Biosphere Reserves and Climate Adaptation

Volume 2 – Climate Change Impacts and Adaptation Svitiaz, 2021

Shatskyi 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) Damaged car after heavy storm
(cc4.0) Ukrainian State Emergency Service

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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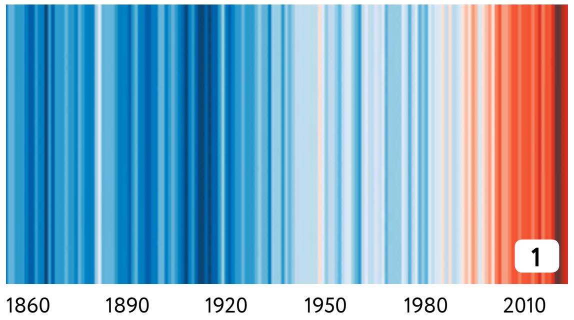
Climate Change
The biggest challenge for humanity

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.

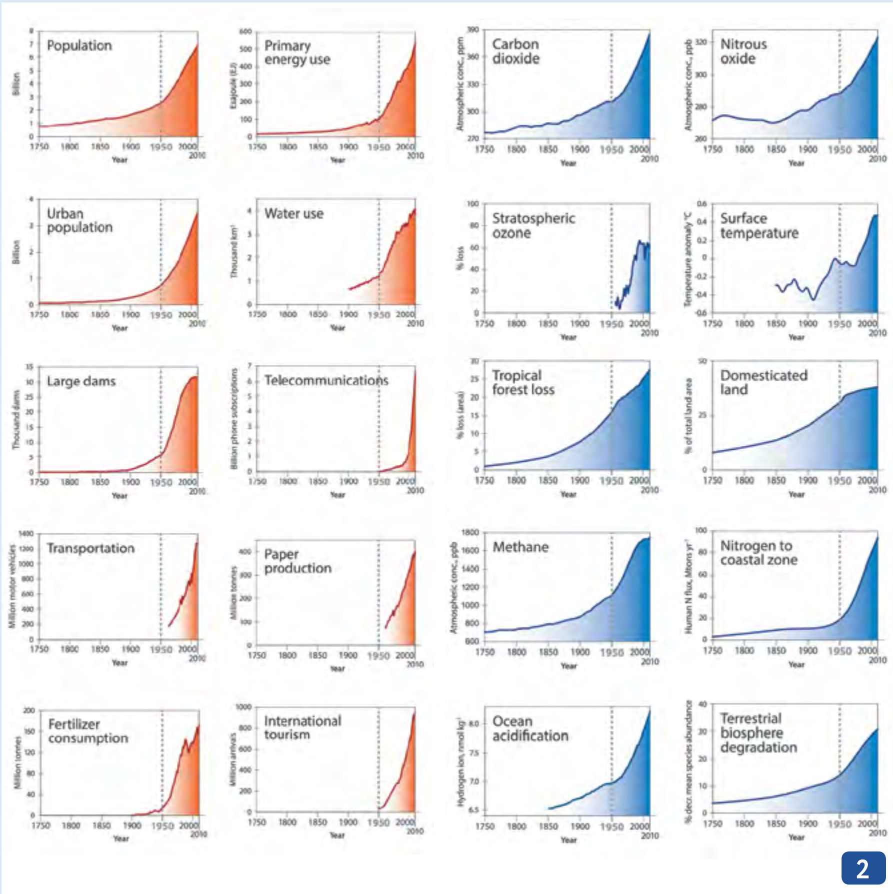
Planet Earth is unique. The interplay of its properties allows water to exist on its surface in liquid form, which is an essential condition for life. The globe of approximately 12,700 km thickness is surrounded by the biosphere as if it were a macroscopic biofilm. This fragmented and delicate film, 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.

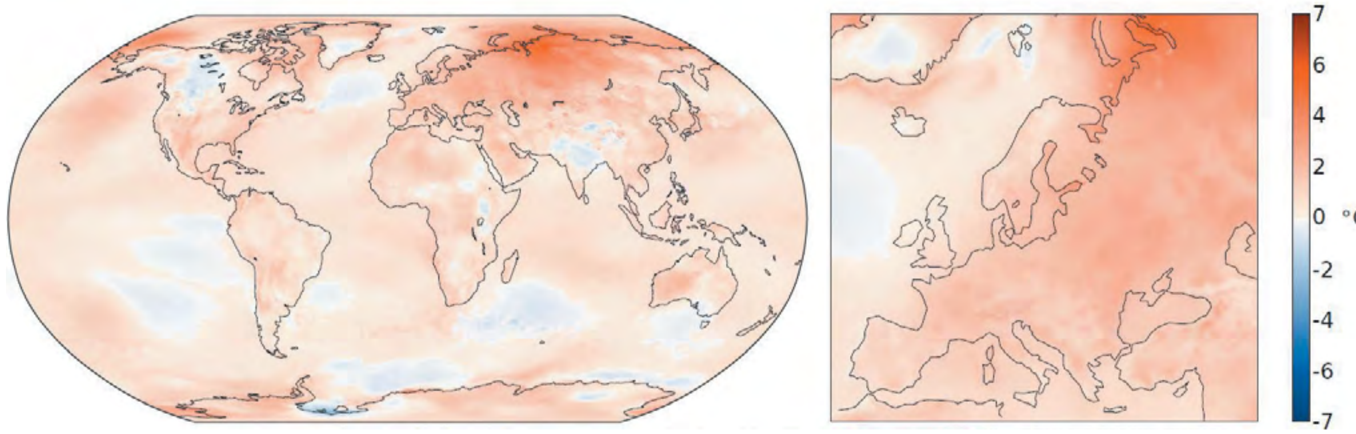
(1) **Warming stripes of the globe**
© Ed Hawkins (University of Reading).
Data: Berkeley Earth, NOAA, UK Met Office, MeteoSwiss, DWD, SMHI, UoR, Meteo France & ZAMG

(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

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.

