Biosphere Reserves and Climate Adaptation

Volume 2 – Climate Change Impacts and Adaptation

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Desnianskyi 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) Extinguishing a cropland wildfire
(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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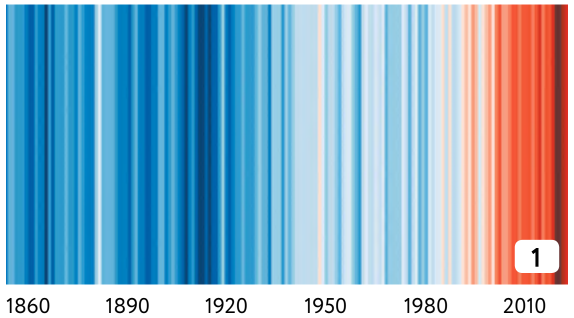
Climate Change
The biggest challenge for humanity

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

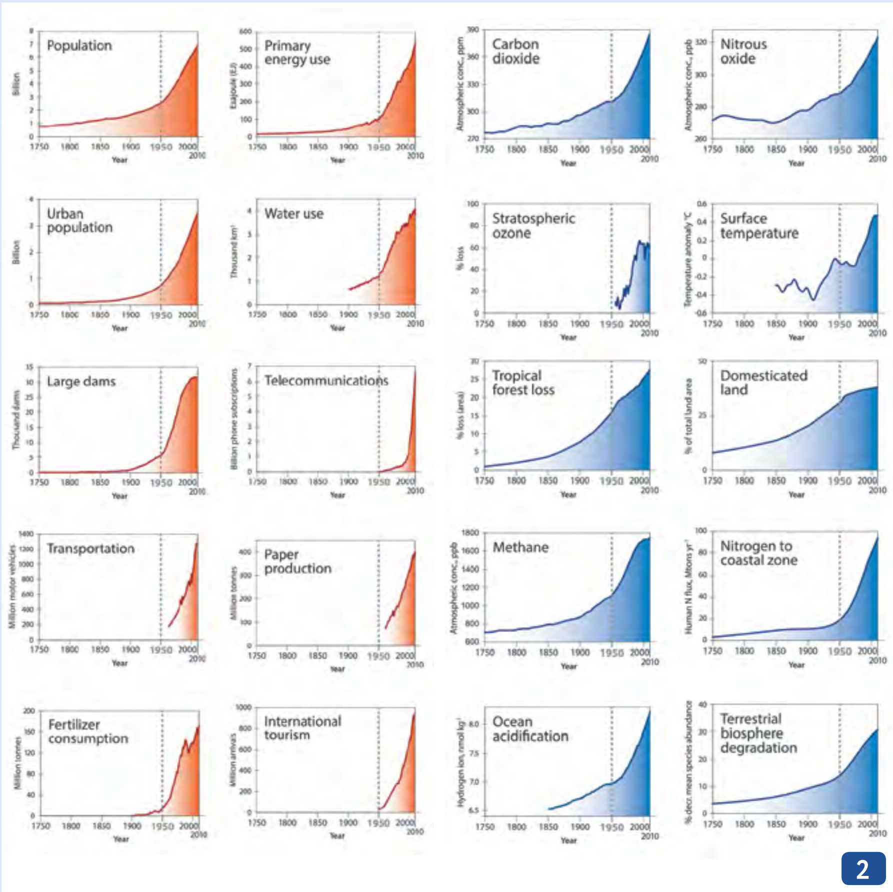
For several hundred thousand years, humans have been just some of the numerous actors in this delicate biosphere layer. But it is only in the last 150 years that technological and social developments have led to the incomparably rapid growth of a wide variety of factors, which have significantly changed 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.

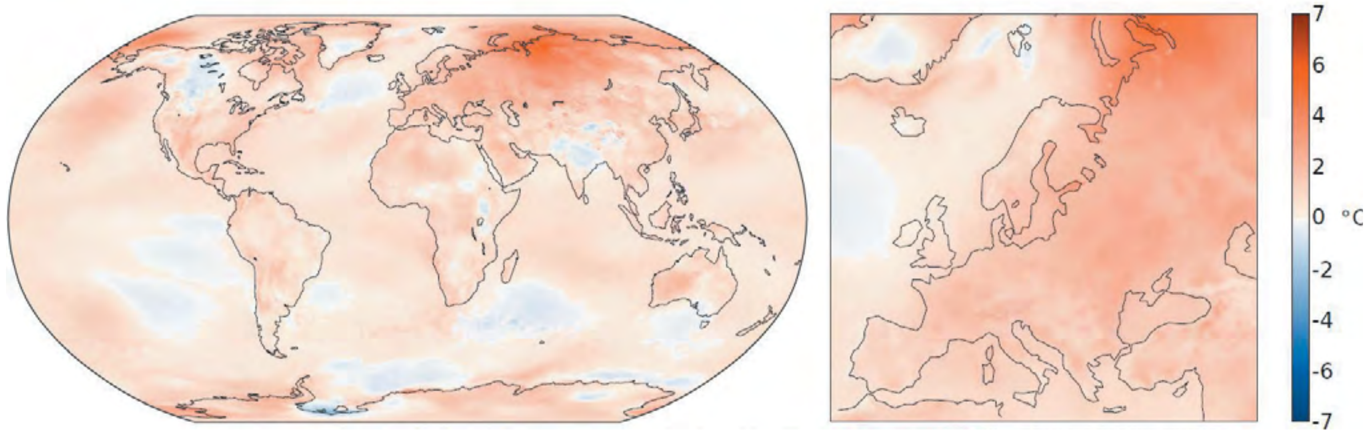
(1) **Warming stripes of the globe**
© Ed Hawkins (University of Reading).
Data: Berkeley Earth, NOAA, UK Met Office, MeteoSwiss, DWD, SMHI, UoR, Meteo France & ZAMG

