Biosphere Reserves and Climate Adaptation

Volume 1/3: "Natural Ecosystems" Ivano-Frankove, 2019

Biosphere Reserve "Roztochya" Natural Ecosystems set the Scene

Nature consists of units that perform work and process scarce resources - the ecosystems.

Ecosystems are complex systems that use energy, which is primarily received from the sun and circulated in the system. Energy is captured, transmitted, transformed, stored and, above all, used to do work with it. They therefore perform work in the physical sense. They are created by living beings interacting with each other and with non-living resources as system components. Thereby, ecosystems develop properties that sustain or even promote their continued existence as self-organizing bioreactors through the interactions of their components.

Results of ecosystem work are, for example, the production and growth of biomass, cooling and moisturing of the landscape, and the creation of resources for many species of plants and animals. These processes and functions are an inherent need for the existence of the ecosystem itself, but also are the foundation of human existence and well-being. Therefore, the conscious preservation and development of **ecosystem services** is one of the most important goals of modern nature conservation.

An **ecosystem-based approach** to the Biosphere Reserve Roztochya for the benefit of humans is therefore grounded on an appropriate assessment of the locally relevant ecosystems and their condition as well as the inclusion of people and institutions who dispose of local knowledge and hold stake in the sustainable development of the area.


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Biosphere Reserves

Special Places for Joint Learning

Biosphere Reserves are places where nature and culture connect.

Therefore, they are internationally recognised for their biodiversity and cultural values and are important "living laboratories" for the preservation of ecosystems by promoting eco-sustainable human and economic development models as well as by ensuring the continuation of research, education and the provision of information.


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A Dynamic World-Wide Network

As early as 1971, the United Nations Educational, Scientific and Cultural Organization (UNESCO) established the Man and the Biosphere Programme (MAB) as an international, interdisciplinary programme with the aim of creating a scientific basis for improving relations between people and their environment. In 1974, a task force of the MAB programme developed the concept of biosphere reserves, recognising that the conservation of biological diversity, the promotion of economic development and the preservation of the associated cultural values are often contradictory objectives.

Since the 1970's UNESCO has designated areas throughout the world as biosphere reserves (BRs). When designated, these regions are commissioned to serve as learning sites and role models for sustainable development, **crafting local solutions to global challenges**. As a result, a network of biosphere reserves was established that currently comprises 701 areas in 124 countries of the world (status 2019), including 21 transboundary sites, and that is constantly growing.

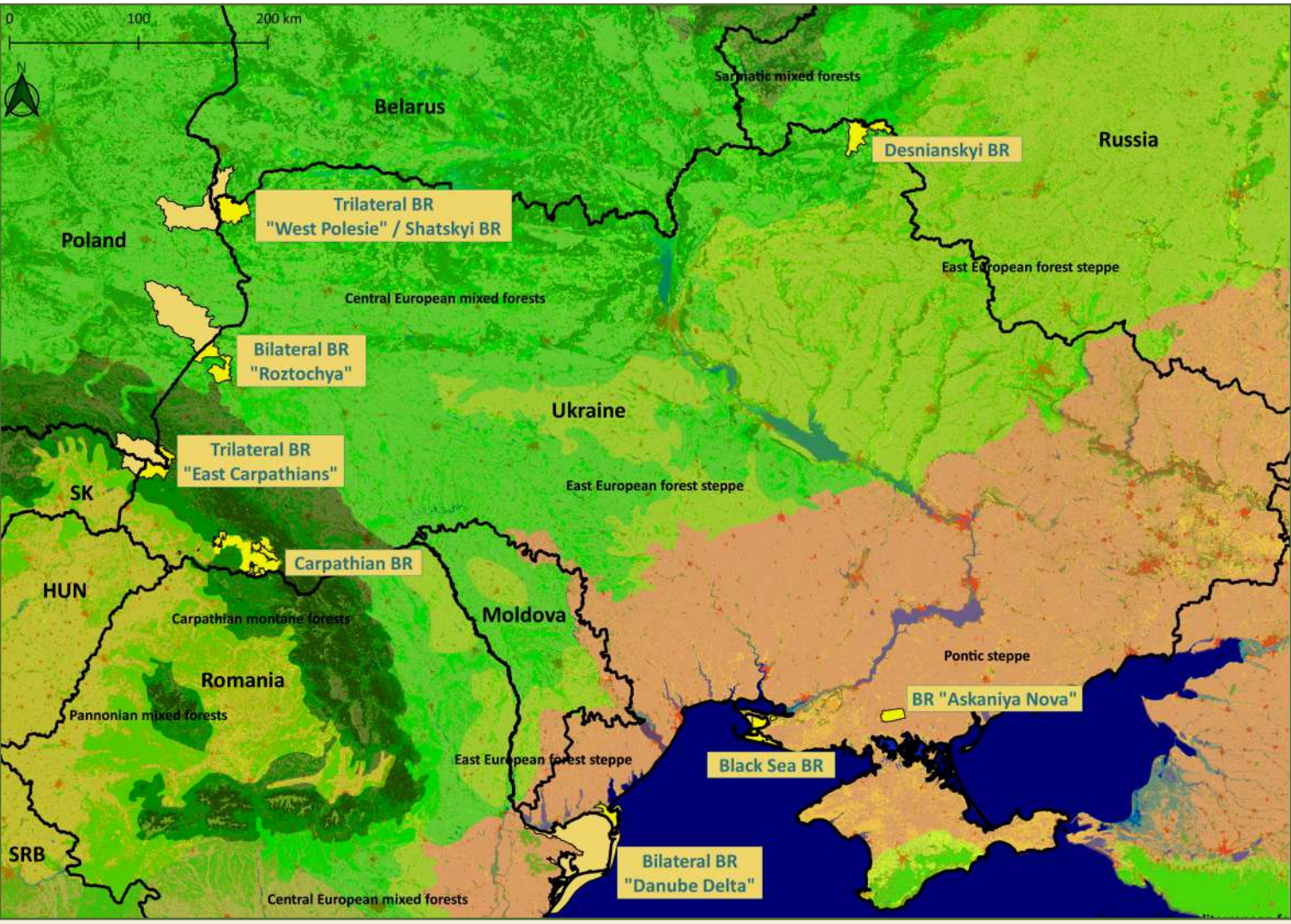
What does a Biosphere Reserve do?

