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**NATURE-BASED SOLUTIONS
IN WATER, FORESTRY AND AGRICULTURAL SECTORS
FOR THE POST-WAR RESTORATION OF UKRAINE
AND FURTHER SUSTAINABLE DEVELOPMENT,
TAKING INTO ACCOUNT CLIMATE CHANGE**

Sourcebook of INSURE project

Nature-based solutions in water, forestry and agricultural sectors for the post-war restoration of Ukraine and further sustainable development, taking into account climate change. Sourcebook of INSURE project. – Kyiv, 2022. 86 p.

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The Sourcebook of INSURE project contains basic information about the concept of "nature-based solutions", its place in the international and national policy agendas, a representation of the main stages of government officials, scientists, and the public involvement in the formation of visions of "climate-smart" development of Ukraine, water, forestry and agricultural sectors, development of recommendations for the implementation of nature-based solutions in the specified industries and the environmental protection area. The sourcebook will be helpful to politicians, government officials, and the public for raising awareness and implementing nature-based solutions in the policy and practice of recovering communities, economic sectors, and the country in general in the post-war period, creating prerequisites for the sustainable development of Ukraine, considering the expected impact of climate change.

The publication was prepared as part of the INSURE project with the support of Sweden

INSURE | moving Nature baSed climate solutions into Ukraine's Reform agEnda



WWF's mission is to halt the degradation of the planet's natural systems and build a future in which humans live in harmony with nature. This can be achieved by preserving the planet's biodiversity, rational use of natural resources, and reducing pollution and wasteful consumption.

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INTRODUCTION

This publication contains information on the progress and results of the INSURE project: moving Nature baSed climate solutions into Ukraine's Reform agEnda, which may be interesting and helpful to politicians and the public on the way to the practical implementation of nature-based solutions (hereinafter referred to as NbS) for the recovery of communities, economic sectors, and the country in general in the post-war period, creation of prerequisites for the sustainable development of Ukraine, considering the expected impact of climate change.

The project started in the summer of 2021 and ended in December 2022. The project's primary goal was to promote adaptation to climate change through NbS. However, with the beginning of the Russian military aggression against Ukraine, the issue of the NbS implementation began to be considered as having a potential for post-war recovery.

The country has already faced the effects of climate change, but with the beginning of a full-scale war, climate goals have taken a backseat; instead, humanitarian requests and economic recovery need urgent solutions. In addition, military actions made the problem of biodiversity loss more profound and complicated the restoration and conservation of nature. Large-scale destruction of settlements and infrastructure, hundreds of thousands of hectares of burned forests and fields, contaminated by hostilities water bodies and soils lead to economic losses, additional emissions of greenhouse gases, and a decrease in the resilience of disturbed ecosystems to climate change, creating risks for safe human life and health of the environment.

"Nature-based solutions are actions aimed to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively. NbS influence human well-being, ecosystem services, and its resilience, and also have benefits for biodiversity" [1]. This definition was approved at the 5th session of the UN Environment Assembly (UNEA) in March 2022 due to understanding the NbS potential to achieve the goals of international conventions and agreements aimed at sustainable development and environmental protection.

According to the conclusions of many international environmental protection institutions and organizations, as well as participants of the national polylogue and experts of the INSURE project, NbS can contribute to environmental restoration and carbon sequestration in biomass and serve as a basis for sustainable development. In particular, NbS is a part of the forestry, agriculture, and water sector, which is a serious reason for emphasizing the importance of their inclusion in the country's recovery strategy and ensuring successful implementation of them in practice through the dissemination of knowledge and provision of appropriate financing from state and local budgets, international donor programs, and private investments.

This analytical document presents the core information on the issues raised during the national polylogue "The place of nature in adaptation to climate change". Also, it provides a brief analysis of the possibility of NbS implementation following international and national legislation, lessons learned from the NbS implementation in other countries, and an understanding of the NbS concept at the national level. In addition, the document gives the vision of the "climate-smart" development of Ukraine formed by the polylogue participants, as well as the possibility of achieving this vision through changes in the water, forestry, and agricultural sectors, including with the help of NbS, and recommendations for increasing institutional capacity, changes in funding approaches and legislation of the country for the successful NbS implementation.



