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Nature Outlook 2050

Scenarios for nature in Slovakia and implications for public policies

Radoslav Považan, Richard Filčák (eds.)

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Nature Outlook 2050. Scenarios for nature in Slovakia and implications for public policies

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Contents

Summary

Slovakia prides itself on beautiful nature and biodiversity, which, in terms of area size, is one of the highest in Europe (Sabo et al., 2011). The mountainous region of the Carpathians meets the Pannonian lowlands, determining the diversity of species and habitats. Nature protection is enshrined in legislative documents on the global, European and national scale. Nevertheless, recent evaluating reports point to the fact that we have failed to reach multiple objectives for the improvement of biodiversity up until 2020. For this reason, it will be necessary to achieve a bigger and principled, transformational change of the whole society, from the midterm (until 2030) to long-term (until 2050), to protect, value, and restore our nature and the ecosystem services it provides.

One of the contributions to last year's celebration of the 100th anniversary of state nature protection in Slovakia was the preparation of scenarios for Slovak nature up until 2050. The main outcome is the creation of one basic and four alternative scenarios of potential development trajectories for Slovak nature. These scenarios present four perspectives, each examining the potential future state of nature, but also the socio-economic factors that may lead to them. The goal of this publication is also to offer information for the future agenda for biodiversity policies after 2020. The expansion of the concept of nature may lead to greater engagement of the civic and business sectors in their efforts to improve nature and the whole society. These scenarios include multiple possibilities of how our nature could develop in the future:

Baseline scenario. Business as usual scenario. This scenario assumes that there will not be any significant changes or disruptions in global and local socio-economic trends or priorities related to these trends. Changes in nature managements and trends in technologies, economies or policies will not affect current trajectories; they may or may not accelerate or slow down.

Scenario 1: Traditions. Nature as a source of cultural identity. This scenario spans from the growing need for cultural identity and for a greater identification of people with the places in which they live. Society values traditional types of landscapes; and local communities, civic associations, farmers and entrepreneurs are taking initiative in the creation of the natural environment.

Scenario 2: Biodiversity. Return to wild nature. This scenario brings to the forefront the significance of undisturbed (wild) nature for individuals and society; it depends on a society-wide transformation of values and development goals and brings about great changes in the use of landscape in the whole territory of Slovakia.

Scenario 3: Economy. Nature within a free-market environment. This scenario is strongly anthropocentric. Nature is subject to economic interests and lifestyles, while nature protection is directed according to a calculation of economic costs of our outputs, applying market principles and economic tools.

Scenario 4: Innovations. Smart utilization of ecosystem services. This scenario is based on the sustainable utilization of nature and ecosystem services. The society is greener and more sustainable, investing in research and innovations and reflecting external costs related to production and consumption.

These multiple scenarios should serve as a base for the preparation of arguments and as a source of inspiration. However, they should not be perceived as plans, nor as a fully-fledged spectrum, that captures a representative range of possible and desired futures. Rather, the challenge for the future will be to go beyond and combine these approaches so that interest and care for nature can be linked to other societal goals. Nature conservation policies will need societal support, which will help to achieve the 2030 to 2050 goals (not only in this area). The exploration of these four scenarios and the ways they respond to the challenges of nature protection policy made us reflect on multiple themes, which should be subject to discussion to gain a wide societal support base. The future will require targeted policies, focusing on critical areas, species, and ecosystem services, which will halt the most dangerous impacts of biodiversity loss on individuals and society. The future strategy for biodiversity will need to engage with wider relationships between biodiversity and other social and economic processes, namely the transformation of the economic and financial sectors and industry to achieve sustainable development within the limits of our planet (for example by food and environment security, health, urban and rural development, entrepreneurial and technological innovations, sustainable consumption and production, water protection and effective utilization of natural resources).

Table no. 1: Key characteristics of scenarios

Area	BAU. Business as usual	Traditions. Nature as a source of cultural identity	Biodiversity. Return to wild nature	Economy. Nature within a free-market environment	Innovations. Smart utilization of ecosystem services
General tendencies	There will be no significant changes or reversals in people's current economic and social trends and priorities. They may speed up or slow down.	Cultural identity and higher identification of people with the place where they live. The society appreciates traditional types of cultural landscape. An initiative of local communities, civic groups, farmers and entrepreneurs who are creating the natural environment.	The importance of intact (wild) nature for individuals and companies; it is conditioned by a society-wide change in value orientations and development goals and also brings major changes in land use throughout Slovakia.	Anthropocentrism. Nature is subordinated to economic interests. Nature protection is governed by the calculation of economic costs and benefits, the application of market principles and economic instruments.	Sustainable use of nature and ecosystem services. The society is greener and more sustainable, invests in research and innovation and takes into account external costs related to production and consumption.
Society and institutions	The EU remains a world leader in the environmental issues. The Ministry of the Environment is gaining in importance and competencies. Increasing social and adaptation costs associated with climate change and environmental degradation are putting pressure on public budgets. Demographic trends and growing social polarization are leading to a further rise in populism and radicalism.	High involvement of local communities, local action groups, NGOs, increased support for nature by local governments. Local patriotism, the positive attitude of the inhabitants to the places where they live as a response to globalization. National and EU authorities are removing obstacles to such initiatives while co-financing them.	Higher form of environmental awareness. Very high participation rate and very important role of local partnerships (NGOs, associations, local government). Regulatory and control role of state authorities and European institutions. New setting of economic instruments, increasing the share of public land (state and municipal ownership).	The EU, the state and the local government give only basic regulations in the environmental field. To compensate for the dominance of economic approaches, a much higher level of participation of the population and NGOs and their environmental awareness or responsibility is needed.	The trust of the whole society and of economic actors that a transition to a green, climate-neutral economy is possible and desirable. The way of use of natural resources has fundamentally changed. The shift from a consumer society to a aware sustainable one, characterized by simple living at various levels (EU, Slovakia, regions and the local level), a paradigmatic shift towards a holistic approach.
State of nature in 2050	Biodiversity targets were not achieved. In Slovakia, some degraded ecosystems have been restored in some areas and the system of protected areas has been simplified. However, there is continuous unsustainable pressure on use of nature and resources. Adaptation to climate change is only partially successful and at a high cost.	Support of nature conservation and accessible nature to people. In addition to natural and semi-natural habitats, there are also cultural and historical elements with the accompanying green and blue infrastructure. Protected areas are attractive to humans for their genius loci. Extensive rural management contributes to halting the negative trend of declining biodiversity and improve conditions for pollinators.	The area of natural areas has increased, with an emphasis on the conservation and restoration of biodiversity. Landscape revitalization and restoration of ecological connectivity using the concept of green and blue infrastructure. New conflicts (human-wildlife/large carnivors, psychological factor, safety of the population, transport, etc.).	Only the necessary regulations in the field of biodiversity, the state provides and finances a minimum system of protected areas belonging to the Natura 2000 system. The rest of the natural areas are in private hands or managed by civic initiatives and numerous NGOs. Admission to national parks, nature reserves, but also private city parks is paid.	Nature is sustainable used and provides services for the benefit of present and future generations. Nature is diverse and functional. The extent of natural areas has increased and their function is primarily to meet local demand for ecosystem services. It is ingenious to build green and blue infrastructure. Owners and users are actively involved in nature conservation.
Land use	Unsustainable pressure on the exploitation of natural resources (forestry, agriculture, industry, energy production, tourism and services) result in irreversible changes in most territories.	Emphasis on the use of natural resources in accordance with the principles of sustainable development, the creation of new habitats, the construction of green and blue infrastructure.	Great contrasts, polarization of the territory into a natural and intensively economically used landscape. Larger share of natural and semi-natural areas, increased risk of intensive degradation processes in the surrounding country.	A country more affected by economic activity. The share of natural and semi-natural areas in the country is lower. Privatization of land and its economic use	Using the landscape in a sustainable way, thanks to which nature provides a variety of ecosystem services. Strengthening ecological connectivity between natural areas, as well as the country's resilience to climate change.