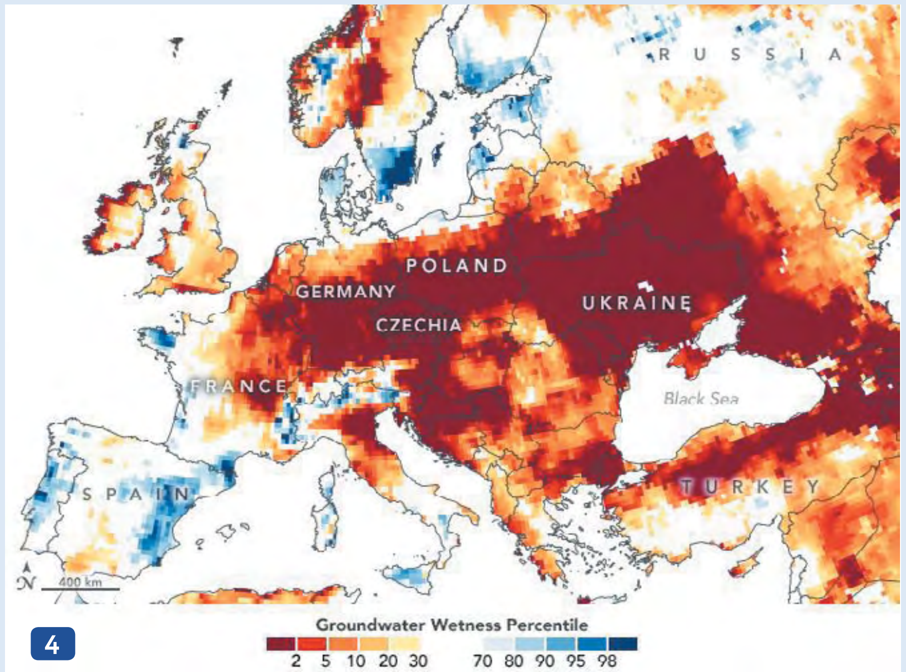
Citation: NOAA National Centers for Environmental Information, Climate at a Glance: Global Time Series, published June 2020, retrieved on June 30, 2020, from https://www.ncdc.noaa.gov/cag/https://www.ncdc.noaa.gov/cag/

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.

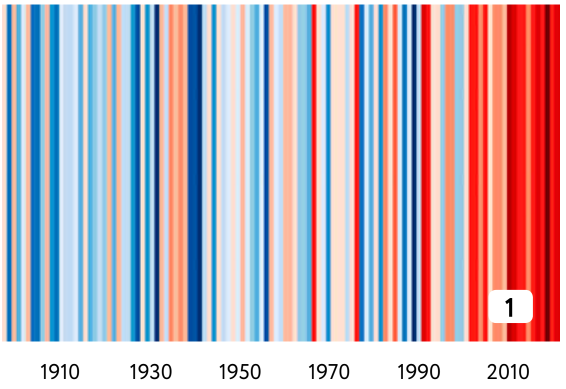
(3) **The map depicts global and European surface air temperature anomaly for September 2019 to August 2020 relative to the average for 1981-2010. It does not show absolute temperatures; instead, it shows how much warmer or cooler each region of the Earth was compared to that baseline average.**
Data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

Temperature change in Ukraine since 1901



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The Shatskyi Biosphere Reserve occupies the most north-western part of the Polesie ecoregion represented by mixed forests with the domination of pine forest stands and admixture of oak. Also, this part of Polesie is famous for the large number of lakes formed after the last glaciation in the Pleistocene. Like elsewhere across Polesie, the natural hydrological regime here was changed by a drainage network, which influenced microclimate conditions as well.

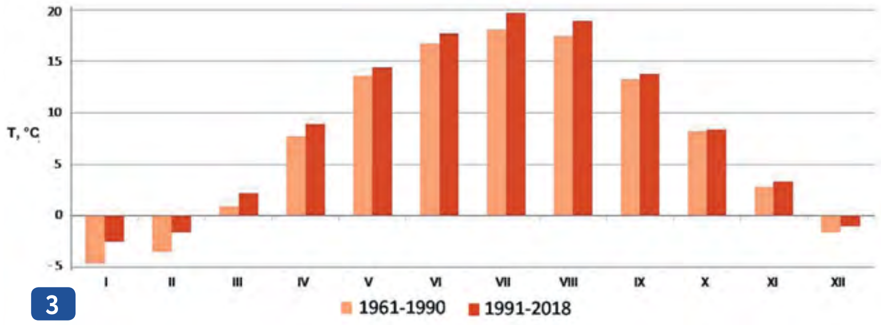
2

(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 Shatskyi BR (Svitiaz weather station)
© A. Smaliychuk

(4) Average sum of monthly precipitation for the modern period (1991-2018) vs. period of climatological normal (1961-1990) in Shatskiy BR (Svitiaz weather station)
© A. Smaliychuk