1 BRIEF PROGRESS AND RESULTS OF THE INSURE PROJECT: MOVING NATURE-BASED CLIMATE SOLUTIONS INTO UKRAINE'S REFORM AGENDA

WWF-Ukraine, with the financial support of Sweden and in cooperation with WWF Eastern and Central Europe, WWF Sweden, and WWF Poland, started the project INSURE: moving Nature based climate solutions into Ukraine's Reform agenda in the summer of 2021 and completed its implementation in December 2022.

The INSURE project: is aimed at forming a broad vision of the development of Ukraine, taking into account climate change, improving knowledge, and building the capacity of state authorities and a wide community of interested groups (stakeholders) in the field of NbS implementation for adaptation to climate change in forestry, water and agriculture. The goals of the project were achieved through the consolidation of the efforts of scientists and practitioners, representatives of key central executive bodies, local communities, youth, and the media around the idea of implementing NbS into national climate, environmental and sectoral policies and practices.

One of the first steps of the project team was a series of meetings with representatives of the Ministry of Environmental Protection and Natural Resources of Ukraine, the Ministry of Agrarian Policy and Food of Ukraine, the State Agency of Forest Resources of Ukraine, and the State Agency of Water Resources of Ukraine. These meetings showed the openness and readiness of the central executive authorities to cooperate, as well as an urgent request for informational materials, recommendations, and practical measures to raise public awareness of adaptation to climate change through the implementation of NbS.

The project brought together representatives of the government, scientists, public organizations, and businesses in the national polylogue (discussion) "The place of nature in Ukraine's adaptation to climate change". Most of the meetings consisted of plenary parts and facilitated discussions, organized with the help of a three-horizon method [2, 3], which allowed to analyze the current situation, form a vision of the desired future and determine ways to achieve it. The national seminar was held in two stages. About 150 participants of the online meeting on December 1-2, 2021, discussed the current situation and trends of change, identified problems caused by climate change in the water, forestry, and agricultural sectors, and also proposed possible solutions, including NbS. The working groups composition was based on the professional interest of the members, which allowed to present a professional view of the situation. More than 50 participants of the "live" meeting on January 27, 2022, based on the results of the previous stage, determined the vision of the "desired" state of water, forestry, and agriculture in the future and formed the drafts of relevant sectoral visions and a broad vision of the development of Ukraine, taking into account climate change. The composition of the working groups at both stages included representatives of state authorities, institutions, and organizations from various sectors of the economics, science, and environmental non-governmental organizations, which are constantly working with climate change and biodiversity conservation issues. This allowed to take into account the interests of the general public and organize intersectoral interaction in forming sectoral visions.

Three sectoral seminars held in February 2022 gave the opportunity to discuss draft visions for the development of the water, forest, and agricultural sectors with industry workers and to determine possible ways of their implementation to achieve a shared national vision. Most of the participants of this stage were representatives of central executive bodies and state and private enterprises working in the water, forestry, and agricultural sectors. The sectoral seminars resulted in a listing of the relevant to Ukraine NbS, which can help to achieve the visions agreed upon at the polylogue meetings.

With the beginning of Russia's full-scale aggression against Ukraine, the project's activities were rescheduled, taking into account new realities, risks, changes in the political situation, organizational problems, and social consequences. Analysis of the war's impact on the state of the water, forest, and agricultural sectors and finding tools for implementing NbS that can contribute to effective recovery in the post-war period became new directions. Thus, the new reality was

considered while organizing the sectoral working groups, the Leadership Youth Program, and the Small Grants Program.