Demography	Slight decrease and ageing of the population in Slovakia. Concentration of productive population in urban agglomerations, rural depopulation.	People's interest in living in the countryside will increase.	**Different demographic and social structure of the countryside (space for alternative communities, but also the risk of depopulation and marginalization of certain areas with accompanying socio-economic problems).**	High concentration of the population in urban areas, depopulation of the countryside as economically insufficiently productive.	The slowing trend of productive population concentration in urban agglomerations, rural areas remain viable.
Economy	**A market economy with a shift to a service-based economy and the outsourcing of most industrial production and parts of services. Material efficiency, shift to waste minimization.**	Economy based on circular principles, aimed at supporting local production. In accordance with the BAU, the material efficiency of production processes will be increased and waste production will be minimized.	**Significant transformation of the management in natural areas. Other areas used more intensively, with a less diverse economic structure. Problems with food security, wood and other raw materials.**	**Strengthening the economy and its transformation nationwide. Focusing on economic profit with its maximization and thus with the risk of negative impact on the landscape and the environment.**	Transition to a green, circular economy. Production and consumption will use optimally the services provided by nature and minimize their impact on the environment. Strong emphasis on innovation and new technologies.
Agriculture	**Contradictory trends: shift to organic production (weaker) and shift to large-scale food production (stronger). Lifestyle changes, the outflow of people from the countryside and the agricultural landscape. Rising food prices due to changes in the global / European market, strengthened by the effects of climate change.**	Increased interest in organic farming and organic production, improving the ecological stability of intensively used agricultural land.	**Reform of the EU CAP, due to the emphasis on shift from large-scale food production and a significant strengthening of agri-environmental measures. Significant strengthening of organic farming in natural and transition areas, on the other hand increasing concentration of agricultural production in other areas.**	Strong pressure to increase efficiency and maximize profits – intensification of agriculture in the open country. Emphasis on the provisioning ecosystem services as opposed to regulatory ones. Products of organic farming are luxury goods.	Support for biodiversity, widespread use of agroecological practices, transition to organic farming, use of precision agriculture.
Forests and forestry	**Climate change fundamentally affects the species composition of forests, the share of accidental logging is increasing; fragmentation of forest complexes. Privatization and ownership concentration. The price of wood is rising. Conflict between production and non-production functions.**	In accordance with the principles of sustainable forest management. Emphasis on adaptation measures to climate change, support for the creation uneven-aged forests and adaptation of the species composition of stands to changing conditions.	**Climate change has a major impact, a large part of forest stands is left to natural development (non-intervention areas). Spatial changes in the location of commercial forests – the area of economically usable forests in natural areas is gradually decreasing, as a counterweight, new areas of silviculture are emerging. Decreasing productivity of a large part of forests – the trend of rising timber prices continues.**	Opportunity for efficient timber production, with increasing application of the principle of ecosystem services and payments for ES. A significant part of the forests is privatized. Private ownership pushes for profit maximization, which is reflected in the intensification of forestry in the unprotected landscape.	**Nature-based farming, agroforestry that will contribute to adaptation to climate change. Strengthening the resistance of forest stands, providing various ecosystem services, payments for ecosystem services, certification.**
Water and water management	**The south of Slovakia suffers from a severe drought. Deteriorated availability of water resources vs. increasing risk of floods. Increased content of undesirable substances and hardly decomposable chemical compounds.**	New technological procedures aimed at improving the quality and retention of water in the landscape (support for agriculture and increasing biodiversity).	**Drinking water sources are more strictly protected. Economical technologies and management methods are favored. Promoting water retention in the country.**	**Lack of water, new dams on rivers for hydropower production or irrigation.**	**Targeted building of blue infrastructure in the country. Massive investments in water retention in the country and its better use, eco-innovative solutions.**

Methodology

We have drawn from the methodological guidance of the European Environment Agency (EEA, 2012); approaches suggested by the Joint Research Centre of the EU (JRC, 2016) and experiences and published approaches for the creation of the European nature outlook (van Zeijts et. al., 2017). These aimed to support public discourse on the state of nature and possible policy responses within the EU. We have built on the pilot phase of scenario building (Filčák & Považan (eds.) et al., 2017) which was one of the first complex attempts utilizing quantitative and qualitative approaches along with participatory methods.

The main outcome is the development of four scenarios of possible development trajectories for Slovak nature and one basic scenario (extrapolation of current trends). These present four perspectives, all exploring the potential future state of nature and the factors which may lead up to those. The scenarios provide alternative views on the ways envisaged global influences and local patterns of production and consumption, demography, social situation, and the public may affect the state of nature.

The methodical approach was based on the method of normative scenarios in multiple steps, which we describe below (preparatory work, development, analysis, and communication of scenarios). Identified key factors and driving forces provided us, along with further analysis results and discussions on plausible scenarios with data and information to consider for long-term thinking. Even though in the creation of these scenarios we worked with theoretical constructs, they are based on detailed analysis of the situation and trends and the combination of environmental, social, and economic factors (which may or may not be plausible).

BAU Scenario

The biosphere, on which humans depend as a whole, is changing on all levels. Over the past decades biodiversity, the diversity of life, has globally decreased at a faster rate than any other time in human history. Hundreds of thousands of species have become extinct and more are at risk of extinction soon. Nature and its vitally important processes that underlie biodiversity and ecosystem services are degrading globally. The goals to protect and sustainably use nature and achieve sustainability by 2030 and 2050 have not been met, as no deep and transformational changes within economic, social, political and technological factors were achieved and urgent sustainability challenges were not resolved (IPBES, 2019; EEA, 2019).

The year 2050 in the business as usual scenario is unfavourable from a biodiversity perspective. Most of the international social and environmental goals were not met, such as the CBD Aichi Targets and the Post-2020 global biodiversity framework or the sustainable development goals of the 2030 Agenda. Within the EU, measures to decrease the pressure on the environment and climate were more effective, however, problems such as biodiversity loss, resources use, and climate change impacts and environmental risks for health prevail (EEA, 2019). Improved management of protected areas was not achieved either (Geldmann et al., 2019). These tendencies threatened other goals as well, such as the Paris Agreement, adopted within the UN Framework Convention on Climate Change or the 2050 Vision for Biodiversity. In the middle of the century, negative biodiversity and ecosystem trends continue or worsen as a reaction to indirect factors such as fast population growth, unsustainable production, and consumption accompanied by technological development. Climate change is an increasingly important driver of change in nature.

The critical scenario of the UN Intergovernmental Panel of Experts on Climate Change was met. The 1.5 °C warming threshold was achieved in 2040. Globally, almost all coral reefs have gone extinct, fires and heatwaves are common, world food supply is not sufficient. The necessary global transformation of the global economy, agriculture and culture didn't succeed. The so-called "Fortress Europe" scenario took place (GEO-6, 2019) – it practically means strong protection of borders, stopping of climate migrants and a focus on adaptation measures within Europe (Costanza & Terando, 2019). These lead to socio-economic changes in European landscape use (Hellwig et al., 2019).

Slovakia is not exempt from this global framework and the outlooks for nature are similar (Filčák & Považan (eds.), 2017). Biodiversity protection was not adequately reflected in the policies of other sectors and decision-making. Biodiversity loss was among the major global risks in terms of likelihood and impact already in 2019 (WEF, 2019).

What is the situation in 2050 according to this scenario? Warming occurred because of climate change and vegetation zones were moved by 150 – 300 m into higher altitudes (SHMÚ, 2010). Biodiversity loss and the degradation of the ecosystems and their services continue, even though some habitats are being restored locally. Certain parts of degraded ecosystems were restored by 2030 (Envirostratégia 2030, 2019), however, these were expensive and complicated projects that were not able to include more than smaller parts of the landscape. The system of protected areas was simplified and the core zone of national parks is predominantly left without any human intervention. In the re-assessed national parks that are classified under IUCN management category II of protected areas, 50% of the total area was without human intervention by 2030 and 75% by 2050. This was achieved by decreasing and amending the borders of national parks and change in the categorization of certain protected areas so to better respond to the real management of the category (its use for example for recreation) as opposed to changing the management to meet the priorities of

the given category (Dudley (ed.), 2008). The efforts to secure the ecological connectivity of the area through the territorial protection of ecological connectivity elements (IUCN-WCPA, 2019) were negated by negative trends such as agricultural intensification, urbanization, suburbanization and the construction of technical and energy infrastructure, which lead to further fragmentation of habitats.

Climate change has become the main driving force of biodiversity loss (GB04, 2014), which seriously affected its state. After 2030 the impacts of rising temperatures and climate extremes (such as long-term droughts, local flash floods, etc.) are manifesting, the Pannonian region (southern part of Slovakia) suffers from drought (MŽP SR & SHMÚ, 2017), and a progressing desertification is transforming the landscape towards a subtropical character (potential evapotranspiration is increasing and soil humidity is decreasing). The north of Slovakia is less affected (the amount of precipitation is moderately increasing there). These are connected to other impacts, such as increasing frequency of forest fires, calamities, species migration, a higher number of bark beetle generations during the year, etc. The warming causes shifts in the phenological phases of plants (for example the beginning of flowering) and inconsistencies with the onset of pollinators. A relatively frequent occurrence of spring frosts (because of arctic air inlet and favourable conditions for the occurrence of frosts) has negative influences on the flowering nature. Erosion deepens because of droughts and torrential rains. It manifests mainly through topsoil removal, soil degradation and deposition in water reservoirs. Climate change and globalization accelerate the spread of multiple diseases (for example the reoccurrence of malaria, tick-borne diseases, viruses transmitted to humans) and prolong the pollen season (allergies).