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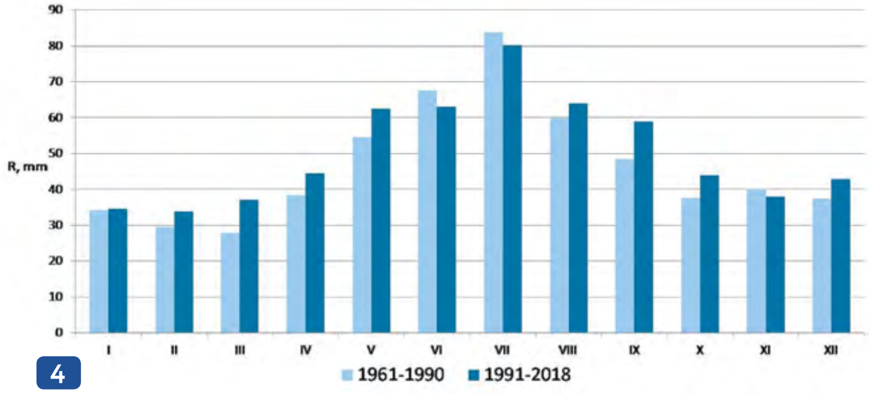

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Climate observations in the Shatskyi Biosphere Reserve have been conducted since 1945 at the Svitiaz weather station located next to Svitiaz – the largest lake in the region. Overall, the local climate is formed by westerlies, which bring about most of the annual precipitation from the west. Moreover, due to a large number of lakes, the microclimate of the Biosphere Reserve also features higher air humidity and a distinguished impact of the breeze wind on air circulation.

Air temperature

During the climatic normal period between 1961 and 1990 (standard reference), the average annual air temperature was about 7.4°C. It reached the maximum of 9.5°C and 9.1°C in 1989 and 1990, respectively. In the past 28 years (1991-2018), the mean annual temperature reached 8.5°C, thus having increased by 1.1°C. It has been particularly high since 2014: each year's value exceeded 9.0°C with a peak of 9.8°C in 2015. 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 -4.6 vs. -2.5°C and 18.1 vs. 19.8°C, respectively. The highest increase in mean monthly temperatures in comparison to the climatic normal was observed in winter (January and February) and summer months (July and August) (see graph 1). Moreover, this trend has accelerated in the past five years (2014-2018) when the highest temperature rise appeared to be more than 2.5°C in February, March, August, and December. It was particularly hot in August 2015 and July of 2014, when the average air temperature reached 21.9 and 21.2°C, respectively, due to extreme heatwaves in those summer seasons. These values correspond 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 from April till September with a total number of 89 days per year as compared to 64 days' average in 2014-2018.

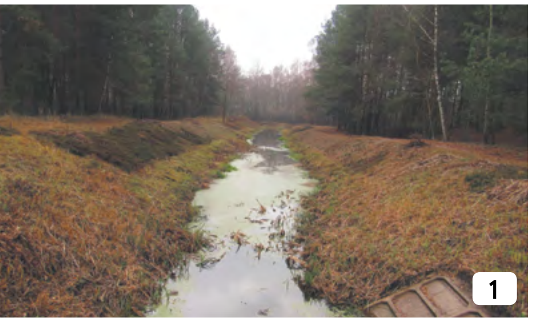
Precipitation

The average annual amount of precipitation in the region of the Biosphere Reserve, as compared to the reference period and last three decades has increased by almost 8 % – from 559 to 603 mm. Furthermore, the amount of precipitation in eight out of twelve years between 2007 and 2018 has exceeded by 120 % the long-term average of 1961-1990. Most precipitation still falls during the summer season, although there are some changes in volume throughout the year (see graph 2). Between 1991 and 2018, a substantial increase in the amount of rainwater was recorded in the spring months and September-October, while only three months (June, July, and November) featured less precipitation in comparison with the climatic normal.
During the last five years, the average duration of a dry period has been 9 days per month, with the longest consecutive period of 25 days observed in August 2015. The highest one-day precipitation usually falls in May-July and September-October with an average amount of 15-25 mm over 24 hours. Its absolute monthly maximum was recorded in May 2014 and July 2018 with more than 130 mm, which constituted more than 20 % of annual precipitation in those years. As compared to the other two BRs, the average number of wet days (with snow or rain) is much higher (ca. 160 days per year) in the Shatskyi BR, thus indicating a shorter duration of the dry period, which, however, is hindered by the low water-holding capacity of sandy soils. Due to specific air circulation, large water bodies within the Shatskyi BR moderate the adverse consequences of climate change in surrounding ecosystems providing them with cool and wet air flows.

Projection for the future

According to the most probable climate change scenarios for the Shatskyi region (B1 and A2 scenarios of IPCC), the mean annual temperature is expected to increase by 2.0 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 can be challenging for the development of sustainable and adapted agriculture and forestry as well as tourism in the region.

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



The ecosystems and, in consequence, the people of the Shatskyi 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 Shatskyi BR, this is a result of past and present human land-use practices: In forest ecosystems, monocultures, clear-cutting, deforestation, and illegal logging play a major role. Intense agriculture, surface sealing, and the use of pesticides and herbicides affect the open land ecosystems leading to degradation of soils, biodiversity- and water loss. Wetlands and water bodies were and are affected by hydro-technical melioration and drainage, pollution, excessive use, and uncontrolled recreational activities by large numbers of tourists. Unrestrained residential development, uncontrolled extraction of mineral resources within the BR, and legal mining activities on the adjacent Belarus territory are also considered to affect the overall hydrological regime.