During the summer of 2022, nine thematic working group meetings were held at round tables to discuss previously prepared recommendations for implementing the NbS. Specialists on the issues declared as topics for discussion took part in the working groups, including responsible employees of relevant ministries and agencies, representatives of the water, forestry, and agricultural sectors, public organizations, scientists, and experts of the project. The participants had the opportunity to provide proposals for recommendations in oral and written forms, which allowed to identify obstacles and perspectives for implementing the NBs and develop proposals to the central executive authorities for changing policies and practices to support the implementation of the NbS.

In October 2022, representatives of the Ministry of Environment, Ministry of Agriculture, Ministry of Regional Development, State Water Agency, State Forestry Agency, and State Geocadaastre took part in a study tour to Germany, the state of Bavaria, with the assistance of the Bavarian Environment Agency. The study program included familiarization with various aspects of the NBs implementation and examples of solving socio-economic and environmental issues in Germany. A comparison of the experience and approach of Ukraine and Germany in adaptation to climate change and the NBs implementation through the private and public sectors' interaction contributed to the development of an understanding of the problems solving options and findings of the alternative approaches, which was also reflected in policy recommendations.

To consider the perspectives of local communities in forming the vision of "climate-smart development" of Ukraine, project experts conducted a series of semi-structured interviews with local authorities and community representatives, which revealed a relatively low level of awareness of climate change issues and the concept of NbS. However, most interviewees noted the impact of climate change on water safety and human health, the interdependence of economic activity and the state of the environment, as well as the readiness to act and the need for reliable information and sustainable financing.

The Small Grants Program drew attention to the possibility of using NbS and ecosystem approaches to adapt to climate change at the local level, contributed to the development of the capacity of local public organizations and the support of public initiatives in NbS implementation in the forest, water and agricultural sectors, as well as during the restoration of disturbed ecosystems in the post-war period. Public organizations in Rivne, Lviv, and Odesa regions organized discussions and prepared recommendations for local and regional authorities regarding the inclusion of NbS in plans for strategic development and post-war reconstruction of communities and regions.

Cooperation with youth is essential in achieving the vision of the future because young people today are responsible for making decisions shortly. The leadership program is a pilot educational course of WWF-Ukraine for active and conscious youth, which united 14 young people aged 17 to 26 from 8 regions of Ukraine. The program took place in June-October 2022 and contributed to disseminating information about the environment, climate, and the potential of youth influence on the water, forest, agricultural, and environmental protection sectors, creating an opportunity for bilateral communication and consideration of youth issues in the developed recommendations. Furthermore, within the program's framework, WWF-Ukraine experts introduced young participants to NbS in the water, forest, and agricultural sectors and NbS for urban environments.

The experts of the project reviewed the international experience in the development of policies and the practical implementation of NbS. They compiled a list of "lessons learned" that can be used to optimize a similar process in Ukraine. European experts advise harmonizing the NbS concept understanding and establishing appropriate standards, harmonizing the goals of NbS implementation with state strategic goals, and developing legislation accordingly, establishing the information field, the ability of authorities and businesses to cooperate in the implementation of NbS, holistically approaching the planning and implementation of such decisions. The approximation of national legislation to the legislation of the European Union within the framework of the Association Agreement between Ukraine, from one side, and the European Union, the

European Atomic Energy Community, and their member states, from the other, was noted as an essential aspect and opportunity for the introduction of the NbS into the reform agenda of Ukraine and fulfillment of obligations under international multilateral agreements on environmental protection.

In general, the project's progress will contribute to the achievement of the long-term goal of reducing greenhouse gas emissions, sequestering carbon, strengthening the resilience of society and the economy of Ukraine to the negative impacts of climate change, and for the sustainable post-war recovery of Ukraine. Among the main achievements of the project are the following:

- a vision of "climate-smart" development of Ukraine and sectoral visions that ensure the reflection of the desire of all involved parties in the national polylogue "The place of nature in Ukraine's adaptation to climate change";
- the first Ukrainian-language Platform on Nature-Based Solutions¹ – a website that is a source of useful information, methodology, and examples of solutions for those who create strategic plans and implement NbS;
- a youth leadership program and an open online educational course aimed at inspiring, engaging, and equipping young people with knowledge, examples of NbS, and ideas for further environmental protection actions;
- a study tour to Germany for representatives of central executive authorities, which allowed to see examples of the implementation of NbS of various scales, learn about difficulties and challenges, exchange experience, get acquainted with the difference in legislation and organizational approaches to the NbS implementation in Germany and Ukraine;
- the small grants program, organized to initiate the inclusion of NbS in strategic development plans and recovery plans of local communities, dissemination of knowledge and promotion of NBs, and the association of public organizations and local authorities to create a dialogue regarding the post-war recovery of communities and their further development in conditions of climate change with the help of NbS;
- policy recommendations on implementing NbS in the water, forest, and agricultural sectors during the recovery of Ukraine in the post-war period and adaptation to climate change.

The project's activities throughout the entire period were accompanied by constant literature review and analysis of legislation. The issue of the possibility of implementing the NbS in the water sector was investigated by Iryna Ovcharenko, Iryna Markova, Lesya Zub, and Ihor Studennikov under the coordination and organizational support of project team members Inna Goch and Daria Boldarieva; in forestry – Natalya Vysotska, Ihor Buksha, Petro Tyestov, Mykola Chernyavskiy under the coordination of Andrii Plyga and Hanna Lobchenko; in agriculture – Andrii Achasov, Maria Bogonos, Olha Ignatenko, Mykola Shlapak under the coordination of Nataliia Pustilnik and Olesya Petrovych. Halyna Levina and Sofia Shutyak prepared the analysis of regulatory and policy documents. International experience in introducing NbS in policy and practice and ecosystem services of NbS was studied by the Earthmind² and MEGA Generation³ experts. More information about the team and the project results can be found on the Platform on Nature-Based Solutions [4].

¹ <https://nbs.wwf.ua>

² <https://earthmind.org/>

³ <http://megageneration.com/>

2 NATURE-BASED SOLUTIONS: FROM THE CONCEPT TO THE APPROVAL OF THE STANDARD

The concept of solutions based on nature (or nature-based solutions) as a means to implement Sustainable Development Goals and better deal with the consequences of natural disasters such as climate change was widely promoted at the Conferences of the Parties to the UN Framework Convention on Climate Change in 2009 and included in the Global Program of the International Union for Conservation of Nature (IUCN) in 2013 [5].



Fig. 1 NbS – actions to protect, sustainably manage, and restore natural and modified ecosystems that effectively and adaptively solve social problems, ensuring human well-being and biodiversity [8].

It is believed that such solutions could reduce the total emissions of greenhouse gases by about a third, mainly due to sustainable agriculture and stopping deforestation.

"Nature-based solutions are extremely important," said Inger Andersen, head of the UN Environmental Programme: "When we protect nature, it provides us with a safe environment to live in. It gives us the water we drink, the food we eat, and the air we breathe" [6].

Therefore, 2009 is indicated as the year when NbS began to be talked about as a concept that combines adaptation and mitigation of climate change consequences, disaster risk reduction, and the development of Green Infrastructure based on ecosystem services [5].

In 2016, the IUCN World Congress defined NbS as actions to protect, sustainably manage and restore natural and modified ecosystems that effectively and adaptively address social challenges, ensuring human well-being and biodiversity [7].

The IUCN World Congress approved the Global Standard for Nature-Based Solutions in February 2020 [8]. It is the result of the work of more than 800 experts, aimed at studying how to make nature an effective ally in the fight against climate change and other challenges of the 21st century. Currently, the IUCN global standard is not mandatory but rather facilitative. It is only intended to assist practitioners in the design, assessment, and scaling of NbS through the following:

- establishment of a common basis for determining what can be considered an NbS and what is not;
- promotion of positive changes by improving the practice of NbS implementation and support in creating an appropriate regulatory and legal framework for them.

The global standard defines that a solution is nature-based if it meets the following criteria:

Criteria 1 – NbS should successfully solve social problems. This criteria refers to the importance of clearly defining the social issue that a particular solution is solving. Sometimes it can be more than one problem.