It supports innovative ideas and projects that aim towards sustainability by promoting:

- **Development** – fostering a sustainable economy and society for people living and working in the region
- **Learning** – facilitating education, training and research to support conservation and sustainable development
- **Conservation** – protecting biodiversity and cultural diversity

To be able to address all these functions a system of three different zonings was developed, which is one of the characteristics of biosphere reserves:

- **Core zone** – a zone with strictly protected ecosystems / no use
- **Buffer zone** – surrounds the core areas – used for scientific and educational activities
- **Transition zone** – largest area – socio-ecologically sustainable land use practices



Overview map of all Ukrainian UNESCO Biosphere Reserves and, if available, the corresponding transboundary areas in neighbouring countries
Terrestrial Ecoregions of the World 2.0: World Wildlife Fund (WWF) - US 2004; Landcover data: Copernicus Global Land Service 2015: Land Cover 100m; Data on Biosphere Reserve areas: WDPA 2018;
Produced by: A. Dichte

The Ukrainian Network of Sites of Excellence

In Ukraine, there are currently 8 UNESCO biosphere reserves, of which four are created as transboundary biosphere reserves, together with neighbouring countries (see map). Further ones are in the planning. During times of the Soviet Union only three biosphere reserves existed inside the territory of Ukraine.

The Ukrainian biosphere reserves cover a wide range of ecological and cultural conditions – from alpine and wooded ecosystems to steppe areas with relatively intensive land use to even river, floodplain and delta areas. This also means that very different challenges and development opportunities emerge depending on the area. Nevertheless, a constant exchange between the areas is very fruitful, as different possible solutions can be tried out and best-practice experiences can be exchanged – the best prerequisite for fresh ideas and new perspectives by learning from each other!

Page 1
1 Citizen workshop in Porichya
(© J. Kloiber)

2 - 4 Biosphere Reserve "Roztochya"
(© 2 - I. Khomin, 3 & 4 - BR "Roztochya" administration)

Page 2
1 Desnianskyi Biosphere Reserve
(© A. Dichte)

2 Shatskyi Biosphere Reserve
(© A. Schick)

3 Desnianskyi Biosphere Reserve
(© A. Dichte)

4 Carpathian Biosphere Reserve
(© L. Strixner)

5 Desnianskyi Biosphere Reserve
(© A. Dichte)

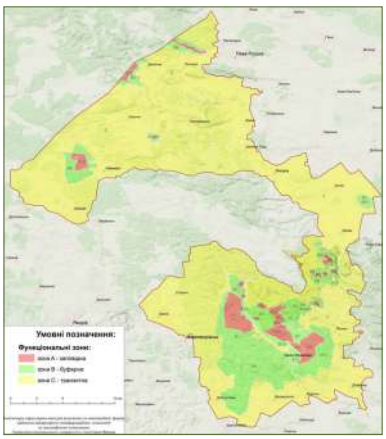
6 Biosphere Reserve Roztochya
(© J. Kloiber)

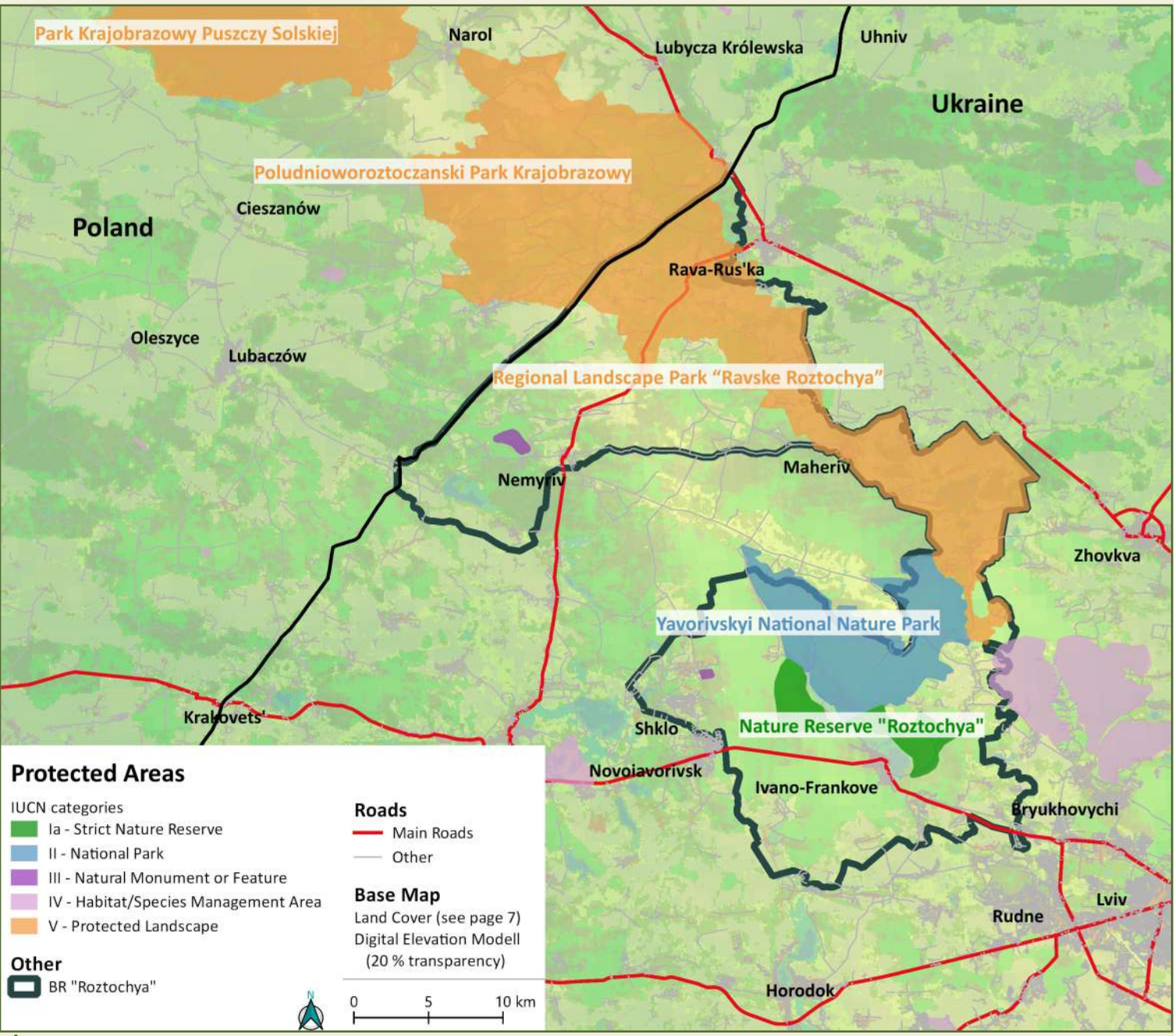
*"To live and work in a biosphere reserve for me is prestigious, I am proud of it! Biosphere reserve areas are the **gemstones of our planet** with unique nature and special people, who have preserved their culture and traditions."*