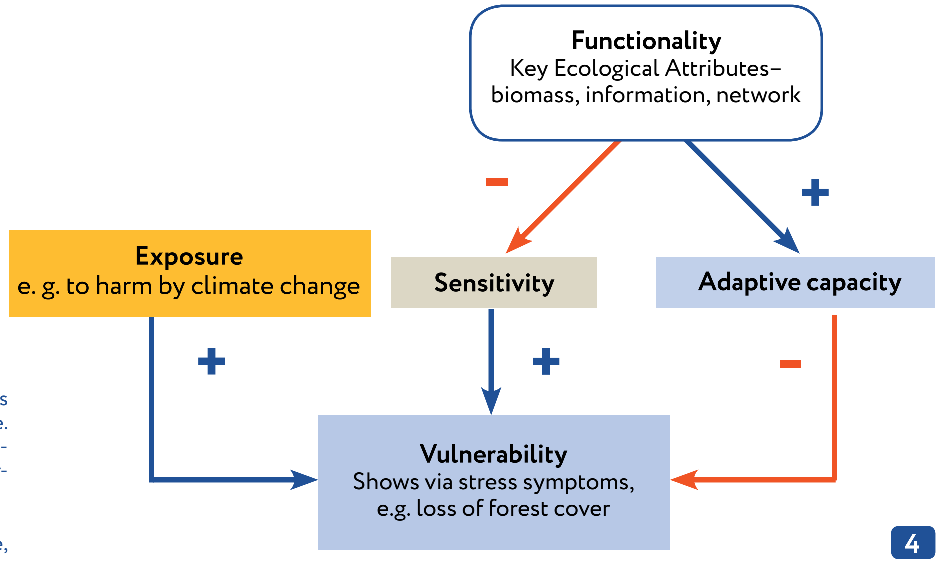
Hot and dry summers and mild winters without frost and snow have become more frequent on the territory of the Biosphere Reserve, especially in the past five years. Increasing average temperatures, hot days, and drought periods drive evaporation and transpiration rates of water-bodies, soils, and plants, leading to landscape dehydration. Combined with changes in quantity and timing of precipitation, higher runoff rates, nearby mining activities, and unsustainable water use by agriculture and private households, the water balance is under additional pressure. Significant was the water-level drop in 2019 of about two dozen lakes, including lake Svitiaz, the largest lake within the Shatskyi BR. It is considered the cleanest and deepest in Ukraine and is recognized as one of the seven Ukrainian natural wonders and a favorite vacation spot. The lake´s water level dropped by 38 cm below the observed normal of the past 35 years. Subsequent hot and dry years, as well as unchanged water-use, pose a major challenge for the lakes´ recovery. Forests, swamps, meadows, and agricultural lands are also increasingly suffering from dehydration. The combination of dryer conditions due to climate change and unsustainable water use by humans increases the risk of fires, in particular in meadows and peat bogs, a rising number of fires are being observed and monitored.

(1) **Drainage channel within a forest plantation – a driver of dehydration and thus vulnerability**
© K. Mack

(2) **Uncontrolled urban sprawl and surface sealing are a threat to functional ecosystems**
© K. Mack

(3) **Water-intense, artificial blueberry farming negatively affects the water balance and soil quality**
© A. Schick

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



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) **Degraded soils as a result of past intense agricultural use**
© A. Schick

(6) **Monoculture forestry – poor in biodiversity, water retention, and cooling capacity**
© Shatskyi Biosphere Reserve

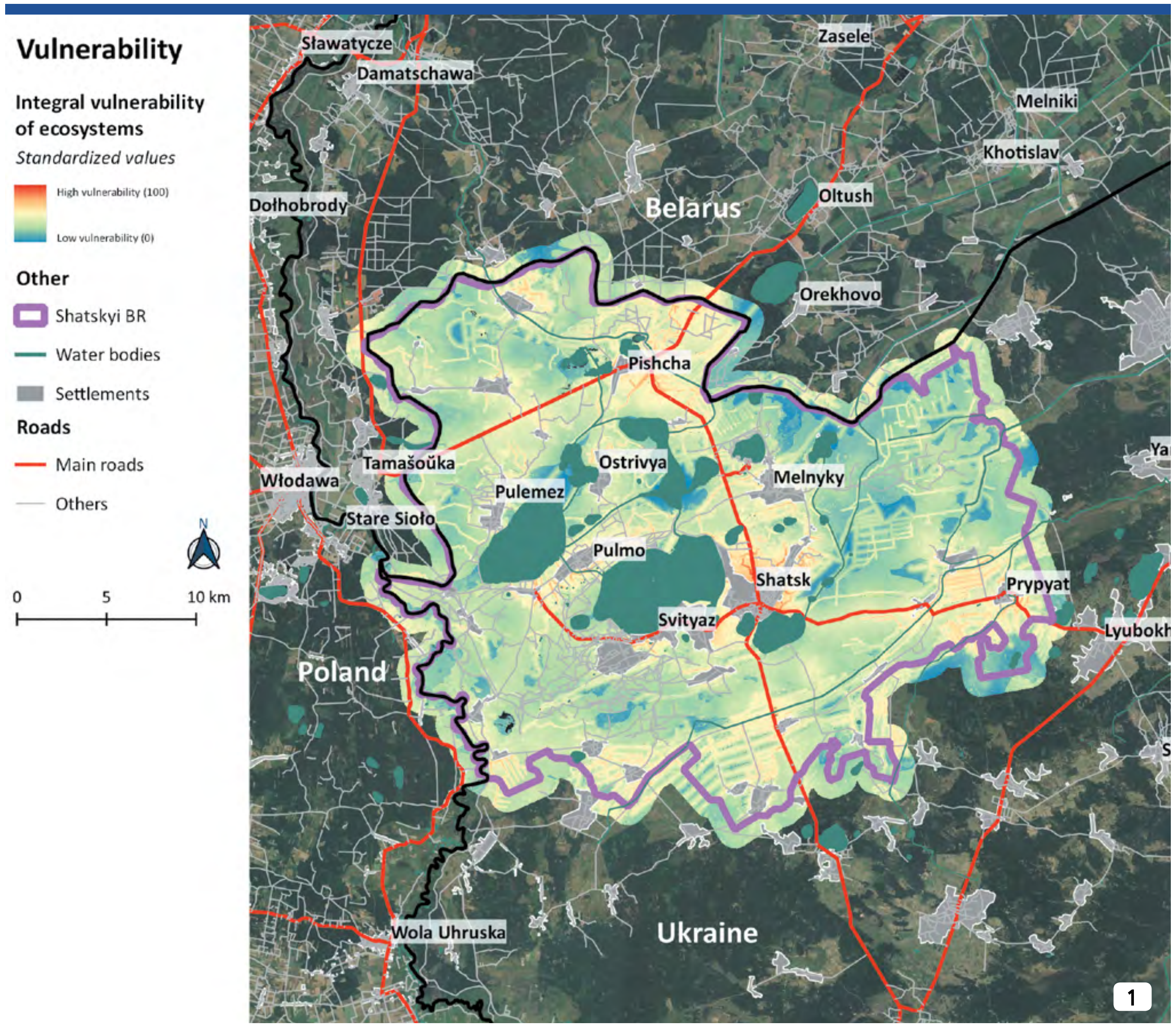
(7) **Lake Svitiaz´ significant water level drop in 2019 related to climate change and human factors**
© Shatskyi Biosphere Reserve