Species decline, especially of pollinators and of insects in general, but also of endemic taxa is rapid. In the past decades up to 40% of insects have gone extinct globally (mostly butterflies, Hymenoptera, including bees and beetles), particularly affected are many water-related species such as dragonflies, stoneflies, caddisflies, and horse flies. Affected groups of insects also include many "common" species with a wider ecological amplitude (Sánchez-Bayo & Wyckhuys, 2019). The wood composition of forests is changing. Regional urbanization, suburbanization and infrastructure development lead to further biotope fragmentation. The development and renewal of green and blue infrastructure (such as removing barriers on watercourses) are slow and insufficient. Hunting and fishing significantly affect populations as well as rare and protected species. The control of environmental crime is improving, also on the international scale, however poaching and illegal killing and destruction of protected plants and animals and their trade remains. The cultural landscape has retreated in less inhabited regions, which are not economically interesting for food production, thermophilus, and often-invasive species have spread, abandoned landscapes have been deserted, and the quality of wetlands has decreased. On the other hand, there was an increase in bushes and sparsely wooded areas. Evermore chemicals like antibiotics and other pharmaceuticals, drugs, hormones and personal hygiene products, detergents or poisons permeate the water ecosystems from urban and agricultural sewage waters (Matějů et al., 2012), but also environmental burdens. Many of these substances cannot be effectively eliminated by purification technologies and they affect wildlife but also human populations.

One of the most significant factors influencing terrestrial ecosystems and their services is agriculture (Pe´er et al., 2019). Habitats and species depending on such landscape use will not exhibit measurable improvements in their status. Soil organisms, agricultural landscape birds, insects (for example butterflies and other pollinators), as well as other species, suffered as a consequence of specific agricultural practices, pesticides and industrial fertilizers (intensification increases yields, but also leads to losses in species diversity – Beckmann et al., 2019), phasing out traditional land use or fencing off plots of land. The use of pesticides in agriculture did not decrease on the national scale. There were only local improvements in places that used agro-environmental approaches and ecological agriculture, which represents 13.5% of the total agricultural land (Envirostratégia 2030, 2019). The number of pollinators rapidly declined. The state of habitats outside the areas with the highest levels of protection continue to deteriorate because of intensive agriculture, changes in the water regime, and increased average temperatures. Land reforms lead to the consolidation of fragmented ownership rights and the subsequent concentration of land in the hands of big

Low Tatras (Chopok) - the development of the ski resort in the national park is in direct conflict with the protection of biodiversity, in addition, the future of skiing is also questionable due to climate change, photo by: J. Švajda

owners. Global climate change drove a dramatic increase in food prices. This led to intensive food production in big industrial farms, including the usage of GMOs, industrial fertilizers, and pesticides. The price of water also increased and production is dependent on its effective management. Only a small proportion of food is produced in bio quality for a narrow group of people who can afford it.

Forest management practices changed and lead to positive effects on biodiversity in areas with higher levels of protection. Timber is harvested sustainably. Logging is prohibited in non-intervention zones, and environmentally friendly land management is preferred in areas with active management (Envirostratégia 2030, 2019). These solutions increase the coherence between the goals of nature protection and sustainable development (Cohen-Shacham et al., 2019). The species composition of forests changed. In particular, the proportion of spruce decreased and was replaced by deciduous trees (such as beech and maple). Conifers are also gradually decreasing in mixed forests and are replaced by deciduous trees such as oak, maple, ash, elk but also by locust. Even as dominant a species as beech has gradually lost a great part of its potential distribution range (SHMÚ, 2010; Thurm et al., 2018). In the southern half of Slovakia, the drought is more prevalent and part of forest cover takes on a forest-steppe to steppe character. The CO2 fertilization effect is becoming more pronounced, the amount of biomass is increasing at the expense of rising water consumption (MŽP SR & SHMÚ, 2017). A considerable part of forests is in private hands. The price of wood and biomass increases which stimulates the growth of fast-growing wood species with high water requirements.

Past attempts at mitigating species invasion were not effective enough to keep pace with growing globalization (Seebens et al., 2017). The suppression of invasive plant and animal species continues to be insufficient and rather unsystematic. Their spread continues, for this reason, simultaneously endangering endemic species and habitats (Filčák & Považan (eds.), 2017). Partial successes, such as the introduction of ecosystem services payments and the application of an integrated concept of landscape protection are met only to a part and are not enough to revert biodiversity loss in Slovakia.

This scenario assumes the existence of the European Union, which is also transforming. Compensation and aid to developing countries facing the impacts on climate change are not enough. EU remains a global leader in environmental protection; it is moving towards a circular economy and moving towards climate neutrality. It has reflected many scientific insights into legislation. Despite that, the ecological footprint of EU citizens is unsustainable. The pressure to comply with environmental legislation is inhibiting negative activities and is a partial guarantee of prevention and control. Nevertheless, the negative phenomena in the landscape remain as a failure to radically transform the pressure from businesses and individual consumption patterns. By 2050 the EU achieved a low-carbon, partially circular economy, yet still dependent on the import of consumption goods. Despite improvements in the state of Slovakia, it did not manage to finalize the transition to carbon neutrality. This failure was the consequence of insufficient measures for its achievement.

Slovakia is relatively prospering and people within the framework of post-materialistic values support the conservation of natural heritage. They do so voluntarily or in the form of compensations. Nature protection, however, has met with structural barriers of increasing consumerism, attempts of opening remote protected areas for tourism, or the increasing local manifestations of global changes or environmental burdens. The country remains an open, liberal democracy based on market economy, with a shift towards an economy built around services and outsourcing of the majority of industrial production. Since 2020, the annual GDP growth rate has been high (approximately 3% annually), however, it gradually slowed down to 0.6% per year (EÚ, 2016). Population and urbanization rates have developed fairly consistently and in line with trends from the beginning of this century (Bleha et al., 2013a,b). By 2050, the overall population of Slovakia had decreased and was increasingly concentrated within two urban poles – on the west of Slovakia and within the Košice-Prešov conurbation. Slower growth was also noted in the area of Poprad and the Tatra Mountains. Transport has been dominated by alternative propulsion technologies (hydrogen, electromobility), which combined with the use of nuclear and hydropower and massive expansion of renewable sources leads to a reduction in transport emissions. Yet at the same time, it has contributed

Pieniny - continuing urbanization along the Dunajec River on both sides of the state border has a significant barrier effect on animal migration, photo by: J. Švajda

to the degradation of certain ecosystems, in particular, aquatic habitats and disrupted river continuity. The material efficiency of production processes increased, while resource management shifted towards almost zero waste. Water supply, canalization, and wastewater treatment plants cover almost the entire population, however, attempts to remove certain substances and compounds in sewage failed and in water resources we met the limits of technologies. Ecosystem-based climate change adaptation measures (mostly related to water retention and flood control) were only partially applied. Grey measures were applied on a large scale (watercourses, dam construction, water reservoir construction), which significantly influenced natural watercourses and their continuity. On the other hand, water reservoirs help to respond to year-on-year droughts (MŽP & SHMÚ, 2017).

The decreasing and ageing population had changed consumption patterns; within the tourism sector, the environmentally aware part of the population prefers soft forms of tourism with a low impact on nature. The growth of social inequalities manifests in diverse pressures on the environment. Rich urban environment increased its ecological footprint. The rural population makes use of survival strategies partially based on local resources. The pressure on the financing of social services increased, while simultaneously the government needs to increase the financing of defence policy, anti-migrant measures, and development aid. The pressure to reduce social spending, along with differences in the pension system has led to the strong social polarisation of society. This has resulted in policy radicalization and the promotion of authoritative forms of government.

Given the current trends point to failures in meeting multiple 2020 biodiversity targets on all levels (global, European, national), the alternative scenarios offer different possibilities for nature outlook by 2050, which are more or less different from the business as usual scenario (see the previous chapter). We will introduce them in the following parts.