Dr. Galina Stryamets, Deputy director of the Nature Reserve "Roztochya" and main representative of the Biosphere Reserve "Roztochya"

Biosphere Reserve "Roztochya"

"РОЗТОЧЧЯ"
біосферний резерват
Biosphere reserve "Roztochya"





Page 4
Small map - Zoning of the Biosphere Reserve "Roztochya" (red - core, green - buffer, blue - transition zone)
Provided by the biosphere reserve administration

Large map - Biosphere Reserve "Roztochya" in a regional nature conservation context
Base map: Landcover data: Copernicus Global Land Service 2015: Land Cover 100m; Digital Elevation Model GTOPO30 (USGS); PA data by WDPA and OSM; Roads and settlement data: OSM 2019; Produced by: A. Dichte

Page 5
1-3 Impressions from the Biosphere Reserve "Roztochya"
(© BR "Roztochya" administration)

Page 6
1 Forest in the Biosphere Reserve "Roztochya"
(© I. Khomin)

2 Small stream in the BR "Roztochya"
(© I. Khomin)

3 Rural settlement in the BR "Roztochya"
(© J. Kloiber)

The UNESCO Biosphere Reserve "Roztochya" was declared in 2011 on an area of 74,416 hectares in the Lviv region in Western Ukraine directly at the border to Poland. The Roztochya region forms an ecological corridor of European importance – a narrow land connecting the Lublin Upland with Podillia and the Carpathian arc, enabling the movement of plants and animals.

The Biosphere Reserve Roztochya is located at the main European watershed dividing the Black Sea and the Baltic Sea river basins. It lies in the heart of Galicia – a geographical region of historical importance between Central and Eastern Europe and borders the Polesian wetland ecoregion to the north. Since July 2017, the area has been involved with its own sub-area in the serial UNESCO World Heritage Site "Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe" (forest between the villages Lelekhivka and Vereshchytsya – part of Nature Reserve "Roztochya").

In immediate vicinity to the east lies the city of Lviv – the largest city in Western Ukraine and one of the main cultural centres of the country with a very diverse history. Lviv's historic city centre is also inscribed on the UNESCO World Heritage List.

The majority of the territory belongs to rural areas, in which residents have preserved the traditional system of hamlet-homesteads and subsistence economy. Main specializations are in farming, stock breeding, fish-farming, and wood-working. In addition, there is the growing tourism sector with a focus on health tourism such as sanatoriums and spa resorts.

The biosphere reserve includes a variety of other protected area types as the Nature Reserve "Roztochya", the Yavorivskyi National Nature Park and the Regional Landscape Park "Ravske Roztochya". These are reflected also in the zoning of the biosphere reserve (see map), where the strictly protected areas are inside the core zones. The biosphere reserve shares a direct border with Poland and therefore with the EU.

19 June 2019, the commission of MAB Programme of UNESCO took a decision to create the Ukrainian-Polish Transboundary Biosphere Reserve "Roztochya" on an area of 371,902 ha. The Polish part is composed of the Roztocze National Park and four regional landscape parks. In this brochure and in the project we are focusing on the Ukrainian part of the biosphere reserve.

The Biosphere Reserve "Roztochya" is managed by the Coordination Board consisting of the directors of the three protected areas mentioned above, scientists, heads of local authorities as well as heads of forestry and agricultural enterprises and NGOs. Meetings of the Scientific-Technical Board as well as other regular meetings and workshops with local authorities sustain a strong and well-developed relationship with local citizens, which also led to a mainly positive attitude towards the establishment of the biosphere reserve.

Functional Zoning

Total area: 74,416 ha

Core Zone (strict protection): 3,314.6 ha

Buffer Zone (scientific & educational use): 10,874.2 ha

Transition Zone (area of cooperation / sustainable land use): 60,227 ha

"For me personally, living in the territory of a biosphere reserve means caring for the future of my children and inhabitants of my native village."

Lesia Koval, Manager of the local small-scale agricultural enterprise "Adonis" in the Biosphere Reserve "Roztochya"

Ecosystems

The Ever Changing Household of Life

Ecosystems are the precious natural environments we are all living in and depend on. They are dynamic systems. If they would be static, they would be dead. Energy is constantly flowing through a functional ecosystem and chemical nutrients are continually being recycled.