(8) **Heat and drought lead to desiccation and loss of flora (and fauna) and increase the risk of wildfires**
© Shatskyi Biosphere Reserve

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

"In recent years, there has been a significant increase in average and maximum air temperatures and a decrease in precipitation, especially in summer and autumn. These factors increase the number of dry days in summer and reduce the resilience of ecosystems."

Vitaliy Turych, researcher at Shatskyi Biosphere Reserve



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

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

Continued from p. 7

Even though the occurrence of forest fires remains low, their risk increases. Enabled by these conditions, fires are mostly triggered by inattentive humans or lightning strikes during thunderstorms. Overall, a reduction in biodiversity is observed both related to climate change and human intrusions. Changes in wildlife, plant populations, and habitats are occurring. This includes the appearance of alien species, while the living conditions of native plant and animal species are deteriorating. A growing number of the spread of pests, diseases, and insect calamities are observed mostly in forest and agricultural ecosystems. Higher levels of insect populations destroying trees and crops are found in arid arrays. Monoculture pine forests are extremely vulnerable – the bark beetle population has now become a major threat to these stands. Climate change also drives an increase in the number of dangerous weather phenomena, such as heatwaves and droughts, torrential rain and flooding, storms, hail-, sand-, and snowstorms, and frosts with 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 little 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 need restoration efforts and reduction of human-induced stresses.

Forestry, agriculture, and pisciculture

Diverse economic sectors relevant to the Shatskyi BR are facing increasing losses due to climate change impacts. Dropping water levels in lakes relevant for tourism, crop failures due to drought, hail, and pests, as well as dying fish, are few examples of the challenges the local economy is and will increasingly face. Forest ecosystems are increasingly affected by heat and drought, storms, and pests. In recent years, a spread of the apical bark beetle in pine plantations of the Shatskyi BR has been noticed.

Past intense land transformation and use has negatively affected the soil quality, destroyed the root systems, led to dryer soil conditions, and caused erosion in the territory. As soil is insufficiently saturated with water, land-users are forced to change cultivation schemes. For example, land that was previously used as meadows by the local inhabitants is now the intensively used and irrigated cropland. For the local population, this leads to higher investments of time and money for growing crops. Yet, the lowering groundwater and surface water levels, visible in the shallowing of lakes, ponds, and reservoirs, make artificial landscaping based on constant watering more difficult and riskier.

On the drained territory of the Upper Pripyat drainage system (Polozhevo village), there is a berry plantation of about 200 hectares, and, as a consequence, irrigation reservoirs are being filled with groundwater. This amount of water use also affects the water availability of surrounding ecosystems and people. The influence of this farm, the domestic and touristic sectors, the Belarus chalk mine, and climate change on the hydrological regime of the Shatsky BR have not been investigated system-wide so far.

Tourism

This sector is highly relevant for the region because of its many lakes, forests, swamps, and recreation sites. Especially in the summertime, it is a touristic hotspot of Volyn Oblast and north-western Ukraine. Climate change poses a serious threat to this unique touristic character of the region, being home to lake Svityaz, one of the seven natural wonders of Ukraine. Additionally, Shatsk district residents and tourist facilities operators make extensive use of groundwater from wells, which are available in most households and recreation centers.

The shallowing and drying of lakes and other climate change-related impacts can cause a serious decline in touristic attractiveness and thus in activity, employment, and income opportunities for the local population. Forest and meadow vegetation dieback is accelerated by drying while insect calamities can negatively affect the aesthetic value of the region for visitors and the inhabitants. Tourism can only remain a stable future income source if land use is sustainably approached and developed. (Near-) natural and functional ecosystems are the basis of securing the economic and social dimension of tourism in the long run. Local tourist operators need to be aware of this and understand ecosystem-based solutions as an opportunity for this sector.

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 and frequency and risk of wildfire
- Shifting production zones
- Soil degradation and 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.