(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.

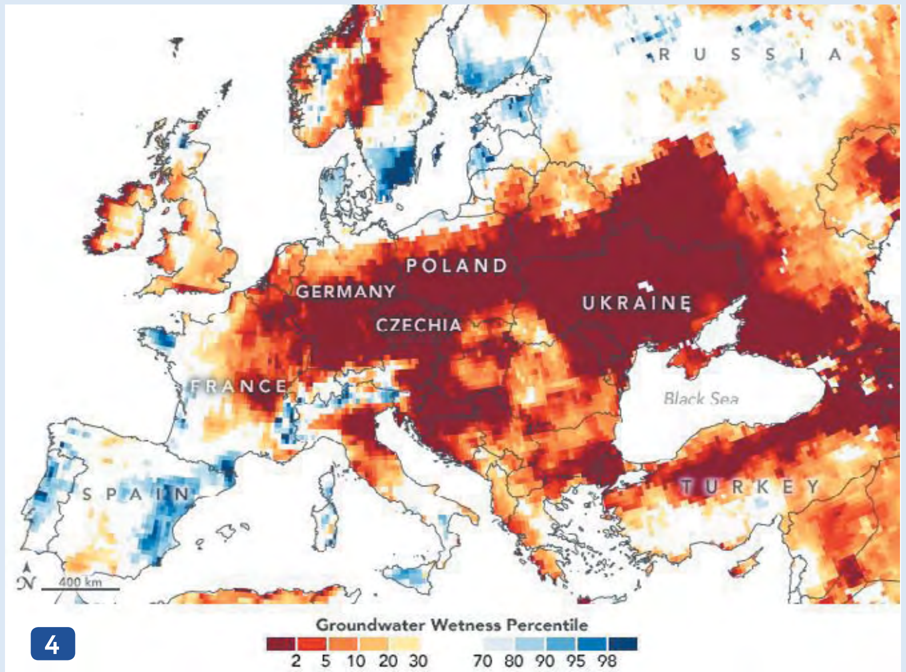
Citation: NOAA National Centers for Environmental Information, Climate at a Glance: Global Time Series, published June 2020, retrieved on June 30, 2020, from https://www.ncdc.noaa.gov/cag/https://www.ncdc.noaa.gov/cag/

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.

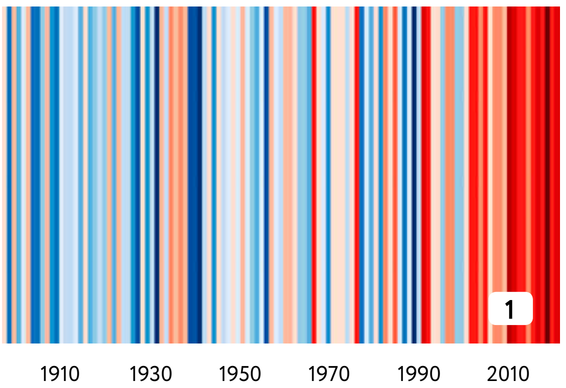
(3) **The map depicts global and European surface air temperature anomaly for September 2019 to August 2020 relative to the average for 1981-2010. It does not show absolute temperatures; instead, it shows how much warmer or cooler each region of the Earth was compared to that baseline average.**
Data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

Temperature change in Ukraine since 1901



The Desnianskyi Biosphere Reserve is located in the far north-eastern part of Polissia ecoregion, which is also called Novgorod-Siverske Polissia in terms of climatic and other environmental conditions. Since it lies at the frontier of mixed forest and forest-steppe zones and embraces the Desna river valley within its boundaries, the microclimate settings there tend to have substantial spatial variations. The region is characterized by warm, humid summers and winters with snow cover and by the absence of significant differences in precipitation between seasons.

"Forest ecosystems of the Desnianskyi Biosphere Reserve are an important stabilizing factor in the process of adaptation to climate change."