Scenario 1: Traditions

This scenario stems from the increasing need for cultural identity and greater identification of people with the places they live. People prefer a calmer life in the countryside. The connection between people, nature, and landscape is renewed and strengthened. Society values traditional forms of cultural landscapes, return to traditions, renewal of cultural and historical monuments. They care about the creation of the natural environment. They consider nature and landscape as an indivisible part of local and regional communities, which is vital for their well-being. The quality of the rural environment and services is improving. Landscape protection is perceived as a shared and collective responsibility. The landscape is highly valued for its beauty, cultural diversity and its role in creating communities. Nature is used and formed in ways that contribute to good and sustainable lifestyles, offering opportunities for local development, employment creation, production of regional products, and recreation. A considerable share of financial resources is devoted to the maintenance and development of green and blue infrastructure, accessible natural areas and rural landscapes. These elements are aesthetically attractive and make up public parks, "green" schools, lakes, and rivers. The landscape and cities are interwoven by alleys of trees. People transform former agricultural cooperative buildings and industrial parks into green recreational spaces. The identity of these transformed areas is strengthened by art, landscape architecture, cultural events organized at these premises. Abandoned and uncared-for cultural objects, such as castle ruins, mansions, old dikes, adits, water mills, chapels, and pilgrimage sites are also renewed. These objects are, depending on the space

Typical landscape of Hriňová surroundings with terraced patches, photo by: Archive of the PLA-BR Poľana Administration

available, completed by residential vegetation and are freely accessible to the public. People enjoy living in rural areas adjacent to cities thus slowing urbanization down. The system of protected areas functions on multiple levels, from local to national. Communal protected areas are declared on a local level. These nature-friendly areas are attractive for their *genius loci*. A mechanism to support direct management of protected areas was established thanks to well-processed strategic materials. It focuses on specific measures, followed up by monitoring of their impact on the favourable state of species and habitats. Biodiversity protection is gradually reflected and integrated into policies of other sectors and decision-making processes. Revitalization projects aim to improve the status of habitats and living conditions of endangered and rare species of animals and plants. They also aim to create bio-corridors and interaction elements between significant areas, which results in an overall improvement of protected areas. Investments in nature and countryside combined with the revitalization of rural landscape bring, in addition to improvements in biodiversity, also improvements in the quality of air, soil, and water, strengthen the ecological network, and renew ecological connectivity. The creation of natural parks and habitats contributes to better living conditions for pollinators. Nevertheless, biodiversity loss continues mostly in cases of the most endangered species and habitats, which are threatened on a global scale. Unfavourable tendencies in the spread of invasive species remain.
The economy of this scenario is based on a circular economy aimed at the promotion of local production. Interest in organic farming and the economy has increased. The increased share of green and blue infrastructure lead to improvements in the ecological stability of intensively used agricultural land. Forest management is carried out sustainably, with an emphasis on such tree species composition and age structure that is capable to adapt to climate change. Similarly, many water retention measures have been introduced in the water sector. Continuous climate change affects the quantity and quality of water, limiting opportunities for sustainable fisheries. Renewable energy sources, such as small wind, solar, and biogas plants are preferred and designed to match regional characteristics and do not disrupt the landscape. These devices produce energy for local consumption and reduce consumers' dependence on large energy companies.

Locals, farmers, and foresters use the agricultural landscape and forests in multifunctional ways. The landscape is characterized by a high diversity of landscape features, in addition to agricultural land, there are field groves, balks, bankside vegetation, stonewalls and traditional or newly built elements of small architecture. Meadows, pastures, orchards, and vineyards are also maintained in more remote areas. Meadows and pastures with grazing cattle or sheep complete the typical character of foothills and mountain areas. Management that is more extensive also benefits natural resources such as water and soil. The increased share of green and blue infrastructure contributes to improving the water cycle and micro-climatic conditions, improving air quality, reducing pressure on ecosystems, as well as improving water retention in the country. The extensive management and application of agrotechnical measures and GAEC rules and the promotion of crop diversification help to reduce soil degradation. The society appreciates traditional types of cultural landscapes, including those located in remote areas – landowners and users receive support to preserve them. Local production is also associated with building regional brands, production, and promotion of regional products. In addition to organic farms, retailers and restaurants offering regional products as well as traditional Slovak cuisine (especially cheese, meat, and pastry) are doing

Wooden carved crosses in Podpoľanie (detail) are an example of local culture, photo by: Archive of the PLA-BR Poľana Administration

well. Increased interest in bio-economy products has strengthened the local sales network, with an overall emphasis on reducing the environmental footprint.

In the area of education and awareness raising, various educational programmes focusing on environmental issues, nature tourism, "zero-waste" activities, etc. are developed and offered. Increasing environmental awareness has also improved the perception of the benefits that nature can offer for human well-being. Recreation and tourism play an important role in the local economy. Preference is given to forms of tourism that are less burdensome to nature. People enjoy the country through cycling, hiking, and canoeing. Popular recreational activities include picking mushrooms and forest berries and cross-country skiing in winter. These are available thanks to a well-developed recreational infrastructure, including a network of footpaths, pilgrimage paths, bike paths, lookout towers, and follow-up services. Sport fishing and hunting also develop in the open, but these are strictly regulated and the number of permits is limited. In regions with a high biological and cultural value, the production of regional specialities, cultural and spiritual activities is important.

Because of this approach, the globalization of the economy and social life provokes a counter-reaction towards a greater appreciation of the local environment. At the same time, increasing the well-being and quality of the environment has raised environmental and social awareness, which encourages local communities to take the initiative to care for the environment. Citizens, local businesses and local governments work together to preserve and create regional quality by sharing resources – money, ideas, and expertise. They develop initiatives to promote the production and sale of local products, apply measures

to develop eco-tourism, agro-tourism and river tourism, or various services in urban parks. Regional authorities facilitate these initiatives, as cultural landscapes and natural areas are considered public goods that the market can provide only to a limited extent. It is, therefore, necessary to develop and reflect on the future of the regions together, taking their history as a starting point. National and EU authorities remove barriers to such initiatives and at the same time co-finance these initiatives. Authorities facilitate the dialogue between professionals and citizens across the EU, stimulating them to create storylines and helping them to finance investments through funds, as many actors at different levels are involved in the creation of the country. The funds consist of public finance (tourist tax, real estate tax) and private funds (green mutual funds, landscape auctions). Thanks to the initiative of local action groups, a revitalization fund is created to build green and blue infrastructure in the country, to restore and enhance cultural heritage, traditional types and features of the landscape, develop cultural identity, cultural traditions and support the non-profit sector. Contributors to this fund are local entrepreneurs who care about improving the natural environment. Rural and regional development funds are pooled in a special and enlarged EU country fund under natural, agricultural, and other policies. In particular, support is provided to regions for the preservation of cultural landscapes, including marginal areas. The EU is also stimulating a regional knowledge exchange on rural development and regional brands. Land consolidation projects are supported both at the national and regional levels, in which public land is earmarked to support common areas, residential vegetation and nature conservation.

Scenario 2: Biodiversity

In the modern society of the 21st century, people strongly perceive the importance of the intrinsic value of nature and feel the shared responsibility to give it enough space and time for natural development. Besides, resilient nature is a prerequisite for mitigating the effects of global climate change and related environmental challenges, which have become a major limiting factor in the quality of life across Europe. The decision about desirability of such development that respects the priority of healthy nature was taken at the EU level and was gradually implemented almost throughout Europe.

The fundamental prerequisite for the feasibility of a nature-based development of Europe was an overall change in value orientations and a consensus at the European Community and the EU Member States level. This change has also occurred in Slovakia, mainly because most of our inhabitants acknowledged their shared responsibility for the state of nature and the necessity of returning to traditional nature. It also provides them with a counterbalance to the modern lifestyles in a reshaped country. People gradually began to choose the natural, "wild" surroundings for their leisure activities or as weekend and holiday destinations. They yet again desire to rediscover the values of freedom, spontaneity, resilience, and awe which nature represents. At the same time, they realize that only unregulated free nature on sufficiently large areas can dampen and regulate the effects of global environmental problems and the changes that Europe is facing.

A network of natural areas, consisting of large bio-centres (extensive non-intervention protected areas), bio-corridors (natural corridors for wild terrestrial and aquatic animals) and interaction elements (extensive use of semi-natural areas), has therefore been gradually created throughout Europe, including Slovakia. Extensive, relatively original and preserved areas were declared non-interference zones – without economic activities. However, their area size was not enough to create a coherent network – therefore, other areas were selected where large-scale renaturation and revitalization projects were carried out, maintained and wisely managed so that they could switch to a non-interference regime over the next few decades. Thanks to eco-tourism, people in natural areas can visit places where large carnivores, other rare animals, and plants grow in natural habitats, where they can experience the peace and grandeur of nature. In Slovakia, approximately 30 – 35% of the territory is left as part of the core areas of this pan-European network (a significant part was established by 2050). It is made up, in particular, of the vast areas of the central and high mountain ranges of the Western and Eastern Carpathian – the central areas of the former national and European network of protected areas. However, it also contains a relatively large area within the lower mountains and lowlands – these are mainly linked to important supra-regional elements of large watercourses, the ridge parts of the hills and highlands and their links with the mountain massifs. In addition to forest areas, important rivers and wetlands have been gradually restored, and rare grassland communities, which, unlike most natural areas require targeted management, have been preserved. Great emphasis is placed on the restoration of watercourses and wetlands – including the removal of technical barriers (dams, reservoirs, artificial canals, hydropower plants) and the restoration of native floodplain and wetland ecosystems. The natural network provides conditions for the return and conservation of sustainable populations of native animal species, including large herbivores and predators. Natural corridors, in particular, allow their migration.