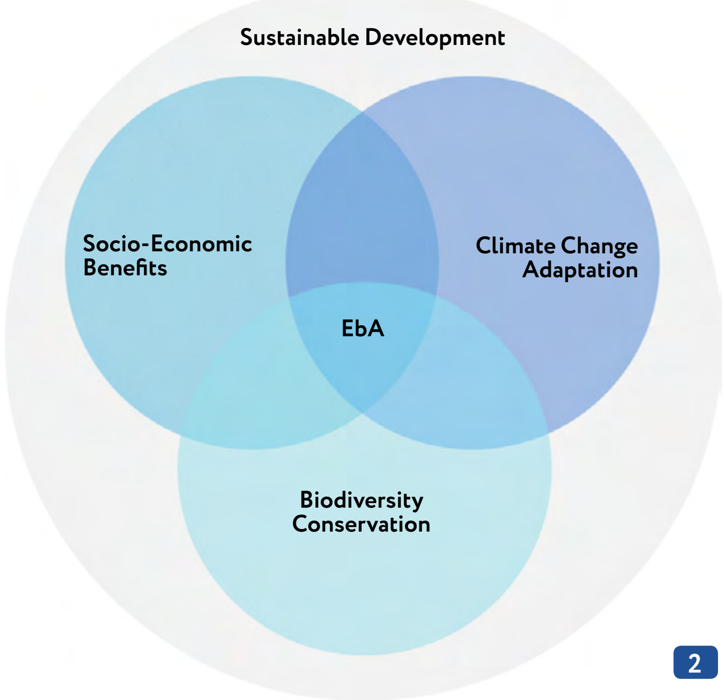
(2) Ecosystem-based Adaptation (EbA) in the context of sustainable development as a cross-cutting approach among several (adapted from Midgley et al. 2012. Biodiversity, Climate Change and Sustainable Development – Harnessing Synergies and Celebrating Successes)

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

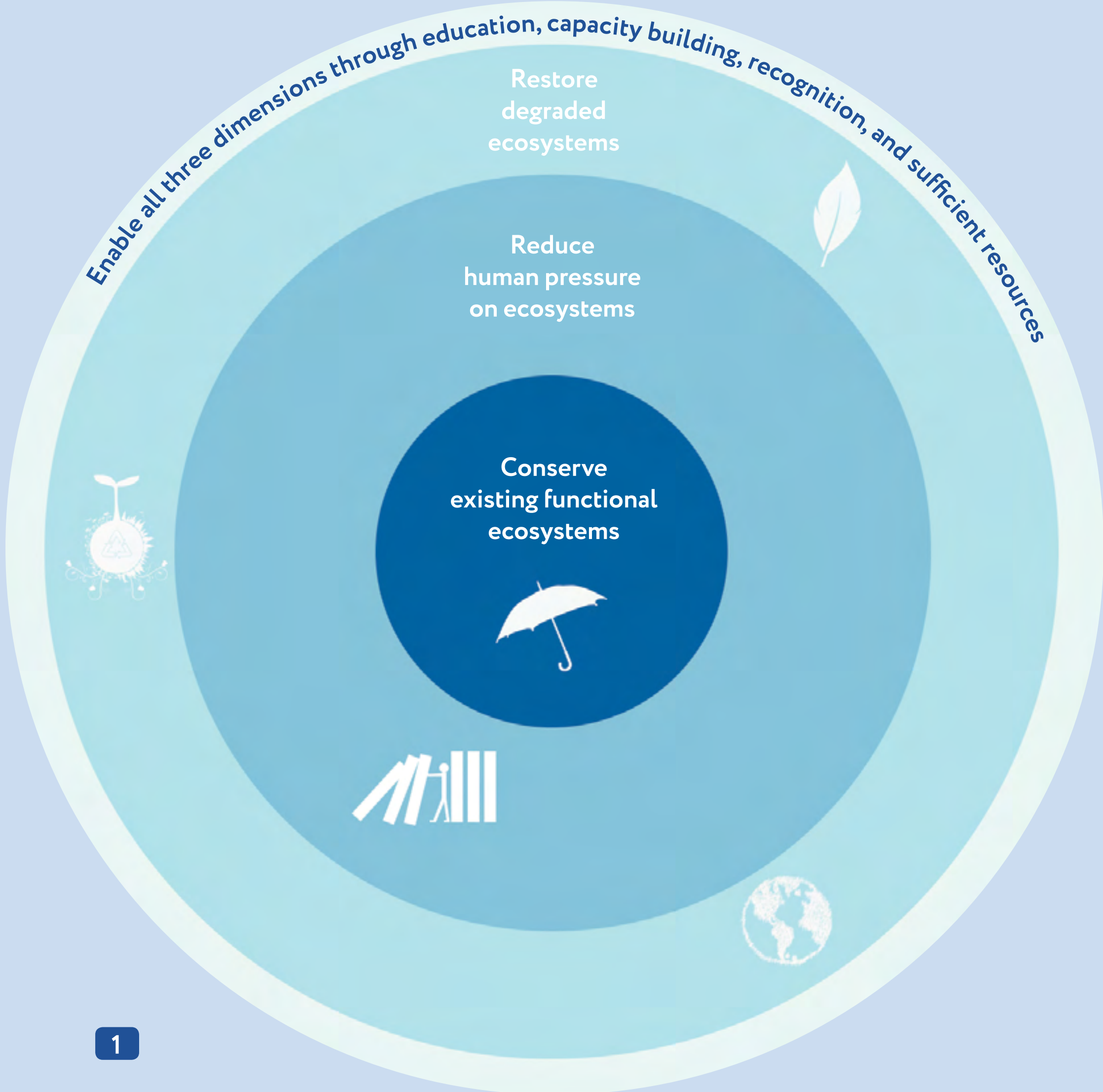
(4) Reed use, e.g. as insulation material, needs functional wetlands

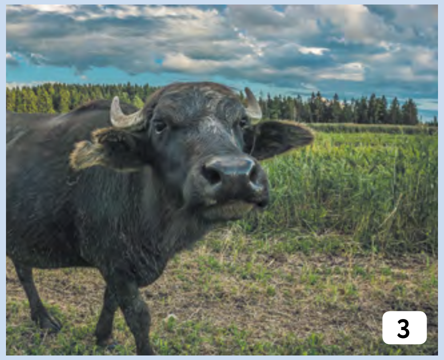
(5) Structure-rich, regenerative agriculture builds healthy soils, keeps water in the landscape, and provides nutrient-rich food

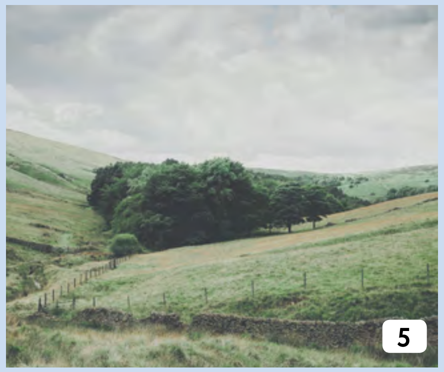
Sources: All 3 images are copyright-free provided by pixabay.com



(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!