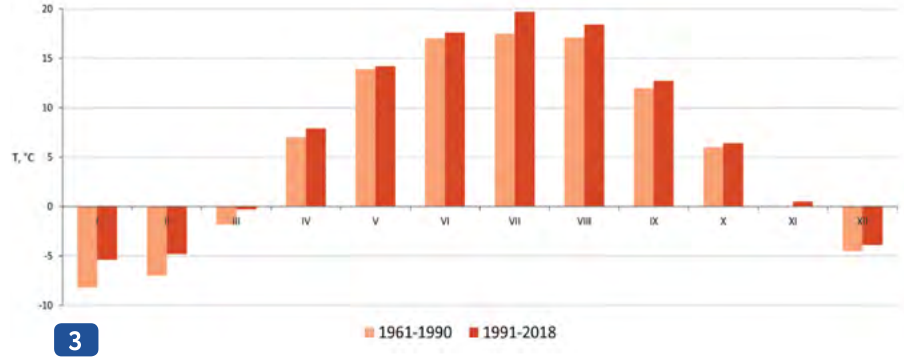
Ph.D. Anatoliy Zhezhkun, director of the State Enterprise "Novgorod-Severskaya Forest Research Station"

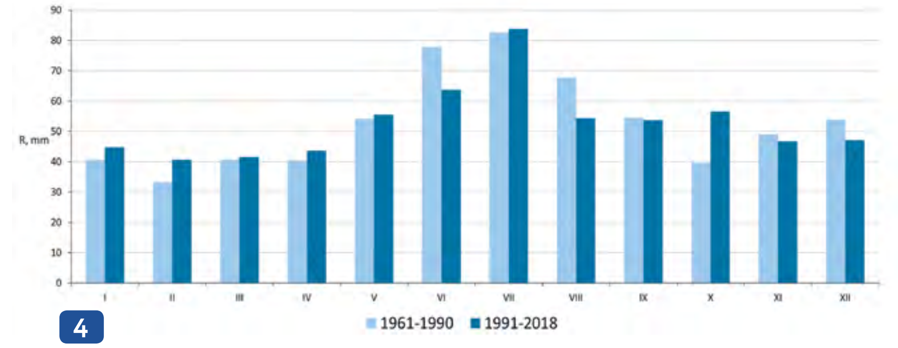
(1) Warming stripes of Ukraine
© Ed Hawkins (University of Reading) Data: Berkeley Earth, NOAA, UK Met Office, MeteoSwiss, DWD, SMHI, UoR, Meteo France & ZAMG

(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 Desnianskyi BR (Druzhba weather station)
© A. Smaliychuk

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





There are no facilities for the regular collection of climatological data within the Biosphere Reserve. The closest weather station that provides information on the climate conditions of the area is situated in Druzhba town (Sumy oblast), which is about 25 km southeast of the Desnianskyi Biosphere Reserve.

Air temperature

During the climatic normal period between 1961 and 1990 (standard reference), the average annual air temperature was about 5.8°C with a maximum of 7.8°C reached in 1975 and 1989. In the last 28 years (1991-2018), the mean annual temperature increased to 6.9°C, i.e. by 1.1°C. It has been particularly high since 2007 with a peak of 8.1°C in 2015. The mean monthly temperature of the coldest and hottest months (January and July) in the periods of 1961-1990 and 1991-2018 was 8.2 vs. -5.4 °C and 17.5 vs. 19.7°C respectively.
The highest increase in mean monthly temperatures in comparison to the climatic normal was observed for the winter and summer periods and March (see graph 1). Moreover, this trend has accelerated in the recent five years (2014-2018), when the highest temperature rise detected was more than 3°C for February and March. It was particularly hot in July of 2014, 2016, and 2018, when the average air temperature exceeded 20°C, which corresponds to the past long-term average of Central Ukraine (e.g. Dnipro city). In 2017 and 2018, summer days (with a maximum daily temperature exceeding 25°C) were observed as early as April, this being yet another evidence of recent climate change in the region.

Precipitation

The average annual amount of precipitation in the region of the Biosphere Reserve in comparison to the reference period and last three decades remained almost the same – 634 and 632 mm. However, in three out of five years between 2014 and 2018, there was less than 500 mm of precipitation. 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 decrease in the amount of rainwater was recorded in June and August, 14 and 13 mm respectively, as compared to the climatic normal. The only month which showed a considerable increase in precipitation was October with 17 mm of surplus. During the last five years, the average duration of a dry period was 12 days per month, with the longest one being between August and November (16-17 days). The highest one-day precipitation usually falls from May to July with an average of 20-30 mm over 24 hours. Its absolute maximum was recorded in July 2018 with 56 mm/day, which constituted 60 % of the entire rainwater for that month. The period between May and July is also characterized by frequent heavy and extremely heavy rains. Due to the air temperature developments, particularly in the winter season, in recent years more and more precipitation came as rain rather than snow, thus having impacted the flooding regime in spring.

Projection for the future

According to the most probable climate development scenario for the Desnianskyi region (A1B scenario of IPCC), the mean annual temperature is expected to increase by 2.5°C by the end of the 21st century in comparison to the 2000-2010 average. It also indicates 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

The ecosystems and, therefore, the people of the Desnianskyi 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 for the ecosystems that are exposed and cannot function properly due to overuse, modification, destruction, and fragmentation.

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 **are at risk**.