Criteria 2 – NbS should be comprehensive and consider the interconnectedness of ecosystems and socio-economic activities at different levels. Each stage of the NbS implementation is developed considering spatial factors and the impact that this decision may have on environmental, social, and economic processes on a local, regional, or national scale.

Criteria 3 – the implementation of NbS should contribute to the preservation and restoration of biodiversity and the integrity of ecosystems.

Criteria 4 – NbS are economically feasible. The evaluation of the benefits from the implementation of the solution should consider both direct economic and indirect benefits (e.g., aesthetic or cultural value).

Criteria 5 – the development and implementation of NbS should be done inclusively and transparently to take into account the opinions of all stakeholders, especially those with less influence, and to ensure the real interest and responsibility of those affected by the decision.

Criteria 6 – NbS must consider trade-offs between achieving the main defined goal and other interests important to society as a whole. The criteria refer to the consideration of the balance of trade-offs that are an integral part of most decisions regarding the management of natural resources (including the balance between short-term and long-term needs). Such compromise decisions must be made fully transparent, open, and through the consensus of all stakeholders.

Criteria 7 – the implementation and management of NbS are adaptive based on scientific data. The practical implementation of a particular solution is combined with continuous learning, which contributes to improving a specific nature-based approach.

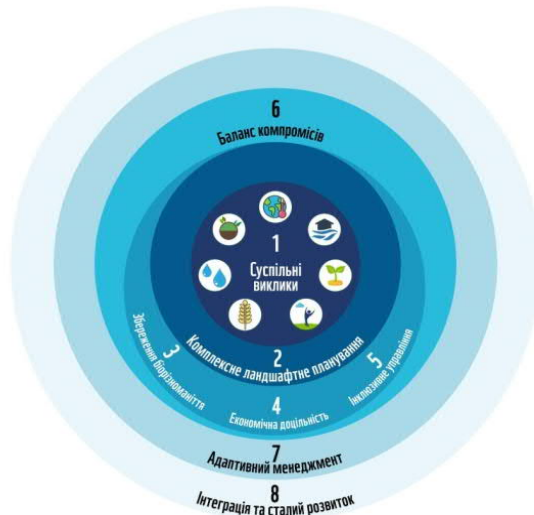


Fig. 2 All eight criteria are interrelated and constitute the IUCN Global Standard for NbS [8].

Criteria 8 – NbS are sustainable in the long term and are implemented within a legal framework, which facilitates their integration into public policy. This can be achieved by aligning them with the program-regulatory documents and national and global obligations.

Therefore, NbS is a unique opportunity to invest in public welfare and the economy without returning to past mistakes.

Anyone can use the international standard. It is a self-assessment tool for compliance of your decision with IUCN criteria and indicators [9]. It can be used before, during, or after the implementation of the decision. The tool can help you improve your solution and effectively share lessons learned with others [8].

3 BENEFITS OF NATURE-BASED SOLUTIONS AND PERSPECTIVES OF ECOSYSTEM SERVICES ASSESSMENT

NbS are often compared to the so-called grey infrastructure. The latter means any man-made installation, structure, and equipment designed to solve socio-economic challenges. Examples of grey infrastructure can include river dams, wave breakers, drainage pipes, filters for water and air purification, defensive walls, and others. The same socioeconomic problems can be solved with either gray infrastructure, NbS, or a combination of both.

However, NbS have specific features and aspects that often make them superior to gray infrastructure solutions, especially in the long-term perspective. While it takes a while for NbS to serve their intended purposes and to provide their benefits since their inception (creation/restoration/rehabilitation), these solutions truly pay off in the long term. As time passes, NbS become more and more performing, beneficial, and cost-efficient, in most cases surpassing the efficiency of gray infrastructure. The explanation here is simple: while gray infrastructure solutions require costs of maintenance and repair, which increase in the long term, well-set-up NbS function based on self-sustained natural processes and therefore often need comparatively less intervention and expenses, which gradually decrease over time, as the ecosystems of NbS stabilize. Nevertheless, regular monitoring and maintenance are still necessary for NbS, as it is for gray infrastructure. In addition, the NbS implementation can represent an opportunity for local community engagement. Taking proper care of an NbS site can create additional jobs and support long-term employment in local communities, while the maintenance of a gray infrastructure solution commonly ignores the involvement of such communities.