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

Several environmental problems in the Shatskyi Biosphere Reserve are caused by human intervention in the natural hydrological regime of this area due to the implementation of a large-scale draining wetlands campaign launched in 1954. This campaign was further developed within the framework of the state land reclamation program back in 1961.

“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

There are no water bodies on the territory of the biosphere reserve, which haven’t been affected by drainage reclamation. Nowadays, they are all characterized by drainage water intake. The drainage basins of many lakes have decreased, leading to their degradation. Drainage of peat bogs, together with the transformation of annual and perennial water regime and water balance, contributed to the changes in local climate, making it much drier: atmospheric droughts, wind erosion, and heatwaves have become typical for the area of the Biosphere Reserve. Therefore, all the preconditions for the emergence and development of negative processes on the drained lands have been formed. Rapid climate change in the last decades has intensified the manifestation of these processes in the Biosphere Reserve and increased the necessity to find ways of eliminating and preventing them. One of such ways is the implementation of adaptation measures.

According to the “Program of measures for establishing a network of protected areas and renaturalization of wetlands in Polissya”, adopted by the Ukrainian government in 1995, the Shatskyi Lake region was selected as the first site in Ukraine for the restoration of degraded wetlands. The first project dedicated to the renaturalisation of such ecosystems – “Renaturalization of the wetland complex of Lake Krymno and its surrounding swamps and peatlands” – was implemented in 1998 with the financial support of EECONET Action Fund based in the Netherlands. About 587 hectares of the territory of Lake Krymno and 440 hectares of wetlands were renaturalized within the framework of this project. This area was selected as a pilot area due to its crucial importance as a stop for migratory birds.

After installing a spillway structure, the ecological parameters of the wetlands have improved – the water level was restored and stabilized and the previously drained wetlands were filled with water. This contributed to restoring wetland vegetation and increasing the number of wetland birds, including rare and highly rare ones (e.g. aquatic warbler (Acrocephalus paludicola), gray crane (Grus grus), as well as to improving their food base.

The second project dedicated to the renaturalisation of wetland ecosystems in the Shatskyi Biosphere Reserve was implemented in 2000 and aimed to improve the hydrological conditions of the lake complexes of Liutzymer and Velyke Chorne lakes and its surrounding swamps. The main goals of this project’s implementation were stabilization of water level in the lakes and flooding the surrounding peatlands, restoration of fish spawning grounds, and reproduction of wetland vegetation.

Furthermore, there were two more similar projects implemented in 2000 on the wetlands of Lakes Pulemetske and Ostrivyanske, also financed by EECONET Action Fund. After the installation of a water overflow structure on the lakes Pulemetske and Ostrivyanske, there was a large increase in the water content of the coastal strip (especially on the east coast). As a result, a nesting area for birds of the wetland complex has enlarged and their food base was enriched. In 2001, a colony of white-winged tern *(Chlidonias leucopteraTemm.)* and black tern *(C. niger)* was noticed there for the first time.

Overall, the implemented renaturalisation measures have significantly increased the capacity of the mentioned lake complexes for wetland bird species. Additionally, due to restoring the natural flooding of these ecosystems, their vulnerability to climate stresses has become lower while their ability to fulfill their climate regulating function, as well as to provide other ecosystem services to the local population, has improved.

The problem of decreasing water levels in local water bodies also affected the pearl of the Shatskyi Biosphere Reserve – Lake Svitiaz. Since it was an endorheic lake in the past, its water level fluctuated naturally. However, to prevent flooding, especially in the village of Svitiaz, a 3 km long canal was dug to connect Lake Svitiaz with Lakes

(1) **New planting scheme with pine and birch species as a measure of cooling, fire prevention, and pest control**

© Shatskyi Biosphere Reserve

Luky and Peremut in the 19th century. As a result, artificial drainage of water from the lake appeared. In 2019, due to the increase in average daily temperatures and decrease in precipitation in the summer period, lake Svitiaz began to intensively shallow. Therefore, an issue of eliminating runoff in the canal, which is connecting Lake Svitiaz with Lakes Luky and Peremut, became acute. For this purpose, in the same year, within the framework of the regional ecological program of Volyn region «Ecology 2016-2020», the floodgate-regulator of the main canal connecting lakes Svitiaz and Luky-Peremut was repaired. The restoration of elements of the hydro-technical construction allowed preventing the outflow of water into lakes Luky and Peremut and to increase water level in Svitiaz.

It is also worth mentioning an interesting experiment conducted by local foresters, which focused on the introduction and increase of the proportion of deciduous tree species to adapt to climatic stresses. In 2011, an experimental forest plantation with a mixed composition of tree species was planted on the territory of Shatskyi educational and research forestry. In Polissya forestry (quarter 59, section 19), around 5600 seedlings were planted on a plot area of 0.7 ha with nine rows of hanging birch and one row of Scots pine. The atypical planting scheme was chosen primarily to control the spread of root rot. Additionally, this mixing scheme helps prevent fires by retaining moisture and shading and therefore contributes to increasing the resilience of ecosystems to the negative effects of climate change.