Both the current capacity of ecosystems to perform and their future ability to cope with disruption are hampered. In the Desnianskyi BR, this being a result of past and present human land-use practices, such as forest clear-cutting, large-scale monoculture forestry and agriculture, surface sealing, land melioration practices and drainage, pollution, excessive use of pesticides and herbicides, and the pressure from uncontrolled recreation.Increasing average temperatures, hot days, and drought periods drive evaporation and transpiration rates of water-bodies, soils, and plants, leading to landscape dehydration. Due to the changing quantity and timing of precipitation, higher runoff rates, and unsustainable water use by agriculture and private households, the water balance experiences additional pressure. Wetlands are not able to recover and continue to dry out.

Forests, meadows, and agricultural lands are increasingly suffering from dehydration. The combination of dryer conditions due to climate change and unsustainable water use by humans increases the risk and occurrence of forest, peat bog, field, and meadow fires. Changes in wildlife, plant populations, and habitats are increasing. They include the appearance of alien species and, simultaneously, the deterioration of the living conditions of native plant and animal species. The growing spread of pests, diseases, and insect calamities is observed mostly in forest and agricultural ecosystems, while higher levels of insect populations destroying trees and crops are found in arid arrays. The monoculture pine forests are extremely vulnerable: for instance, the bark beetle population has now become a major threat to these stands.

(1) **Structurally poor, dry-condition sunflower plantation in spring**
© Desnianskyi Biosphere Reserve

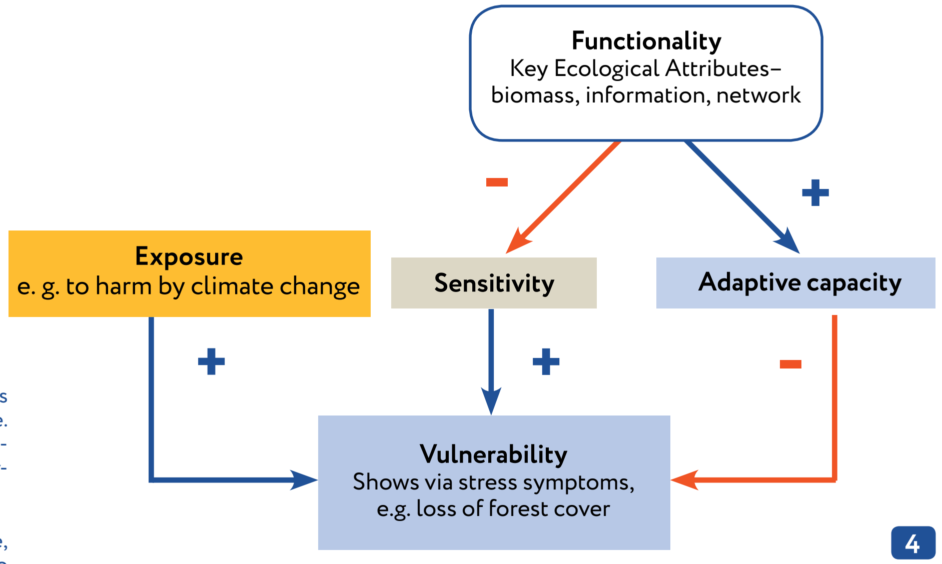
(2) **Monoculture forestry – poor in biodiversity and water retention capacity**
© A. Miskov

(3) **Wood demand drives logging and forest overuse**
© K. Mack

(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) **Shallowing of a fire-fighting pond**
© Desnianskyi Biosphere Reserve

(6) **Dropping water levels and contamination – stress for aquatic ecosystems**
© Desnianskyi BR