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"Ecosystem" is a scientific term that describes the natural structures in which the various components interact intensively and perform a wide variety of services. An ecosystem is a husbanding system which not only gains, stores and converts energy, but also efficiently processes other resources such as water and nutrients (the prefix "eco-" [oikos] comes from Greek and refers to this household). The individual parts are all in dynamic interaction and development, are exchanged, multiply and make the bigger whole more and more mature. However, this only happens under certain conditions: 1. energy must be constantly supplied from outside (sunlight!); 2. there is a certain availability of water – a basis for life; 3. the system is not disturbed in an extreme way; 4. the system can increase biomass, information content (e.g. the information stored in genes) and internal networking, so that more and more parts can work together effectively. These conditions can be described as key ecological attributes – the essential ingredients for ecosystem functioning.

Ecosystem Types

Ecosystems can only be separated from each other to a limited extent, since they have no closed borders and are in exchange with each other. They can be very small like a pond or big like a forest or even the earth. The different ecosystems of the earth share the same atmosphere in which water and energy are transported from one place to another by weather phenomena. Running waters, while themselves being an ecosystem, are always an important connecting element between different ecosystems.

Which ecosystem type we find at a certain place depends on many natural factors such as soil conditions and water availability as well as other climatic conditions. But also through human use ecosystems have changed and even completely new ones have emerged – like agricultural lands and settlements.

Ecosystems of the Biosphere Reserve "Roztochya"

The territory of the Biosphere Reserve "Roztochya" belongs to the ecoregion of Central European mixed forests (see map page 3) bordering in the south the Carpathian montane forests region. Because of its location and the corridor function mentioned in the previous chapter, plant species of three eco-regions – Polissia, Podillia and Carpathians – occur here. At the same time, a special feature of the area are its natural boundaries such as the north-eastern distribution limit of European beech.

The area consists of 47.1 % forests, 8.4 % meadows, 3.5 % water bodies and 1 % wetlands. The remaining areas comprise mainly agricultural and settlement areas.

For the purpose of this project we distinguish the following ecosystem categories:

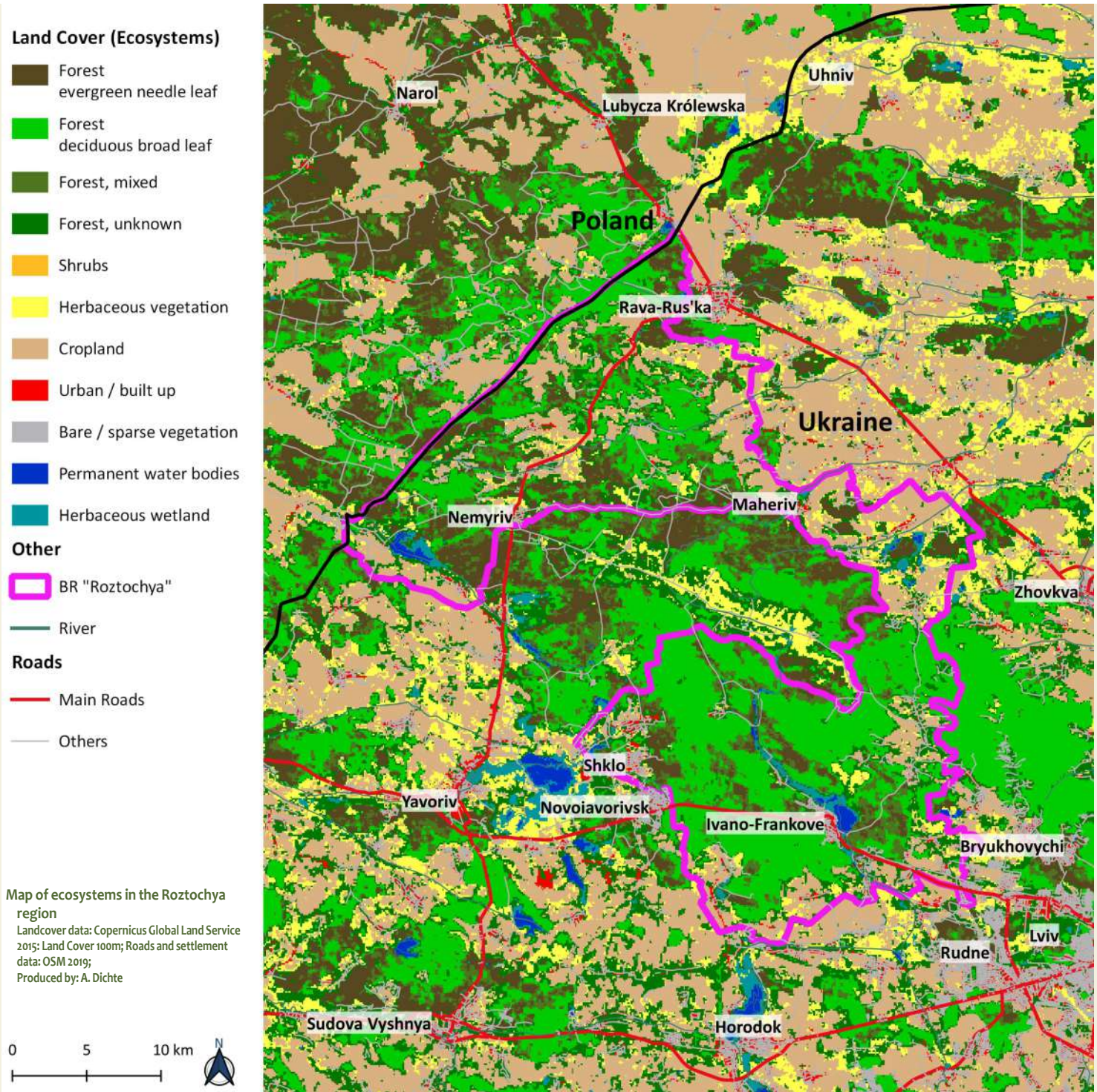
Forests
The region consists of numerous heterogeneous forests. Especially in the southern part, encircling the military area, more or less large-scale coniferous, broad-leaf and mixed forests can be found.

Open Land Systems (Arable Land, Pasture)
In the area, we still find a substantial part of small-scale subsistence agriculture in and close to settlements. But also large fields of the more industrialized agriculture developed historically.