Besides offering a solution to a problem they had been established for, NbS provide several additional valuable benefits to people, especially to local communities and visitors. These complementary benefits range from improvement of people's mood through aesthetic pleasure to maintenance of health and wellbeing and concrete economic gains. Compared to NbS, gray infrastructure, in most cases, serves only its primary purpose and performs only a single function without generating any extra value. As a result, NbS often provide more benefits and are more cost-effective per hectare of land than any gray infrastructure installation. Therefore, again, NbS often win against gray infrastructure in the amount and value of gains they produce as time goes on.

The ancillary gains of NbS frequently have positive spill-over effects, thus generating value beyond an NbS site. Gray infrastructure solutions produce benefits mostly on their construction site and adjacent to it. The positive influence of NbS can stretch out to vast distances and offer benefits to far more people and communities than initially intended. This positive influence can include contributing to climate change mitigation, improving weather conditions and air quality, pollination support to farmers and gardeners, and improving people's health and well-being far beyond an NbS site.

In many cases, NbS can support and enhance other ecosystems and NbS by making those more functional, beneficial, and valuable. For example, healthy upstream riparian buffers (for example, regulated coastal protection strips) and floodplain forests can significantly improve the performance and quality of ecosystem services of downstream buffers and forests. And forests connected with green corridors are more resistant, adaptive, and richer in services and gains than fragmented forest areas. This enhancement potential is much lower or totally absent in most gray infrastructure alternatives [10].

Due to the above-mentioned extra benefits and value with their positive spill-over effects, the opportunity costs of allocating land for NbS versus other purposes could be quite low compared to gray infrastructure. Implementing a traditional infrastructure project in a particular territory usually implies the impossibility of using it for something else. On the contrary, an NbS site can serve multiple purposes and offer numerous opportunities, such as being a picturesque spot for recreation, sport, and tourism, hosting some organic agriculture and/or agroforestry, and even

representing an attractive location for the livelihood of vulnerable community members, the place that has increased protection against unfavourable natural phenomena.

These features and aspects of NbS make the latter an attractive option for strategically addressing various current socio-economic challenges: from sustainable production and supply of healthy food and clean water to climate change mitigation and adaptation to its devastating effects. Thus, when choosing between an NbS and a gray infrastructure installation, one is advised to follow an approach of “green where possible, gray when needed” [11]. And when there is a possibility to implement both an NbS and a gray infrastructure solution, one should attempt to go forward with both of them and integrate them into one hybrid project, where solutions work in tandem, as well as augment and complement one another.

NbS offers its value and benefits to people through the natural ecosystems these NbS incorporate and all the processes in those ecosystems. For instance, an agroforestry plantation includes a forest ecosystem, which performs [and supports] a variety of functions and processes, such as the formation of soil and maintenance of its fertility, cycling of nutrients, water and waste treatment, preservation of local biodiversity, air quality regulation, carbon capture and sequestration, and many other. Concrete socio-economic gains and utility, which people receive from those functions and processes of natural ecosystems, are called *ecosystem services*. Practically all functions of a healthy, sustainable, and resilient natural ecosystem provide valuable benefits to our society and economy. Hence, an NbS that relies upon such an ecosystem can be an unlimited source of those benefits.

To organize the variety of all possible ecosystem services and to highlight the socio-economic gains each one offers, those services are commonly grouped into several broad categories. However, the quantity and naming of these categories depending on what taxonomy of ecosystem services one chooses to follow. The scientific community has developed these taxonomies in conjunction with various intergovernmental entities. In describing the socio-economic value of NbS and their ecosystem services in this publication, we selected the categorization proposed by Millennium Ecosystem Assessment and the Economics of Ecosystems and Biodiversity, where ecosystem services are grouped into four categories: provisioning, regulating, cultural, and supporting services [12-14].