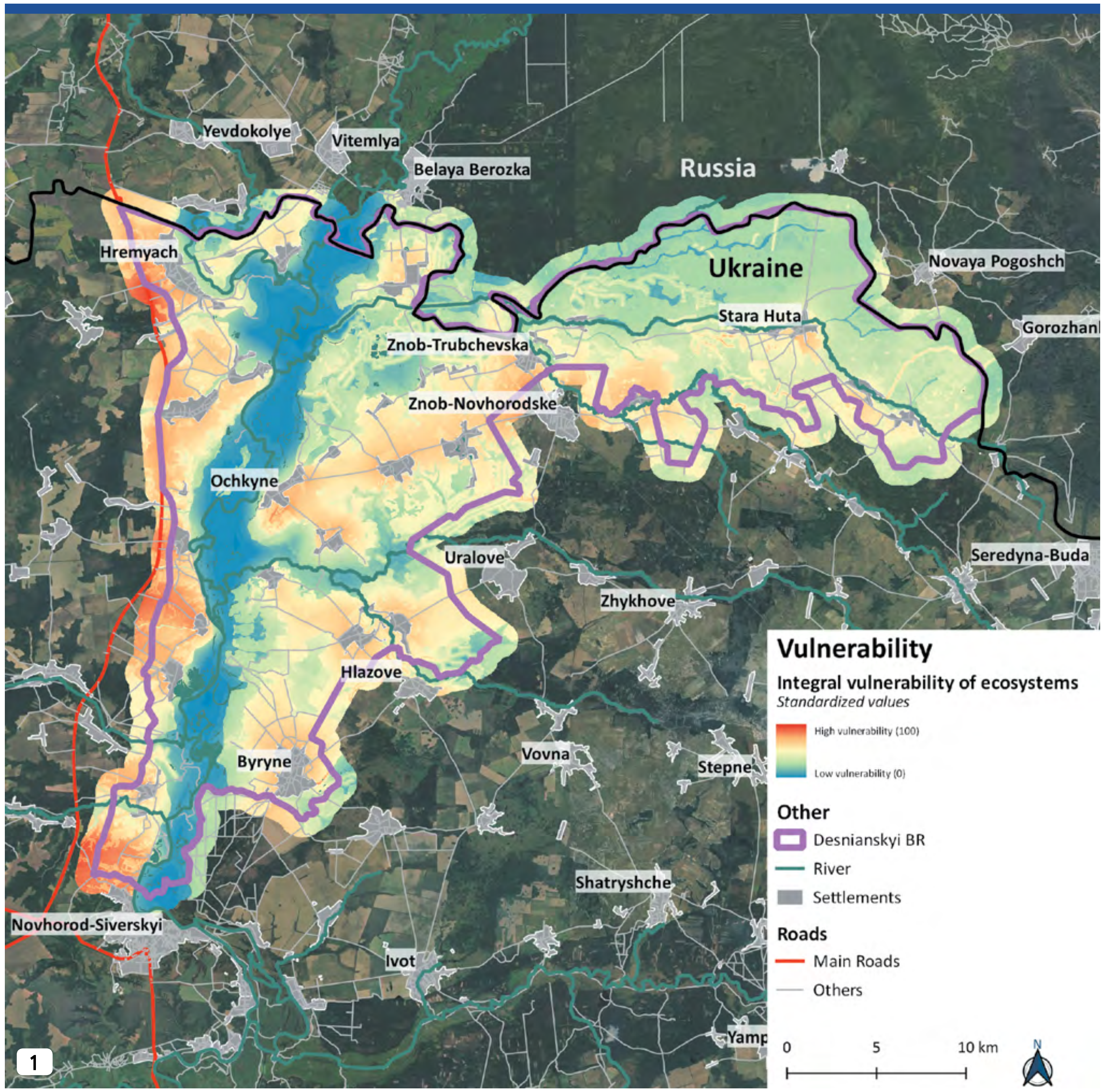
(7) **Pine plantation after fire**
© Desnianskyi Biosphere Reserve

(8) **Vulnerable pine monoculture plantation damaged by bark beetle (ips acuminatus)**
© Desnianskyi Biosphere Reserve

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

"The decline in groundwater levels in the last decade has a detrimental effect on all ecosystems in the BR, especially in areas that have been drained in the past."

Tatyana Marukha, deputy of the Desnianskyi Biosphere Reserve and chief naturalist of the Desnyansko-Starogutsky National Natural Park



Continued from p. 7

Climate change also drives an increase in the number of dangerous weather phenomena, such as storms, heat waves, flooding, hail- and sandstorms, frosts, and icing in late spring. The ecosystems and humans, forming part of them, are affected at different levels and under different spatial and temporal conditions by manifold consequences of such events.

To obtain a spatial overview of the 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, neighbourhood 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 their integration into the vulnerability map, where the areas ranging from highly (red-yellow) to lowly vulnerable (green-blue) ones are indicated.

The level of vulnerability also indicates the places where land- and natural resource use is imposing stress on ecosystems and, consequently, where the regulating functions necessary to buffer climate change impacts and secure ecosystem services for human well-being are reduced. Blue and dark green areas designate the territories where the ecosystem-based conservation efforts are of particular importance. Light green, yellow, and red areas require, in addition to conservation, restoration efforts, and reduction of human-induced stresses.

(1) Map of ecosystem vulnerability in the region of the Desnianskyi 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

Forestry and Agriculture

A large area of the Desnianskyi BR features forest plantations, which do not correspond to the composition and age structure of native, natural stands. Past and present timber and agricultural demands have led to the felling of deciduous forests, driving a decrease in soil fertility and water retention capacity and causing changes in the hydrological regime and microclimatic regulation capacity. The forest plantations which now grow on former cropland have reduced robustness against the impacts of climate change due to little structural and species diversity and humus and biomass content. They are more vulnerable and susceptible to calamities and extreme weather events. Hundreds of hectares of forest have been damaged and destroyed by droughts, storms, fires, and insect calamities in recent years, causing repercussions on human health and well-being and having consequences for the economic sector.

In addition to forestry, agriculture is one of the most developed sectors in the Desnianskyi BR, experiencing an intensive expansion driven by large corporations. Both past and present demands and pressure from agricultural activity have led to a variety of ecological stresses and increasing vulnerability to climate change.

Fishery and tourism

The previously described interrelated impacts of climate change and land-use on the ecological situation and hydrological regime, the shallowing of the Desna River and tributaries in particular, also impose a negative effect on the fishery sector.

For tourism, the Desnianskyi Biosphere Reserve offers natural richness and beauty. Undisturbed and functional ecosystems are providing the basis for versatile cultural and provisioning ecosystem services which attract tourists, often from remote areas. Climate change is endangering the provision of these services and thus can have negative repercussions on touristic attractiveness and activity, as well as on income and well-being of inhabitants.