(Small-Scale Ecosystems in) Urban Areas
There are several towns (urban villages) in the Biosphere Reserve – Ivano-Frankove, Shklo, Nemyriv, and Maheriv. Apart from that, we find many small villages and settlements that can be viewed as ecosystems too – the least natural ones of course.

Water Bodies (Lakes, Ponds, Rivers)
On the territory of Roztochya many artificial reservoirs and ponds were created. The Vereshchytsya river valley for example contains almost 6 km² of ponds for fish-farming. The region is rich in sources and streams that form many small rivers in the watershed.

Wetlands (Swamps, Bogs)
To enable agriculture and forestry on damp areas, some land, especially in the Eastern and Southern part, has been drained in the past.



Map of ecosystems in the Roztochya region
Landcover data: Copernicus Global Land Service 2015: Land Cover 100m; Roads and settlement data: OSM 2019;
Produced by: A. Dichte

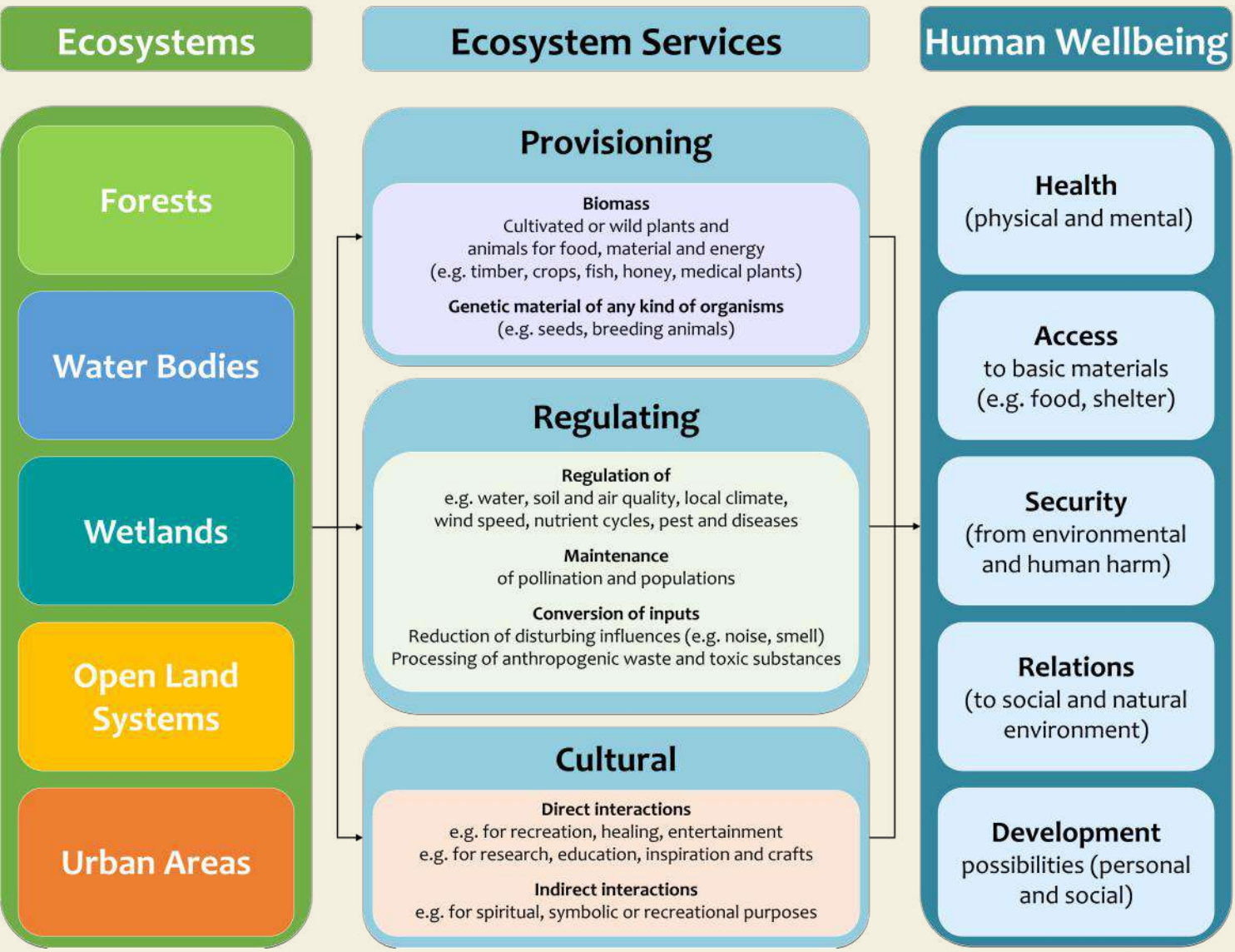
Ecosystem services

The Prerequisite and Basis for a Good Life

Ecosystem services are of central importance for human well-being. Ecosystems provide for example water, food, protection from natural disasters or good air quality, as well as recreational opportunities in nature and a variety of cultural and scientific stimuli.

In recent years, the understanding of ecosystem services has changed significantly. On the one hand, they are no longer understood carelessly as virtually inexhaustible "free products of nature", but as values that need to be preserved and developed. On the other hand, the one-sided concentration on provisioning services is being replaced by a more comprehensive appreciation.

Findings to the questions "How do we use nature and how does it contribute to human well-being?" provided and discussed among local citizens who participated in a workshop series in the BR "Roztochya" in November 2018.



Provisioning ecosystem services are those goods that are produced by ecosystems and used by humans. Food (such as fruit and vegetables), drinking water, timber (e.g. as building material) and fuel are provided by ecosystems.

Regulating ecosystem services are now receiving increasing attention and are of utmost importance to adaptation to climate change. These include services that result from the fact that the work of ecosystems positively influences the quality of the environment. Air and water purification, pollination, fertile soils, flood prevention (e.g. through soil and plant water retention), climate regulation and storage of the greenhouse gas carbon dioxide or biological control of pest infestation are important examples.