Ecosystem services provide people with concrete physical goods that can be consumed, exchanged, or traded on respective markets. These goods include food products; fresh water for drinking, irrigation, and other purposes; raw materials for construction, energy generation, and so on; and medicinal resources for preventing and treating illnesses. For example, forests managed in a close-to-nature way can serve as sources of berries and mushrooms as food, clean drinking water from streams and ground reservoirs, timber for building and burning to generate heat energy, and herbs with healing and regenerative properties.

Ecosystem services regulate the surrounding environment and its processes, thus creating favourable living conditions for people. With these services, natural ecosystems regulate local climate and air quality, assist in climate change mitigation by capturing and storing carbon from the atmosphere, maintain the health and fertility of the soil, treat waste and wastewater, ensure pollination of plants by insects, and so on. For example, the availability of preserved and protected wetlands in the area contributes to climate change mitigation through carbon sequestration, accumulation and slow release of water, helps filter surface and groundwater from nitrates and protects the nearby landscape from severe flooding.

Cultural ecosystem services offer people a number of non-physical yet valuable benefits that satisfy high-level needs, namely the need for knowledge and learning, the need to express oneself, and the need for beauty and aesthetic pleasure. Cultural ecosystem services can manifest themselves in the opportunities for tourism, sport, and recreation, which boost physical and mental health, thus reducing the risk of illness and increasing people’s productivity, happiness, and satisfaction with life. Cultural services can also be an inspiration for people’s culture, art, education, and science. For instance, floodplain forests provide very good protection against flooding and serve as tourist spots where people come for hiking, relaxation, and admiration of the surrounding magnificence of

Nature. At the same time, researchers could visit such ecosystems to study local flora and fauna, while teachers could bring their students here for outdoor lectures and practical seminars.

Supporting, or habitat, ecosystem services ensure the proper functioning of natural ecosystems to continue providing all the services described above. Without these services, people would not be able to enjoy all the other gains that ecosystems and, therefore, NbS supply. These processes and functions include cycling and replenishment of nutrients, formation and maintenance of soil, production of organic compounds, creation and preservation of habitats for species, and biodiversity of the latter. For example, farms being managed according to the principles of organic agriculture and having green corridors and strips of natural vegetation or forest around them retain most of the supportive services to a high degree. Specifically, organic agriculture with green corridors supports proper soil maintenance and nutrient cycling and offers habitats for a diversity of species, including valuable pollinators.

Gray infrastructure is not able to offer many of these services. This is what makes NbS that rely on natural ecosystems much more effective. And this is why policies that create, restore, and/or protect NbS represent one of the most efficient long-term investment opportunities. Nevertheless, one may well combine both NbS and grey infrastructure in a hybrid solution that solves a specific socio-economic challenge in a cost-efficient manner, while also securing additional valuable benefits to local communities.

Nature-based solutions must be recognized and valued by people to deliver social and economic benefits and value. Economic assessment is a predominantly anthropocentric methodology where natural ecosystems and their services have a monetary value only when they are realized and valued by people. However, people may use ecosystems and NbS directly, benefit from them indirectly, or not be connected to these ecosystems and NbS at all. In the latter case, society can still appreciate the benefits of ecosystems or specific NbS existence. For example, some city residents may never visit an old-growth forest located in a remote mountain area or a self-seeded forest on an abandoned agricultural plot. However, the contribution of these forest ecosystems to mitigating the consequences of climate change, their role in improving the overall air quality of the country, preserving habitats for plants and animals, and simply the existence of this forest and its availability to other people and future generations can be evaluated (fig. 3).