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

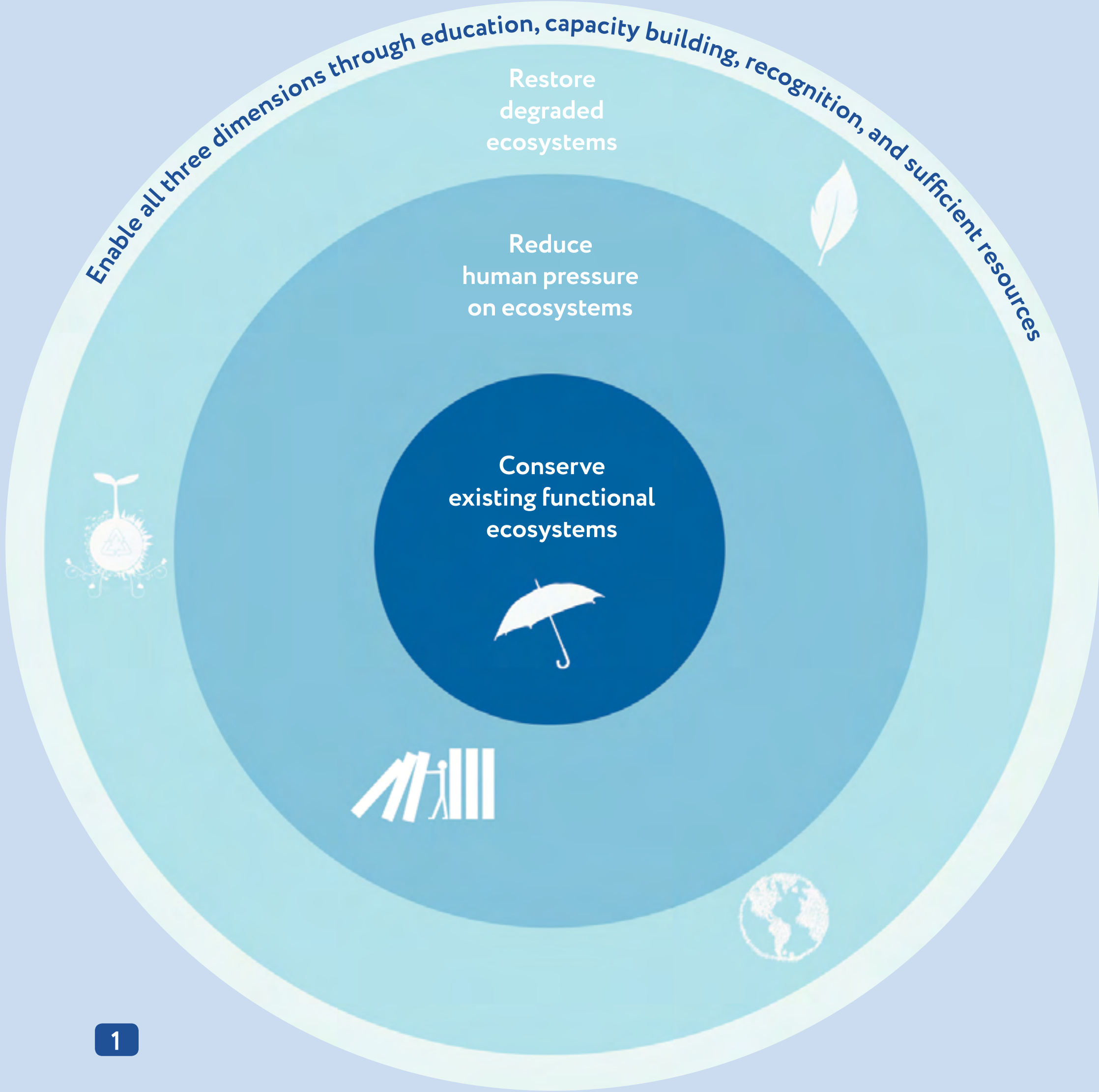
Key impacts – soil and agriculture:

- 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!



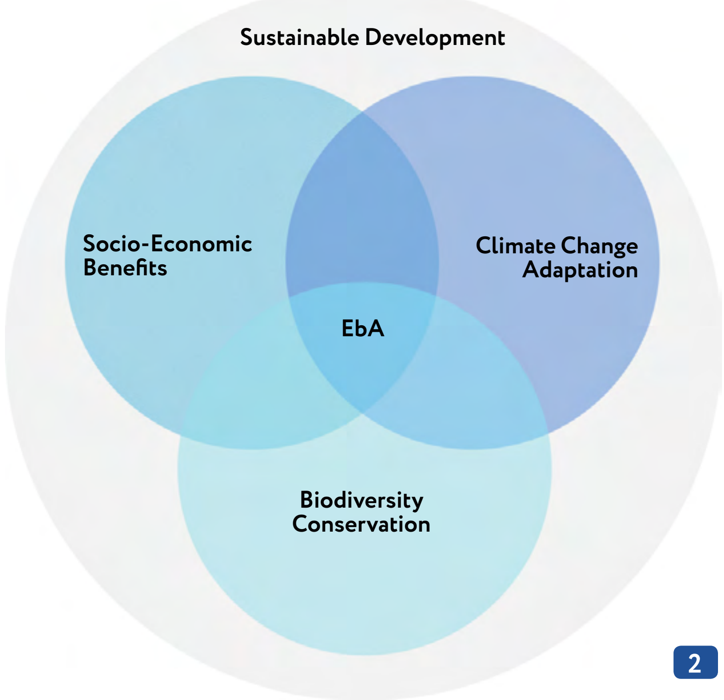
(2) Ecosystem-based Adaptation (EbA) in the context of sustainable development as a cross-cutting approach among several (adapted from Midgley et al. 2012. Biodiversity, Climate Change and Sustainable Development – Harnessing Synergies and Celebrating Successes)