Wild nature is gradually penetrating the urbanized environment, including places where large nature reserves have been gradually built and maintained by large corridors linked to natural areas. Selected watercourses and wetlands were revitalized, removing barriers. The emerging "urban nature" is home to a rich diversity of flora and fauna, and accompanying threatening phenomena (such as carnivores and wild animals, mosquitoes and other bothersome animals, flooding of water during floods, etc.) are generally accepted. The concept of green infrastructure is also widely accepted and implemented as the most important factor for urban development, thus increasing the share of natural and nature-based solutions (including elements of green architecture) and thus supporting the effect of natural areas.

There have been major changes in land use. In natural areas, technical elements (and especially barrier structures such as waterworks, engineering networks, selected transport corridors, and industrial sites) have been gradually liquidated or revitalized. New zoning measures were adopted. Transitional zones with special management regimes were adopted (in particular extensive agriculture and forestry with defined restrictions and managed urbanization) – the role of these zones is to dampen the effects of intensive farming on the surrounding countryside and natural areas. The transitional zones are typical of the lower parts of the mountains, margins of basins and lowlands, and the surroundings of large natural corridors. Together they cover 15 – 20% of the area of Slovakia. The existence and natural functioning of natural areas are also linked to the socio-economic agenda – they provide new sources of income from sustainable tourism and recreation, sustainable forestry, fishing, and hunting, creating new jobs for both domestic residents and new settlers. In addition to the economy of these territories, the composition of the population has gradually changed. It has been enriched by groups for whom a healthy environment is a priority, by young families, communities with alternative lifestyles and communities enjoying the possibility of working from home. Thus, some natural areas are also successful from the socio-economic point of view, especially those in the most attractive areas with a long tradition of tourism. On the contrary, many traditional and especially newly created natural and transitional areas have the opposite problem – emigration, ageing populations, subdued economic activities, and insufficient income. They, therefore, develop mostly thanks to grant programs and external financial compensation resources. Overall, the development of natural areas in Slovakia is still unbalanced in social and economic terms – the solution to this problem remains a task for the future.

The use of other areas outside the network of natural areas and transitional zones is intensive because less space is reserved for the provision of the necessary amount of raw materials, goods and services than in the past (their total area is 45 – 55% of the territory of Slovakia). The vast majority of economic activities takes (majority) place here, from the extraction of raw materials to industrial production, intensive agriculture, forestry and water management, to the development of settlements, transport, and related technical infrastructure. Nevertheless, there are problems associated with the local lack of production of basic local raw materials and goods (water, food, wood, building materials, etc.). Within the transitional zones and other areas, there are also smaller nature reserves and landscape features (so-called stepping stones), which increase the biodiversity of the landscape and allow the migration of animals. Compliance with environmental standards and related (fairly frequent) conflicts of interest are addressed by existing instruments in the area of spatial planning, nature and landscape protection, and environmental impact assessment. In case of serious conflicts and disputes between economic sectors and nature conservation interests, the opinion of nature and landscape conservation authorities with cross-cutting and cross-sectoral competences is decisive. Conflicts and clashes occur quite often in cities, due to the intersection of various interests and activities in populated areas. Although even in such cases compensation payments and measures are applied, there is a relatively large group of citizens and businesses that actively counteract the concept of natural areas or at least try to influence public opinion.

Exploring nature with children - The elder-flowered orchid (Dactylorhiza sambucina), photo by: R. Považan

As the intention to preserve and restore natural areas at the European level, including Slovakia, was very ambitious and costly at the time of its initiation (after 2020), its establishment required extra effort and investment. Mainly EU funds were used in the first phase – they were redirected from the structural funds for agriculture and rural areas, regional development and cohesion policy directly to nature and landscape protection. In the first few years, particularly demanding preparatory work was carried out – in addition to expertise and studies aimed at identifying areas for natural areas and the necessary further steps, discussions with representatives of stakeholder groups, from international to national and regional, were extremely important. Large funds were invested in the purchase of land and a compensation scheme for owners and users. At the same time, the first phase of the network development in existing protected areas with a higher level of protection took place. The initiatives have been coordinated at the transnational level to create and maintain a functioning coherent European network of natural areas. Gradually, other areas followed, and by 2040, most of the planned natural areas were established and managed, and by 2050 most of the so-called transition zones followed. Revitalization measures and the construction of new ecological areas and corridors in agricultural and urban areas have been and are the most expensive and time-consuming. This includes the renaturation of large watercourses that face partial disagreement between owners and the public. Several of them have not been established mainly due to ongoing legal disputes, some of them due to technical, financial, and competence problems.

The management of existing natural areas depends on the ownership and the level of protection of the territory – from the strictest non-intervention zones owned by the state (which are a priority for halting biodiversity loss – Di Marco et al., 2019) through controlled protected areas of combined ownership (state, local associations, private owners) with limited activities of ecotourism and the local economy, up to areas with nature-based forestry and agricultural management owned by various entities (local associations, private owners) and with a developed system of subsidies and financial compensation. The management and use of these territories take place mainly in partnership between diverse groups of society – state administration, municipalities, civic associations, and private investors. Each natural area has developed so-called management plans (care program) with defined priorities, objectives and measures (including a precise list of permitted, limited and prohibited activities). Nature conservation agency and authorities have been considerably strengthened in terms of personnel, finance, and competencies – its organizations have played a key role especially in the establishment of respective territories, but they also have important professional and management competencies in the phase of their operation and maintenance. Much of the competence is delegated directly to regional organizations managing respective territories. In the management of natural areas, there is also space for local and regional initiatives, such as the establishment of local programs and partnerships, modern local and regional planning, and the promotion of appropriate local economy instruments – with the common goal of ensuring the conservation and sustainable use of these areas.

Due to the extraordinary difficulty of the whole process described above, the construction of the network of natural and semi-natural areas in Slovakia is not completed by 2050 – it is therefore obvious that the next decade will be the final phase of this plan to finalize the construction and secure the sustainable management of individual areas.

Scenario 3: Economy

This scenario seems to be most in line with current trends. It is characterized by a market-based and property rights approach. Environmental legislation should not restrict property rights. Private ownership and the retention of personal freedom in nature management are therefore only regulated at the national and European levels. Rather, voluntary rules are encouraged, based on the assumption that the owner will protect his/her property in his/her interest.

The objectives of biodiversity and climate change between 2020 and 2030 could not be met (IPBES, 2019; EEA, 2019; Environostratégia 2030, 2019; Filčák & Považan (eds.) et al., 2017). The dominance of economic aspects in society was significantly influenced by the deterioration of biodiversity and climate change (SHMÚ, 2010; MŽP SR & SHMÚ, 2017). So much so that it led to constant extreme weather manifestations (long-term droughts, fires, torrential rains, supracellular storms with hail, etc.), disintegration of several ecosystems (for example, of spruce forests in the Carpathians, non-forest biotopes in the Danube region), species loss (in particular insects and pollinators) and a significant onset of invasive species altering (semi)natural habitats and causing severe allergies in humans (in particular, onset of ragweed, ailanthus, box elder, buckwheat or goldenrod, Portuguese slug or malaria disease vector *Anopheles* mosquito). These changes have led to a faster (positive) change in attitude to nature at the local level. For some part of the population, motivation to environmental behaviour has increased, environmental-oriented private entrepreneurs have become more prominent, the role of environmental education has increased, civic engagement has grown, and NGOs are an important part of society.

The European Union remains the world leader in environmental protection in 2050, moving towards a circular economy and translating scientific knowledge into legislation. In the field of nature conservation, it aims primarily at creating a level playing field for economic actors and providing a basic quality of life for all. Slovakia is a prosperous country supporting the conservation of natural heritage voluntarily or through compensation. However, the need for nature protection is faced with structural barriers to increasing consumption, market pressure, and private interests.

Within the framework of this approach, nature is seen as a source of economic growth. State-owned natural resources (forests and open land, including protected areas) are privatized. Different economic interests and different levels of environmental awareness of owners and users lead to both positive and negative impacts on local nature. Private

actors have different motives and different ideas about nature protection, especially about what constitutes effective protection. Economic indicators push economic actors to use raw materials more efficiently, yet at the same time, they must pursue economic objectives. This system introduces environmental taxes that have an effect on the deterioration of the environment or, on the contrary, tax relief/incentives for beneficial activities and sustainable alternatives. The supply and demand principle is applied; conscious consumers do not support unsustainable business behaviour. The state is trying to translate negative externalities into the price of all goods and services, but entrepreneurs who operate by their competitiveness actively block this trend. Nature conservation is secured in limited areas that generate profit (for example through entry-based, site-linked services or souvenir sales).