(2) **Water retention facility on the drainage channel between lakes Pulemetske and Ostrivyanske – a hybrid adaptation option**

© Shatskyi Biosphere Reserve

Although this area is experimental, foresters have already started to notice its effectiveness: the soil has been enriched with organic matter and forest stands have become better established than comparable coniferous monoculture plantations.

“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)

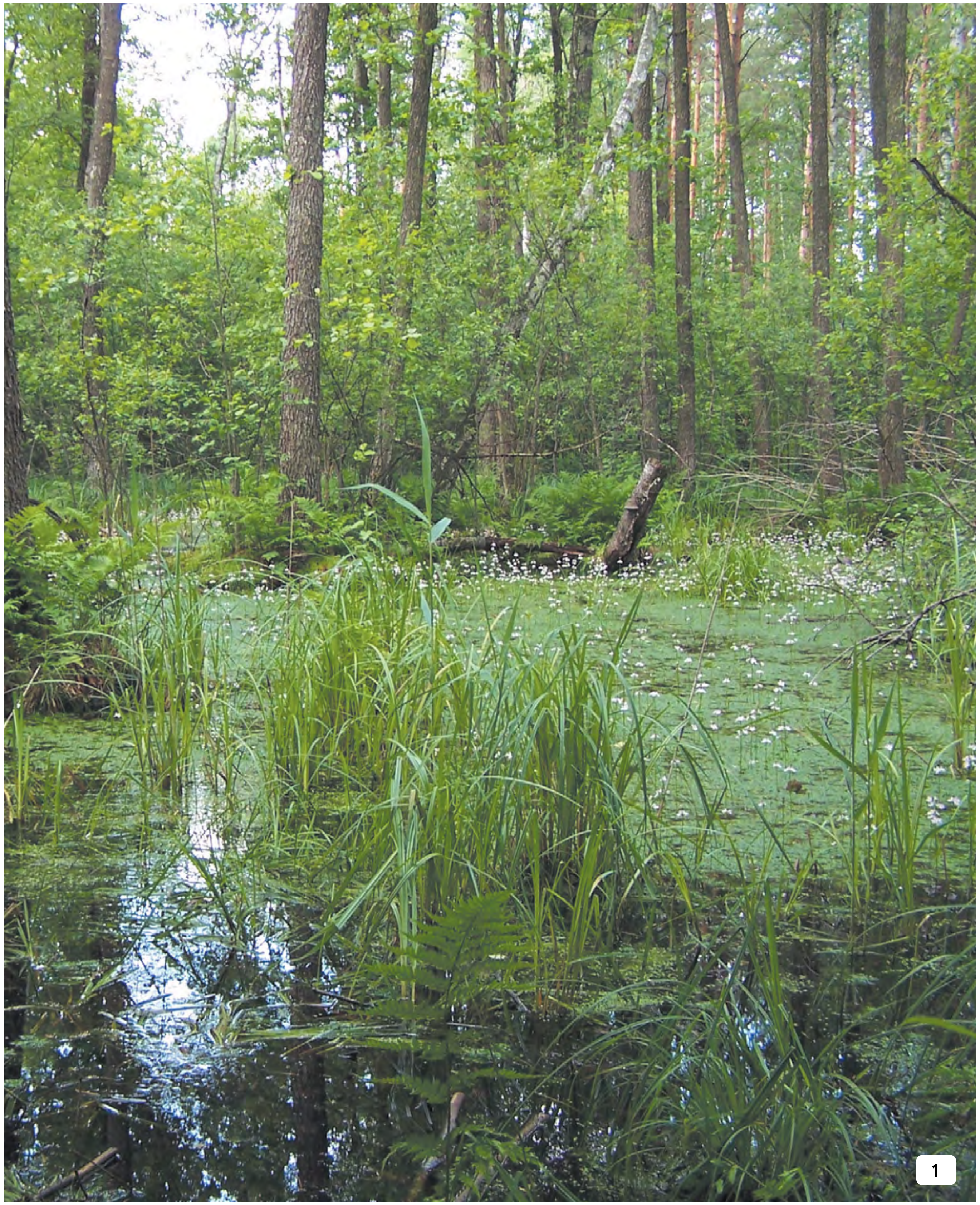
(2) Maria Khrystetska (Shatskyi Biosphere Reserve) speaking at a meeting in the Ministry of Energy and Environment of Ukraine
© K. Tugai

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

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

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

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) Swamp forests and forest mires on the territory provide manifold ecosystem services, including, water retention and thus flood protection, as well as cooling of the landscape

© Shatskyi 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"

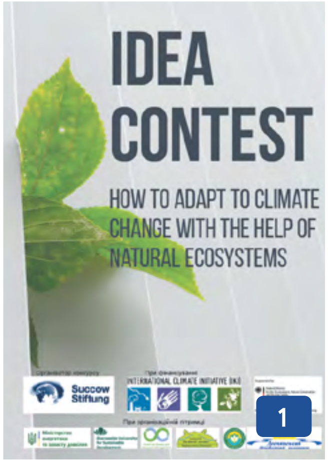
From 1st March until 24th April 2020, the three biosphere reserves Roztochya, Shatskyi, and Desnianskyi had a chance to participate in an idea contest on the topic "How to adapt to climate change with the help of natural ecosystems." The jury, composed of representatives from the Michael Succow Foundation, 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.



"Cooperation with qualified experts from Germany and Ukraine provides an opportunity to gain new knowledge and skills and to use them in practice. It also enhances the visibility of the Biosphere Reserve and provides a good basis for further work towards climate adaptation."

Oksana Havros, press secretary of the Shatskyi National Nature Park

(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

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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”**

Шацький національний природний парк

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