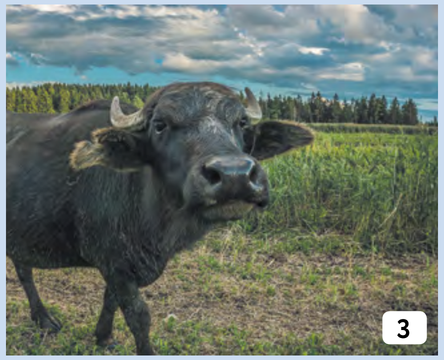
(3) Water buffalo husbandry as an alternative form of land use for wetlands instead of drainage or after rewetting

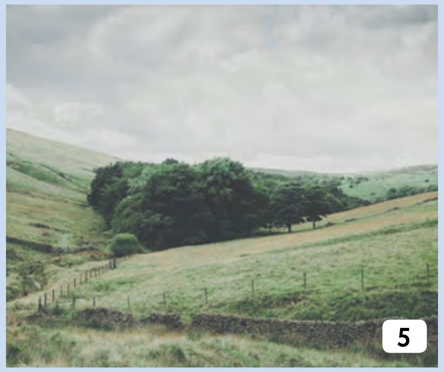
(4) Reed use, e.g. as insulation material, needs functional wetlands

(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







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

Before the left bank of the Desna River within the Desnianskyi Biosphere Reserve was inhabited by humans (ca. VI-VII centuries), it was completely covered with forests and swamps. These ecosystems were replaced by modern structures of land use, dominated by a variety of agricultural lands (arable land, meadows, and hayfields). The first cleared areas were drained and ploughed or used for livestock. Since the territory of the Biosphere Reserve is located in the Polissia zone, it is characterized by poor sandy soil conditions. Consequently, the long-term land use contributed to the decrease of nutrients' content in the soil, thus threatening agricultural production under current conditions of rapid climate change. These recent tendencies pushed land users within the Biosphere Reserve to put forward some initiatives and to implement a few measures to create perennial forests on degraded and other agricultural lands. Such measures serve as an example of the first pilot activities aimed at the adaptation to climate change in the region.

"The developed ecosystem-based adaptation and monitoring plans have become a solid basis for the implementation of the ideas of harmonious coexistence of humans with nature within the Desnianskyi Biosphere Reserve"

Serhiy Kubrakov, Director of the Desniansko-Starohutskyi National Nature Park and main representative of the Desnianskyi Biosphere Reserve

Another example of the pilot adaptation measures is a hybrid solution, i.e. a land-use form with a few elements of EbA, implemented by a local family. Its members had received 12 hectares of land for personal use, and after several unsuccessful attempts to grow crops due to low yields, they decided to create plantations of Christmas trees and pines on this land. The first two hectares were planted with spruce in 2002. The remaining ten hectares were gradually planted (2 hectares per year) with spruce and prickly spruce, Scots pine, and Crimean pine.

Every year in November-December, before New Year's Eve and Christmas holidays, trees are selectively felled, so that 20-30% are felled during the season, and the rest are left to grow. In spring after felling, new seedlings are planted on the site of the felled trees. As a result, the land is constantly covered by forest vegetation. Furthermore, there are also shading trees in the forest stand, represented by pine and spruce. Their main function is to shade the plantation and to ensure the natural regeneration of young conifers. This is supported by planting in spring. Felled deciduous trees (birch or aspen) remain at the place of felling to rot. This hybrid adaptation measure provides the opportunity to obtain new ecosystem services with a higher value than that of agricultural land use. It shifts the land use and vegetation pattern somewhat closer to the natural state, when these areas were mostly forested alongside the floodplain grassland and mires. It is also worth paying attention to its positive impact on climate and soil: land surface overheats less on hot days, the processes of wind or water erosion are reduced, and biodiversity and soil fertility increase.

Yet, to make it a full ecosystem-based adaptation measure, it is necessary to let more natural development occur in buffer areas between artificially grown tree rows. A larger number of deciduous and diverse native species, an uneven age structure, more biomass accumulation, and long-term self-development will further increase the regeneration of soil quality, water retention capacity, and therefore cooling and other positive effects. A more organically evolving and long-term developing forest ecosystem is needed to better reduce negative climate change impacts while maintaining productive use for the landowner. The major challenge is to strike the right balance between the system's artificiality and use intensity, and the natural development and non-use in the face of changing climatic, social, and market conditions.