The government and municipalities are responsible for the basic system of protected areas and the favourable conservation status of priority species and habitats of Community interest. Private companies, NGOs or the public provide management of protected areas outside the system. Increased environmental awareness of owners and users benefits nature, especially at the local level. A motivating environment has been created for environmental education providers. It is believed that individuals and the private sector are well placed to take responsibility for the management of natural areas. At the same time, however, the prevailing view is that nature is resilient and able to recover from any negative effects. In this approach, the responsibility lies primarily with private actors. It can also encourage private actors to engage in, contribute to, or finance nature conservation. The basic number of protected areas and green infrastructure is considered a public property that should be protected and which is mainly financed by public funds. All other nature is considered a private good to be developed and used by private businesses, nature conservation organizations, and citizens. Thus, nature is used for recreational activities such as space for human recovery or an attractive environment. Within this approach, there are significant differences in people's lifestyles. While particularly wealthy people are willing and able to pay for living in a green environment, for quality organic food or holidays in protected areas, others cannot afford it. Social differences mean that nature is a luxury for a large part of the population.

Managers of protected areas have found ways to earn revenue for the co-financing of nature conservation, mainly through diversification of resources (for example through exclusive natural adventure activities or renewable energy production in natural areas). The importance of protected areas for health is brought to the forefront in connection with the economic value of improved mental health of its visitors (Buckley et al., 2019). In this scenario, private actors will take the initiative – be it companies (including real estate or healthcare companies and insurance companies, tourism service providers) or individuals (owners and users, but also philanthropists), nature conservation organizations and many non-governmental organizations. Public-private partnerships in managing protected areas are becoming commonplace.

The state-owned nature reserve system, which is part of the European network, is well protected concerning land use. However, outside this, environmental regulation is minimal. The State guarantees that there is no net loss of biodiversity, for example through regulations imposing compensation for the degradation of natural resources. The government also stimulates private nature conservation initiatives. The core network of Natura 2000 protected areas is publicly managed and financed, while other natural areas are managed and financed by private individuals. Especially in regions with a high value of tourism (Tatras, Nízke Tatry, Malá Fatra and Veľká Fatra, Malé Karpaty, Slovenský raj, Liptov, Orava region) private companies invested in protected areas and the wider landscapes. However, increasing number of visitors is no longer sustainable for sensitive areas (Eagles, 2004). Alternatives are offered by small and medium-sized enterprises that focus on natural tourism (for example birdwatching and large carnivore observations). Only paying visitors or members of the relevant natural territory management organization can access these areas. Nature in the Carpathian Mountains is used for all kinds of leisure activities, such as hiking, paragliding, climbing. Only winter resorts at an altitude of 1 000 m above sea level and higher were kept, related to the reduction in the number of days with snow cover.

The return of beavers means not only a demonstrable improvement in water quality and positive impact on the water regime including formation of new habitats, but also the potential for human-wildlife conflicts (flooding areas, etc.), photo by: J. Švajda

Private semi-natural areas are being built with villas, including parks, alleys, meadows, and lakes, mitigating the effects of climate change. These elements of green and blue infrastructure provide space for human relaxation as well as habitats for some wild plants and animals. However, these are relatively artificial systems, similar to organized parks. These landscape elements can be created through the cooperation of several stakeholder groups. Private parks (for example near shopping malls and residential areas) are created in cities where membership or entrance fees are normally paid. They help to mitigate the effects of climate change (Bastin et al., 2019). The owners are private individuals or groups of inhabitants. Public parks are rare and small. Rich neighbourhoods are greener than the poorer ones, and many wealthy people also own second homes in rural areas.

Agriculture and forestry are focused on profit and efficient food and wood production. The principle of ecosystem services (for example the non-production functions of forests, protection of water and soil) is increasingly applied here, but it cannot compensate for the intensive use of nature and landscape. A large part of the forests is already privatized and access to them is restricted to owners, users, and paying visitors. Efforts to restore economic growth resulted in strong pressure to increase efficiency, manifesting itself in the form of intensified land use in agriculture and forestry. Wherever economically feasible, there is a mass acquisition of land by private investors. The wilderness with minimal human intervention is pushed to peripheral areas with low production potential. A small portion of organic food is produced for a narrow group of people who can afford it. The remainder is based on the principles of intensive agriculture, including not only the use of multiple fertilizers and pesticides and increased mechanization but also the use of robotics and precision farming, more efficient use of inputs and achieving homogeneous crop growth. These include, for example, field expansion, efficient irrigation, or groundwater management. In the mountainous (Carpathian) and dry regions (part of the Pannonian region, especially in eastern Slovakia), large-scale agricultural production has proved ineffective, further exacerbating the abandonment of large amounts of agricultural land from the past, particularly in the case of livestock production. As private actors ensure the balance between services, the focus is on provisioning services (for example food, wood, hunting). Regulatory services whose benefits are long-term or less visible are underestimated, which increases the risk of serious damage caused by extreme events.

New dams for hydropower or irrigation are emerging on rivers, increasing the fragmentation of aquatic ecosystems and overall loss of biodiversity. Due to the drought, the use of water reservoirs has intensified, resulting in fluctuating river flow. The risks of soil degradation and erosion, floods, mud floods, and drought are mitigated by a combination of nature-based measures (such as wetland construction) and technical solutions (dams). Alternatively, if disasters cannot be prevented, they are financially compensated through insurance.

Other sectors, such as construction, but also healthcare, are more engaged in nature protection than in the past. This was achieved by making citizens, businesses, and organizations responsible for nature outside the core network of protected areas. In this way, more resources are generated to protect nature.

Scenario 4: Innovations

In 2050, policies are coordinated horizontally and a portfolio of diverse measures to optimize the use of ecosystem services is applied. Activities that are harmful to the environment or threatening ecosystem services are no longer supported by public sources. For example, it is unthinkable to subsidize the fossil fuel industry, including subsidies for the extraction and combustion of local brown coal. Research, development, and innovation, as well as lifestyle changes and context-specific solutions, are encouraged (GEO 6, 2019). These changes include cleaner technologies, changing consumer preferences, resource efficiency, and increasing corporate, social, and environmental responsibility.

The Natura 2020 network is completed and is adequately funded. By 2030, policies have been put in place to address the causes of wetland decline and degradation. Their network, including Ramsar sites, is effectively protected and managed. Wetlands provide a wide range of ecosystem services, including particularly important regulatory ecosystem services, and contribute to mitigating the effects of climate change (Ramsar Convention, 2015). The society recognizes and appreciates these benefits, uses wetlands wisely and restores degraded sites.
Forests are managed predominantly through close-to-nature management practices. Non-intervention zones make up to 75% of the total area of each national park. Particular attention is paid to the protection of old-growth forests and primeval forests, which are effective carbon sinks (Luyssaert et al., 2008). The species and age composition of the forests is diversified, and the harvest cycles in private forests have been extended to at least 80 years (Law et al., 2018). The widespread application of forest certification tools stimulates the implementation of sustainable forestry practices (Linser et al., 2018).

The share of organic farming in domestic production increased significantly. Farmers use nature-based solutions and agro-ecological practices. Monocultures were eliminated. The use of natural elements (such as field groves or grassland flowering edges) is widespread which promotes biodiversity (mostly pollinators) and natural predators, which regulate pests. Farmers have abandoned industrial fertilizers and pesticides and prefer soil biodiversity-friendly practices. They use traditional agro-ecological practices such as diversified crop rotation.

The level of science and research in Slovakia has been steadily increasing since 2020. Coordination between departments, executive bodies and organizations improved. Science and research are transparent. The share of public and private investments in R&D has increased significantly, reaching the European average by 2050. Public investment in applied research is growing and focuses on the greening different sectors. Higher education forms the core of Slovakia's research potential in the field of basic and applied research and is an integrated part of the European Research Area. As a result, regional innovation clusters are being developed in industry and services, inviting the participation of secondary vocational schools and the private sector. These provide not only education for young researchers, but also the creation and transfer of innovation usable for a sustainable and innovative regional economy.

Since 2020, the reading and science literacy of Slovak pupils has increased and achieved significantly better results than the OECD average. By 2050, vocational school students, including non-graduate students, achieve significantly better scores and no longer belong in the PISA risk group. In addition to increasing knowledge, education focuses on the development of key competences for sustainable development (UNESCO, 2017), which include systematic, critical and creative thinking, the ability to cooperate, future-oriented thinking or integrated problem-solving skills. Media and digital literacy are an integral part of the formal education system. Students can deal with dilemmas, take positions and act in favour of sustainable development. In 2050, every student has an equal opportunity to study in high-quality schools, regardless of their place of residence or socio-economic background. In the classroom, the share of action learning has increased. In 2050, project-based learning that examines and solves problems within the school surroundings is an essential part of education.