Cultural ecosystem services are of high relevance, especially in a modern, technology-oriented society. Varied and semi-natural landscapes offer a high recreational, educational and adventure value. The typical features and the condition of ecosystems have a complex effect on the human psyche. In this way they also create identity and contribute to people feeling connected to their habitat.

1 Wood for heating in the BR "Roztochya" (© I. Khomin)

2 Haying in the Carpathians (© A. Dichte)

3 Erosion control through vegetation in Desnianskyi BR (© S. Panchenko)

4 Grazing in the Carpathians (© A. Dichte)

5 Fishing in Shatskyi BR (© J. Kloiber)

6 Religious tourism in the BR "Roztochya" (© I. Khomin)

7 Subsistence farming in the BR "Roztochya" (© A. Schick)

8 Water tourism and recreation in Shatskyi BR (© Shatskyi BR administration)

9 Water retention in Shatskyi BR (© A. Schick)

There are interactions between many ecosystem services. If the human promotion of one service weakens another, this is called a trade-off. In contrast, if the promotion of one service also strengthens other services at the same time, this is called a synergy effect. A trade-off, for example, could be the large-scale planting of fast-growing tree species. This promotes the supply of large quantities of biomass. However, this comes along with the loss of biodiversity, soil formation processes and many other regulating services. It increases the risk for calamities and negatively affects microclimate and landscape water budget.

Trade-offs as well as synergies can be managed in the course of well-considered and adaptive management in such a way that they reduce disadvantages for society and improve the functionality of ecosystems and thus the well-being of the people living in them. For example, nutrient runoff from agriculture can be reduced by minimising the use of fertilisers and conservation tillage, or by maintaining riparian zones. This can be done without excessive losses in food production. At the same time, improving a service, such as increasing nutrient storage by promoting vegetative riparian zones, can also improve landscape beauty, wind protection, water quality, biodiversity and plant production, thereby increasing the benefits to society.

Regulating Services

In the past, people prioritized the supply and cultural offers of nature. In view of accelerating climate change, however, the focus is increasingly on regulating ecosystem services. The (self-)regulation of ecosystems is ultimately also a prerequisite for their household and basic functioning.

This is the only way to safeguard all other services, especially the provisioning services. In this respect, the regulating services actually deserve the greatest attention and to do so ecosystem-based climate change adaptation is of utmost importance.

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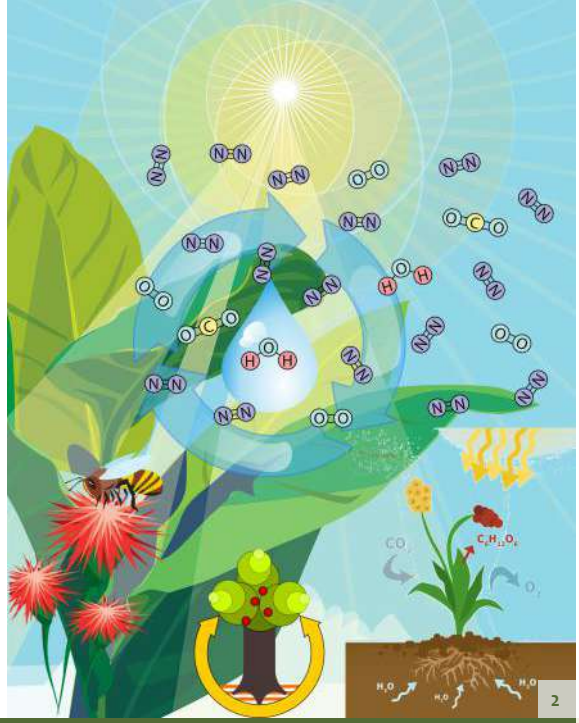
1 Old-growth forest with great structural variety and a large stock of biomass
(© A. Dichte)

2 Illustration of a selection of regulating ecosystem services
Produced by: A. Dichte



Regulation of the Energy Balance

The formation of plant biomass and the enlargement of the surface area of all green leaves strengthens the capacity of ecosystems to convert and store light energy. This thermal mass can warm up and cool the environment as well as **damp fluctuations**. Neighbouring ecosystems often influence each other: water bodies and forests cool themselves and their surroundings. Cooling air flows from areas where fresh air originates via cold air paths to other areas, especially in settlements. In cooler, buffered and more humid ecosystems, the risk of extreme energetic events such as forest fires decreases. The efficiency in dealing with additional incoming energy increases in more mature ecosystems rich in biomass.

Regulation of the Water Balance

Mature ecosystems rich in biomass **retain water** particularly effectively and contribute to their own **humidification**. Especially in drought periods, but also during heavy rainfall events, the ability to seep, retain, store and slowly release water is of great value. Important factors for the effectiveness of ecosystems in this case are also **biomass** and the structures or organic matter formed from it in soils. Reduced surface runoff and reduced flow velocity are also important for the **prevention of water erosion**. The corresponding regulating services are often provided across ecosystem boundaries (e.g. water flows out of the forest into open land). Structurally rich and humid vegetation also seems to attract precipitation - a typical positive feedback in ecosystems.

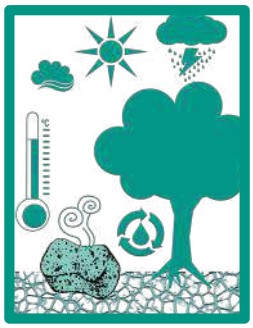
Regulation of the Mass Balance

Mature, functioning ecosystems also reduce losses of critically needed substances, e.g. by root systems and soil-covering vegetation slowing wind drift and leaching. The interaction of vegetation and soil-forming organisms with the soil also promotes the purification of water. Above-ground vegetation can have a filtering effect both on the input of substances (e.g. harmful substances) and on the discharge. Corresponding barrier and filter effects of substances and dust particles become particularly relevant in very dry conditions and in the case of uncovered soils.