The main use of one of the neighbouring land plots with an area of 0.5 ha, which has undergone natural forest succession, has been changed and included in the category of forest use. A forest management plan was developed for the area, and forestry activities started to be implemented. Changing the main use of these land plots has led to the following positive effects in the ecosystem: increase of accumulation of humus; avoidance of wind and water erosion; prevention of land surface heating by growing trees and their contribution to the reduction of negative impacts of heat stress; increase in biodiversity having a positive effect on the adaptation ability of the ecosystem to climate change. Additionally, the list of ecosystem services provided by the land plot has been expanded by mushroom picking, firewood harvesting (after intermediate felling), erosion control, and air purification. In the future, birch plantations on the plot area are planned to be transformed into mixed deciduous stands with native species composition (e.g. oak, lime, alder) adequate for the present habitat conditions. Despite this small positive example, nowadays hundreds of hectares of similar lands within the Desnianskyi Biosphere Reserve are still being uprooted and ploughed, leading to further land degradation and increased vulnerability to climate change impacts.

Another measure, dedicated to climate change adaptation in the Desnianskyi BR, aims at the restoration of native

(1) Forest plantation on degraded agricultural land – a hybrid option with a need for more natural development and (native deciduous species) diversity

© Desnianskyi Biosphere Reserve

species composition of tree stands. The centuries of intensive land use have largely transformed the local forests into even-aged coniferous forests, characterized by an increased risk of forest fires and insect calamities, low moisture retention, and depleted biodiversity. To restore the native composition of tree stands in the Biosphere Reserve, reforming logging has been practised since 2007, primarily in the tracked pine plantations with 17 research and production stationary areas. One-step and, periodically, two-step thinning of the tree stands was carried out at the experimental sites. Various ways and methods of promoting natural regeneration and the introduction of deciduous and coniferous species have been tested. There are 72.4 hectares of forest areas, where, as a result of logging and reforming activities on the site of tracked pine monocultures, multi-aged mixed stands with a close to natural composition were established. There are also areas with a sufficient amount of natural regeneration due to favourable conditions, which require the implementation of less harmful and selective felling techniques to preserve these systems´ health and functionality.

Furthermore, seven research and production stationary areas have been established on the territory of the Biosphere Reserve to monitor natural regenerative processes in deciduous forests, which are more resistant to climate change. The methods and ways to promote the emergence and growth of natural regeneration of deciduous species are being tested in these forest areas.

(2) Natural reforestation on abandoned agricultural land

© Desnianskyi Biosphere Reserve

Among the adaptation measures, it is also worth mentioning new approaches to clear-cut logging, tested by one of the regular forest users in the transition zone of the Biosphere Reserve. In particular, during clear-cut logging in 2011-2012 on five plots of 4.5 hectares all deciduous trees were left standing. These trees perform several important functions: they create shading for seedlings, which are planted after the logging, serve as a source of deciduous seeds and help to form different aged mixed tree stands in the future.

"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

(2) **Serhiy Kubrakov (Desnianskyi Biosphere Reserve) participating in an online meeting of the working group on the Ukrainian Strategy for Adaptation to Climate Change**
© Kateryna Hankyna

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)

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)

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

Multilevel Governance for Adaptation

"The project facilitates the introduction of ideas of sustainable development on the territory of the Desnianskyi Biosphere Reserve, as well as the creation of a legislative basis for the functioning of biosphere reserves of Ukraine"

Tatyana Marukha, deputy of the Desnianskyi Biosphere Reserve and chief naturalist of the Desnyansko-Starohutskyi National Nature Park

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) River Desna, a still functional and nowadays rare, freely meandering river section within the Biosphere Reserve
© A. Miskov

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"

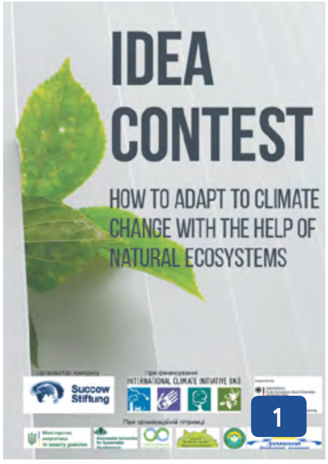
From 1st March until 24th April 2020, the three biosphere reserves Roztochya, Shatskyi, and Desnianskyi had a chance to participate in an idea contest on the topic "How to adapt to climate change with the help of natural ecosystems." The jury, composed of representatives from the Michael Succow Foundation,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



> "The Ukrainian-German project of Ecosystem-based Adaptation to climate change provides an opportunity to start implementing ecologically oriented management methods in agriculture and forestry. The introduction of operational plans and pilot projects has attracted the attention of many people interested in the rational use of ecosystems"

Serhiy Kubrakov, Director of the Desniansko-Starohutskyi National Nature Park and main representative of the Desnianskyi Biosphere Reserve

(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”**

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