As the onset of new technologies, processes or business models require a culture of experimentation, the government encourages experimentation through various forms of sustainable innovation and builds transformative coalitions or innovation networks. It takes a portion of the risk off the innovators to increase their willingness to engage actively. Public investment in research is increasing, focusing primarily on the greening of production systems and products. Their adoption and use are supported and disseminated by central government authorities. However, it should be noted that some innovations could also harm the environment (such as geoengineering, GMOs, synthetic biology, digital sequence information, etc.).

New, cross-disciplinary partnerships are being created that focus on different types of transformative and radical innovations (for example social innovation, organizational innovation, educational innovation). These innovative partnerships use the principles of open science and are based on a shared ambition to strengthen the green economy and the overall sustainability of the country.

Already in 2030, emissions were halved compared to the 1990 level. By 2050, Slovakia achieved carbon neutrality and decarbonized its energy, industry, agriculture, and transport sectors. Energy sources comply with rules and criteria for their sustainable use, respecting regional potential, economic advantage, impact on the energy system or protected areas. For this reason, the impact of hydropower on the hydrology of river ecosystems has been mitigated. Solar power plants are mainly located on the roofs, parking lots or former brownfield sites, and not on fertile soils (Envirostratégia 2030, 2019). These measures have also improved air quality so that it no longer harms human health and the environment.

Urbanization is planned and the protection of ecosystem services is a priority of land-use planning processes. Vegetation and water features that provide a healthy environment are spreading in cities. The streets are lined with diverse tree species that are adapted to the local climate. Rain gardens are planted on the sidewalks; buildings use extensive and intensive green roofs or vertical greenery. Residential forest parks are established. Citizens receive support for the creation and long-term maintenance of community gardens where they grow fruit, vegetables, and flowers. Degraded urban ecosystems and brownfields are recovered in various ways, such as through bioremediation. All hazardous waste landfills, which had a direct negative impact on the health of the population in the past, were remediated.

Buildings are renovated and insulated. In the industrial sector, energy demand has declined since 2025 because of more ambitious efficiency policies. The rising price of the EU Emissions Trading Scheme (ETS) is the main driver of investment in more efficient technologies (MŽP SR, IEP & The World Bank, 2019). Energy demand in the transport sector has decreased, thanks to the tightening of emission standards for cars and vans, electrification of transport and increased use of biofuels. Freight transport is shifting from roads to railways or water; in passenger transport, shared forms, cycling and walking are preferred.

At the same time, ecodesign regulations were adopted and the best available technologies are applied in steel, cement, and aluminium sectors. Investments in renewables and nuclear energy have increased. The efforts to decarbonize foresee the development of new nuclear power generation capacity. In the end, the shift to a low-carbon economy has boosted GDP growth while reducing household consumption. GDP grew between 0.5 – 1% compared to BAU between 2025 and 2035 and by 3 – 4% between 2040 and 2050 (MŽP SR, IEP & The World Bank, 2019).
The removal of administrative and legislative barriers to the use of regional and local systems for renewables reduces dependence on centralized power sources. Decentralized power sources and local power systems are popular.

The whole of society and all economic actors are building up trust in the belief that the transition to a green, climate-neutral economy is possible and desirable. The way the economy and society use natural resources has changed fundamentally. Production and consumption make optimal use of the services provided by nature and minimize their impact on the environment. Private companies, civic and public organizations know how to integrate sustainable use of resources into daily practice.

The key to this scenario is a gradual change in the interpretation of what constitutes a good life. There has been a shift from a consumer society to a conscious, sustainable, voluntary modesty. This reduces the number of indirect causes of biodiversity loss.

The change in consumer behaviour is manifested at different levels. Minimalist lifestyles, characterized by an anti-consumer approach and the ‚less is more' principle, are intensifying. Having less is manifested in the enjoyment of more immaterial values (Dopierała, 2017). The physical quantity of products and services consumed has decreased along with personal energy consumption and kilometres travelled. People avoid unsustainable products and prefer ecotourism. The other part of this change lies in improved energy efficiency. Outdated technologies are being exchanged for more energy-efficient and low-carbon technologies, such as electromobility (IGES, 2019). Sustainable lifestyle has become a new standard supported by the government, making them available to the majority of the population. Many prefer vegetarianism and veganism.

People understand the importance of ecosystem services as well as the fact that natural ecosystems have the greatest capacity to provide regulatory and supporting ecosystem services, which are also most important in terms of nature and landscape protection (Mederly & Černecký et al., 2019).

Conclusions

For the future of our nature to be sustainable (or even desirable?), it is necessary to address the most important challenges which are perceived in several of the above-mentioned documents and referred to in the global biodiversity framework. They can be summarized as follows:

- the natural challenge: the protection and enhancement of biodiversity as a fundamental prerequisite for the functioning of nature and thus society,
- the economic challenge: sustainable use of the natural resources, ecosystem services, and the landscape by rationalizing production and consumption and transitioning into a circular economy,
- the societal challenge: changing the development paradigm of the whole society, working together and the integration of various approaches and sectors.

It is most likely that only an integrated solution to all major challenges can achieve long-term sustainable development. The development scenarios outlined in this publication represent the basic frameworks for possible development. Everyone has a specific relationship to these challenges; they have their advantages and disadvantages:

The Baseline scenario does not envisage fundamental transformational changes and would certainly not lead to a sustainable future. Improving the situation in individual areas would depend mainly on external pressure and instruments (EU). Slovakia's internal potential will not be enough.

- *Scenario 1 – Traditions* focuses on promoting traditional values and developing local potential. It is driven by bottom-up initiatives, which can guarantee sustainability in local communities and improve the situation in active regions, but it does not have to address economic and natural challenges requiring integration and coordination at national and higher levels.
- *Scenario 2 – Biodiversity* prefers the natural challenge by defining an extensive network of natural areas, but at the risk of unsustainable development in other areas. It does not exert pressure on the overall transformation of the economy and society. Moreover, it requires a normative approach from above, which is the risk of not being accepted by some citizens.
- *Scenario 3 – Economy* is based on private initiatives and the commodification of nature. On the one hand, it may bring revitalization of the landscape in some areas and greater emphasis on the protection of local natural resources, but the risk of disproportionate pressure on nature in other areas is significant. Nor can it be described as ‚fair' – it would probably entail a deepening of the economic and social polarization of society.
- *Scenario 4 – Innovation* builds on the concept of ecosystem services. It is perhaps the closest to meeting the challenge of the sustainable use of natural resources and landscapes, and supports economic transformation and cooperation and the integration of approaches and sectors. It is questionable how it could address the issue of biodiversity enhancement and protection, especially in populated areas and areas with a high potential for economic activities, as well as the risk of several innovations that could harm the environment.

The actual societal development will not be, most probably, unambiguous, nor straightforward in terms of following one of the outlined scenarios. Nor is it the task of this publication to identify any of them as ‚desirable'. It is more about drawing attention to the opportunities and risks of the potential development of our society, to think about them – with the aim to initiate and support the development, if not the desired or optimal future, at least the future, in which the main challenges for sustainable development of Slovak nature and society are captured and solved.