Regulation of the Interplay of Species and Biological Control

Mature ecosystems with native communities and a large structural diversity are characterised by a strong biological regulation, i.e. the mass reproduction of individual species and the strong occurrence of non-native invasive species are rather suppressed. This is of great importance in terms of pest and disease control and prevention in agriculture and forestry.

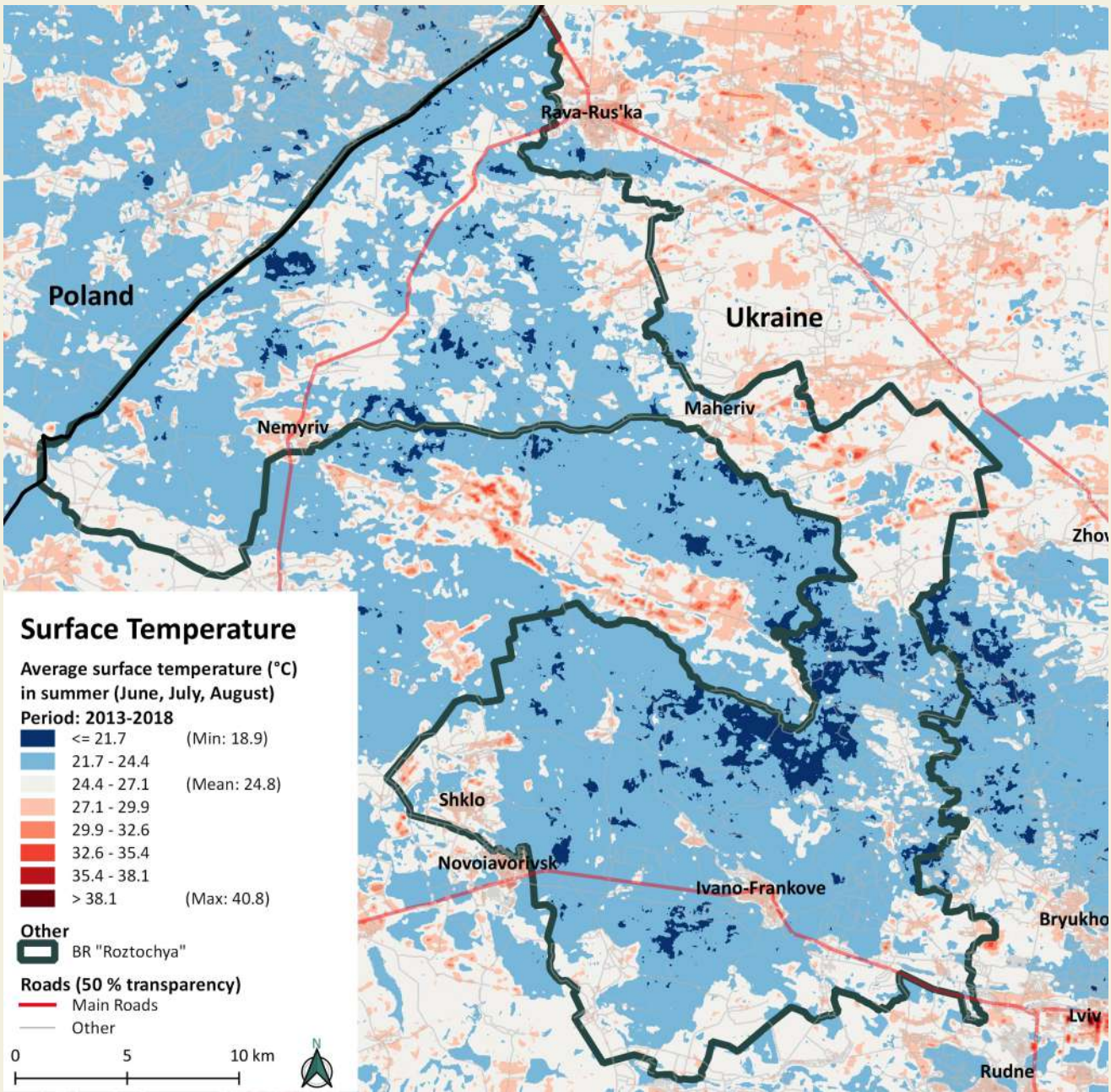
Microclimatic Effects



The weather, which results from large climatic conditions in specific locations, is influenced by a variety of properties such as the nature of the land surface and the vegetation. For example, steeper southern slopes are warmed more by prolonged exposure to sunlight, shady northern slopes are cooler, and lower basins or depressions in the terrain may accumulate colder air masses. Valleys and hills influence the climate just as much as forests and water bodies.

The Surface Temperature Map shows land surface temperature patterns in the Roztochya region obtained by the Landsat 8 satellite every two weeks from 2013 till 2018 with a high spatial resolution of 30 m. Reviewing the map on page 7, it appears that settlement and arable land produce the warmest (red) areas and, on the other hand, especially the larger and denser areas of forest are the cooling centres (dark blue) of the region. Therefore, the map allows conclusions about the ability of different ecosystem types and their state to handle increased incoming energy, buffer it and to cool down themselves or even surrounding areas.

Sources: Landsat 8 OLI & TIRS: US Geological Survey, Roads & settlements: OSM 2019; Data processing and analysis by: S. Kriewald (PIK); Map produced by: A. Dichte



Requirements for a functioning self-regulated microclimate

1 Accumulation of biomass - living and dead in Uholka old-growth Beech forest (Carpathian Biosphere Reserve)
(© A. Dichte)

2 Intact wetlands in the Biosphere Reserve Roztochya
(© BR "Roztochya" administration)

3 Large spatial extent of undisturbed forests in Uholka old-growth Beech forest (Carpathian Biosphere Reserve)
(© A. Dichte)

4 Large and deep waters with natural vegetation growth and water regime in the Desnianskyi Biosphere Reserve
(© A. Miskov)

5 Extensive floodplains in the Desnianskyi Biosphere Reserve
(© S. Panchenko)

6 Richly structured landscape in a swamp area in the Shatskyi Biosphere Reserve
(© Shatskyi Biosphere Reserve administration)

Satellite-based remote sensing data for the reflection of heat radiation now make it possible to estimate surface temperatures worldwide (see map). Taking into account information on land use, water vapour in the atmosphere and cloud cover, the temperature can be determined with a resolution of 30 meters. The map shows selected data on the summer average temperature (June-July-August; only daytime) in the years 2013-2018.

