The jury, composed of representatives from the Michael Succow Foundation, HNEE/CEEM, and the three partner biosphere reserves, encouraged residents of the Roztochya, Shatskyi, and Desnianskyi Biosphere Reserves to submit their ideas on small-scale pilot projects to demonstrate ecosystem-based adaptation in their region. By the end of the deadline, the jury received 29 applications showing a strong interest and motivation of the biosphere reserves´ inhabitants.
Finally, nine proposals (three per biosphere reserve) were selected for the funding up to € 10.000 per project. The project ideas cover a wide range of ecosystems and activities, such as rewetting of mires, reforestation, organic farming, or restoration of soil fertility. The EbA-Ukraine project team eagerly looks forward to supporting the upcoming implementation of the ideas and is sincerely grateful to all participants of the competition!

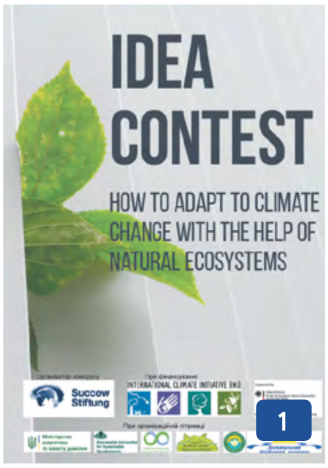
Project Website

The website on Ecosystem-based Adaptation to Climate Change in Ukraine (https://eba-ukraine.net) was developed and launched in 2019, both in Ukrainian and English languages.

Its general aim is to serve as a knowledge hub for anyone interested in the EbA approach and related concepts being introduced, discussed, and implemented in the three Ukrainian biosphere reserves. The website will provide the following:

- Introduction of the EbA approach to a wider audience and interested parties within the region.
- Presentation of EbA activities.
- Sharing of findings and knowledge accumulated during the project implementation.

Today, the website gets updated on the developments of the project. The findings include a broad range of written and other, also downloadable, materials, such as maps, tables, or brochures.



"This project involves mini projects for the local population, which is crucial for climate adaptation. Think global – act locally."

Ph.D. Nataliya Stryamets, Researcher at Roztochya Biosphere Reserve, Ph.D. in Forestry and in Forest Sciences

(1) Idea Contest Flyer
Designer: Nazar Tuziak

(2) Workshop session at Eberswalde University for Sustainable Development
© K. Mack

(3) Guided excursion at the re-naturalised Sernitz valley spring fen
© K. Mack

(4) Guided excursion at Treuenbrietzen post-forest fire site
© A. Dichte

(5) Launch of the idea contest (24th February 2020) in the Ukrainian Ministry of Energy and Environment
© Kyrill Tugai

(6) EbA-Ukraine project website
© Dilfuza Yuldasheva

"This project is one of the most relevant, covering research issues, raising awareness, and creating examples of adaptation measures to climate change. I hope that the results of the project and the developed climate change adaptation plans for the three biosphere reserves will serve as models for many regions of Ukraine, because the demonstrated approaches and methods are understandable and available for practical implementation"

Ph.D. Olesia Petrovych, Chief specialist, Department of Protected Areas, Ministry of Environmental Protection and Natural Resources of Ukraine

This brochure has been edited by:

Biosphere Reserves and Climate Adaptation

'Biosphere Reserves and Climate Adaptation' has been elaborated in the frame of the Ukrainian-German project «Ecosystem-based Adaptation (EbA) to climate change (CC) and regional sustainable development by empowerment of Ukrainian Biosphere Reserves». It consists of two volumes. Each volume is an open-access journal for Ukrainian biosphere reserve residents as well as any other interested parties. Each volume will be available in Ukrainian and English languages.

For a digital version, please, visit our website: https://eba-ukraine.net

Volume 1: **"Natural Ecosystems"**
Volume 2: **"Climate Change Impacts and Adaptation"**

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