Scenario: Traditions

Nature

Vision 2050

Urban areas

Scenario: Traditions

Vision 2050

Scenario: Traditions

Wetlands

Vision 2050

Forestry

Scenario: Traditions

Vision 2050

Scenario: Traditions

Agriculture

Vision 2050

Nature

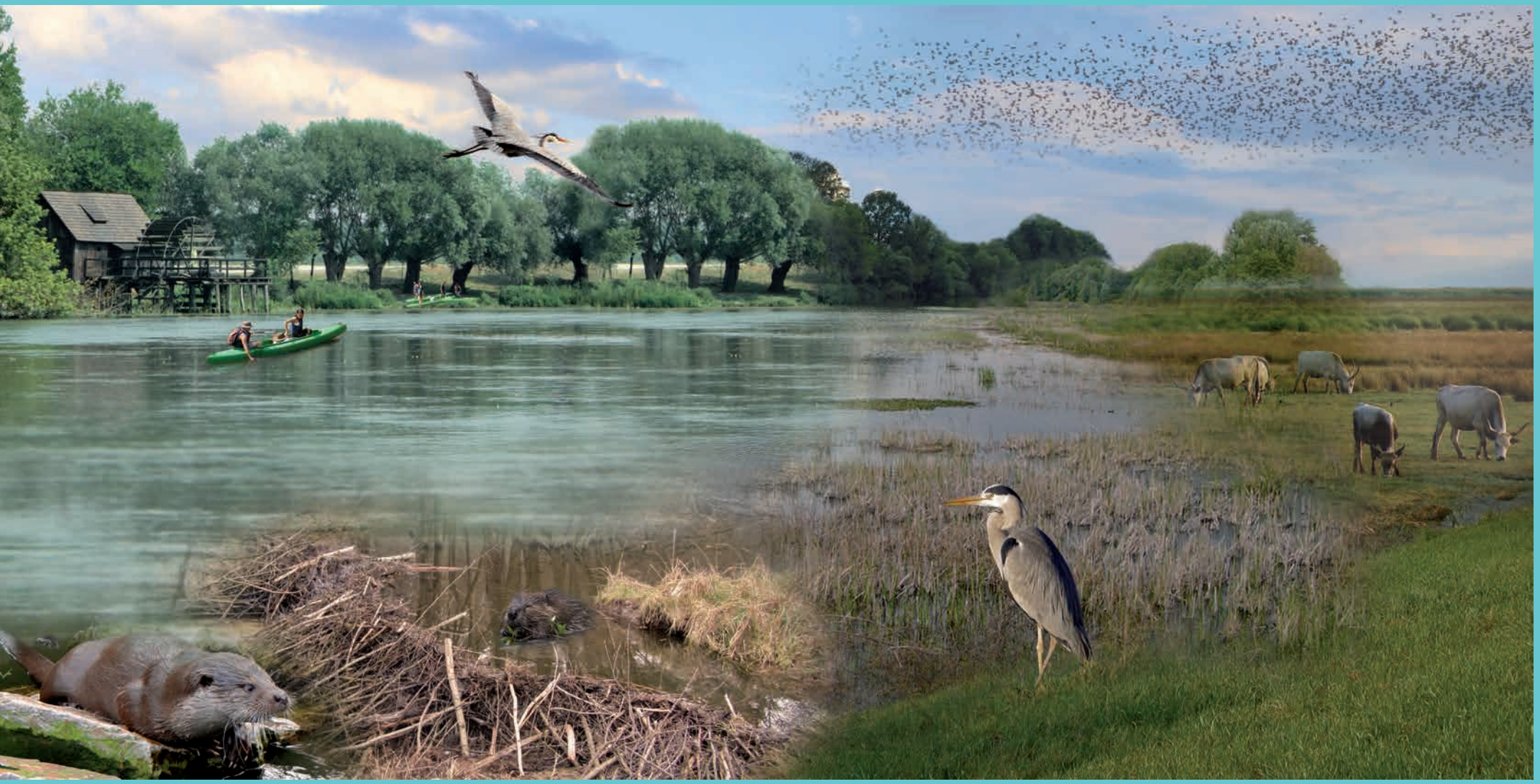
Scenario: Biodiversity

Vision 2050

Scenario: Biodiversity

Urban areas

Vision 2050



Wetlands

Scenario: Biodiversity

Vision 2050

Scenario: Biodiversity *Forestry*

Vision 2050

Agriculture

Scenario: Biodiversity

Vision 2050

Scenario: Economy

Nature

Vision 2050

Urban areas

Scenario: Economy

Vision 2050

Scenario: Economy

Wetlands

Vision 2050

Agriculture

Scenario: Economy

Vision 2050

Scenario: Economy

Forestry

Vision 2050

Nature

Scenario: Innovations

Vision 2050

Scenario: Innovations

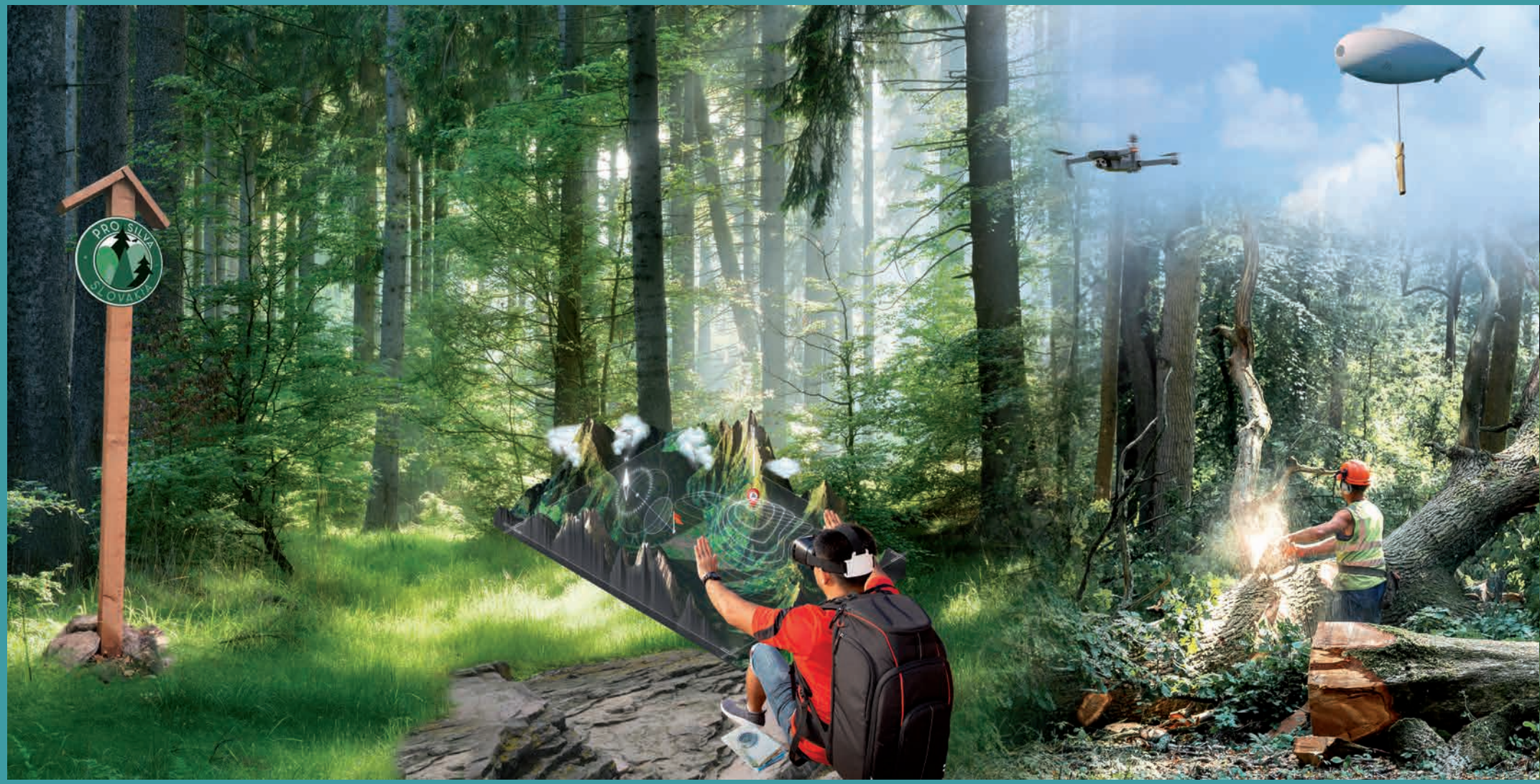
Urban areas

Vision 2050

Wetlands

Scenario: Innovations

Vision 2050



Scenario: Innovations

Forestry

Vision 2050

Agriculture

Scenario: Innovations

Vision 2050

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The nature protection in the Slovak Republic has recently celebrated its 100th anniversary. It has been a turbulent time, defined not only by the war, changes of political regimes, impressive rise in the standard of living, but also by the unprecedented changes of nature and by the growing negative impacts of climate change. It is equally important to understand the past as it is to have an open discussion about what the future holds for us.

This publication brings an important impulse into this discussion. It introduces potential scenarios of nature in Slovakia in a long-term horizon, stretching to 2050, while considering current trends, key drivers and uncertainties, which might shift the future trajectory away from its current course. The analysis of alternative scenarios is an important problem-solving tool applicable in the context of the implementation of public policies, programmes and projects. The relevance of this tool is all-the-more relevant when faced with different kinds of uncertainties.

Together with the Ministry of Environment of the Slovak Republic and the Slovak Academy of Sciences we started our work on strategic foresight studies with the objective to better analyse future risks and uncertainties several years ago. The present publication is released at the time when the world is facing the pandemic of the SARS-CoV-2 virus causing the COVID-19 disease, coupled with major economic and social challenges.

Foresight studies elaborated under the auspices of the European Environmental Agency – as well as our studies – have considered the risk of new, emerging, and recurring diseases and pandemics. This potential risk has nowadays become a reality. High concentration of people in cities, climate change, increased mobility of people and goods are among factors causing and accelerating such pandemics. For this reason, they need to be adequately considered in the context of strategic foresight. The biggest wild card – situation defined by low probability, but major, often asymmetric, consequences – is presented by the societal changes after the experience with this pandemic. The major question is which scenario will most accurately illustrate the changes in nature and society in Slovakia.

The present publication is the result of a collaborative effort, involving a broad spectrum of experts from a variety of disciplines. At the same time, its ambition is to provide readers with an opportunity to become familiar with strategic foresight, environmental matters and nature protection in a broader context.

Richard Müller
Director General at Slovak Environment Agency