Clear temperature differences of up to approximately 7 °C can be observed. The spatial temperature patterns are not coincidental, but are clearly related to properties of the land surface. The coolest spaces in the Roztochya region are the forested areas, especially the bigger and more dense ones in the centre. The heat poles of the region are located in the settlements. The so-called "heat island" effect in cities has been well known for a long time. On hot days, heat stress is particularly severe for people, animals and plants in settlements. Accordingly, it is important that cool air can flow in and that cooling areas are also taken into account in urban planning.

There are various mechanisms that contribute to cooling in the landscape. Dense vegetation literally shades itself; water bodies and biomass containing water can absorb certain amounts of heat and contribute not only to cooling but also to buffering temperature fluctuations. In productive vegetation, the conversion of light energy into biomass and the evaporation of water are also important factors for cooling. Cooler temperatures and lower fluctuations also mean higher and more balanced humidity and a reduction in heat stress. Richly structured landscapes regulate their own microclimate to a considerable extent and thus secure their own living conditions.

"Ecosystems are the basis of our economic activities - which we often forget, because they are simply there and their services are seemingly unassailable and free."

Prof. Dr. Pierre Ibisch, Biologist, Professor for Nature Conservation and Co-director of the Centre for Econics and Ecosystem Management at the Eberswalde University for Sustainable Development, Germany

Ukrainian-German Cooperation


1

Project Aim

Michael Succow Foundation and the Centre for Econics and Ecosystem Management at Eberswalde University for Sustainable Development joined forces for proposing a project that would benefit three Ukrainian biosphere reserves: Desnianskyi, Roztochya and Shatskyi (component part of Transboundary Biosphere Reserve West Polesie). The goal is to integrate an EbA-informed approach to national and regional planning and action, leading to better adapted land-use and wide-ranging sustainable development.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The International Climate Initiative of the German government is funding this project since July 2018. The duration of the project, now implemented by the partners and under the auspices of the Biosphere.Center, is three years.

Ecosystem-based Adaptation (EbA) to climate change and regional sustainable development by empowerment of Ukrainian Biosphere Reserves

The expected outcome is to empower the three biosphere reserves in three different ecoregions – Desnianskyi, Roztochya and Shatskyi – for becoming role models that catalyze the introduction of a new type of participatory and adaptive ecosystem management in the wider landscape.


3

Beneficiaries and Target Groups

The project targets a wide range of stakeholders (e.g. inhabitants, land users, administration staff of the Biosphere Reserves, and downstream ecosystem service beneficiaries) as well as national and regional policy makers. Novel methods allowing for a strong stakeholder participation will be introduced and adapted to safeguard long-term benefits for all actors involved.

The biosphere reserves are empowered to interact with the population and relevant actors using appropriate tools and concepts and not only to moderate the transfer of knowledge, but also to act as a partner concerned with the interests of the population and the local economy. Of particular importance here is the possibility of financing and testing strategies developed in the region – an EbA innovation fund to awaken local commitment.


4

Project Activities

The project was initialized with a series of stakeholder workshops involving diverse actors - from school children to foresters up to the employees of the biosphere reserves. The participants exchanged knowledge and discussed views on the local ecosystems and their services.

In the first half of 2019, spatial analyses were carried out. An expert workshop was held in Ivano-Frankove from 30 May to 1 June 2019, at which the results of the previous workshop were further developed. The output is a first comprehensive diagnostics of the area, including challenges to ecosystem functionality as imposed by climate change as well as a first inventory of potential ecosystem-based strategies for adaptation to climate change.

"The participants´ professional inputs and active discussions at eye-level have contributed to the success of the workshops and provided valuable insights into both the regions eco- and social systems. Thank you!"

Kevin Mack, Project team member and research fellow at the Centre for Econics and Ecosystem Management at the Eberswalde University for Sustainable Development, Germany

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1 & 3 Excursion with the experts group after the MARISCO workshop in June 2019 in the BR "Roztochya"
(© 1 - A. Dichte, 3 - G. Stryamets)

2 Citizen workshop in Porichya in November 2018
(© I. Khomin)

3 Expert workshop in Ivano-Frankove in May 2019
(© P. Ibisch)

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1, 3 & 4 Expert workshop held in Ivano-Frankove in May 2019
(© 1 - A. Dichte, 3 & 4 - P. Ibisch)

2 & 5 Citizen workshops in Porichya
(© I. Khomin)

"Biosphere reserves are model regions for social and ecological land use – a focus should be on climate neutral agriculture and humus building. Also, regional products and nature tourism have big potential and can help people to make a living without destroying nature."

Prof. em. Dr. Michael Succow, Founder and Chair of the Michael Succow Foundation

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Centre for Econics and Ecosystem Management

Eberswalde University for Sustainable Development

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 three volumes. Each volume is an open-access journal for Ukrainian biosphere reserve residents as well as any other interested person. Each volume will be available in Ukrainian and English language. For the digital version, please visit our website: www.eba-ukraine.net

Volume 1/3: "Natural Ecosystems"

Volume 2/3: "Impacts of and Adaptation to Climate Change"

Volume 3/3: "Acting in Climate Change"

"РОЗТОЧЧЯ"
біосферний резерват
Biosphere reserve "Roztochya"

Administration of the Biosphere Reserve "Roztochya"
Sichovih Striltsiv Str. 7
vil. Ivano-Frankove, Yavorivskyi Raion, Lvivska Oblast
81070 Ukraine

Authors: Angela Dichte, Pierre Ibisch, Galina Stryamets, Judith Kloiber, Anatoliy Smaliychuk, Kevin Mack, Ina Rohmann

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