In addition to providing natural resources for consumption, nature-based solutions can provide essential benefits with significant socio-economic value. Properly planned and sustainably managed NbS provide ecosystem services unrelated to direct consumption. Although these services may have a monetary value, they do not generate direct financial gain. The benefits of NbS are manifested, mostly indirectly – through the improvement of living conditions and prevention of the impact of natural disasters, improvement of health, and increase of labor productivity and general well-being of people. For example, floodplain forests can indeed be harvested for timber, which is a profitable economic activity in the short term. But this activity is a very unsustainable way of using such forests, as the deforestation of floodplain forests threatens the ecological state of aquatic and coastal ecosystems. On the other hand, adequately protected and managed floodplain forests with very limited and carefully controlled logging (or without logging) provide many other equally valuable benefits. Here could be mentioned the protection of local communities and their property from floods, improvement of air quality and microclimate, contribution to mitigating the consequences of global climate change, and support of the recreational potential of the area and its aesthetic appreciation (fig. 4).

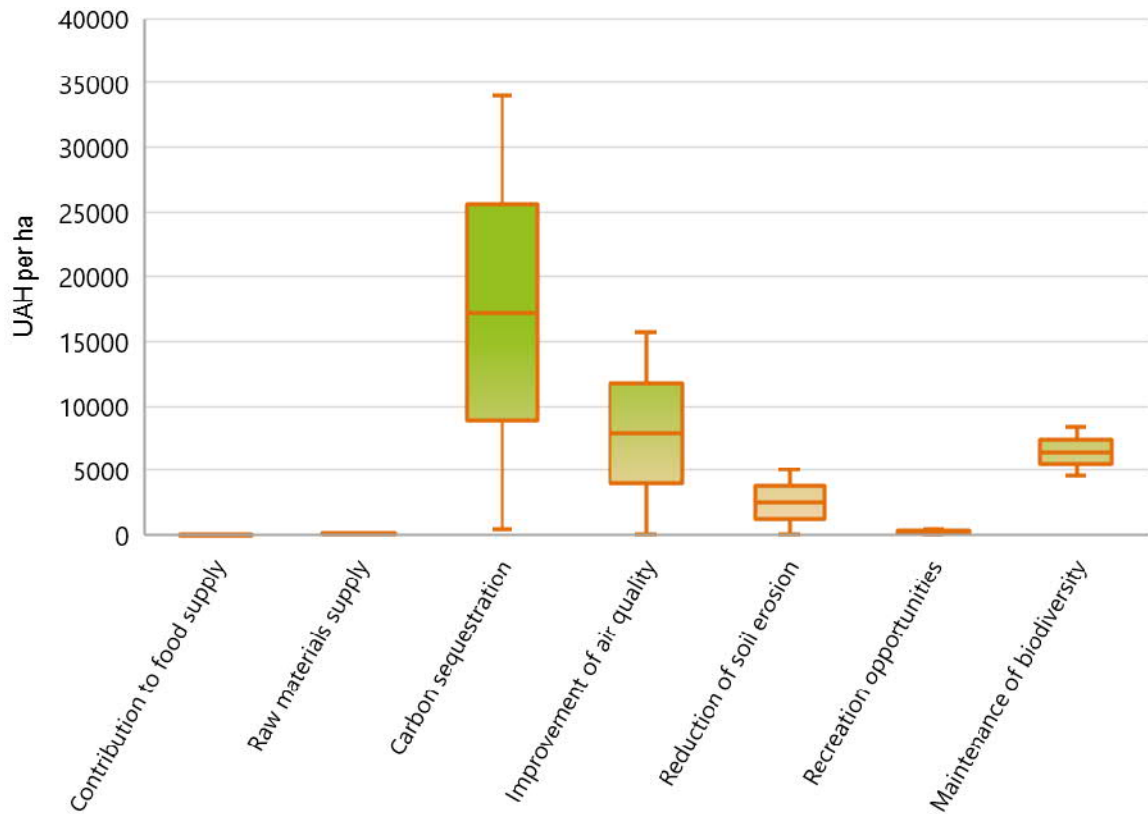


Fig. 3. Assessment of ecosystem services and socio-cultural benefits of old-growth and self-seeded forests (UAH/ha.).

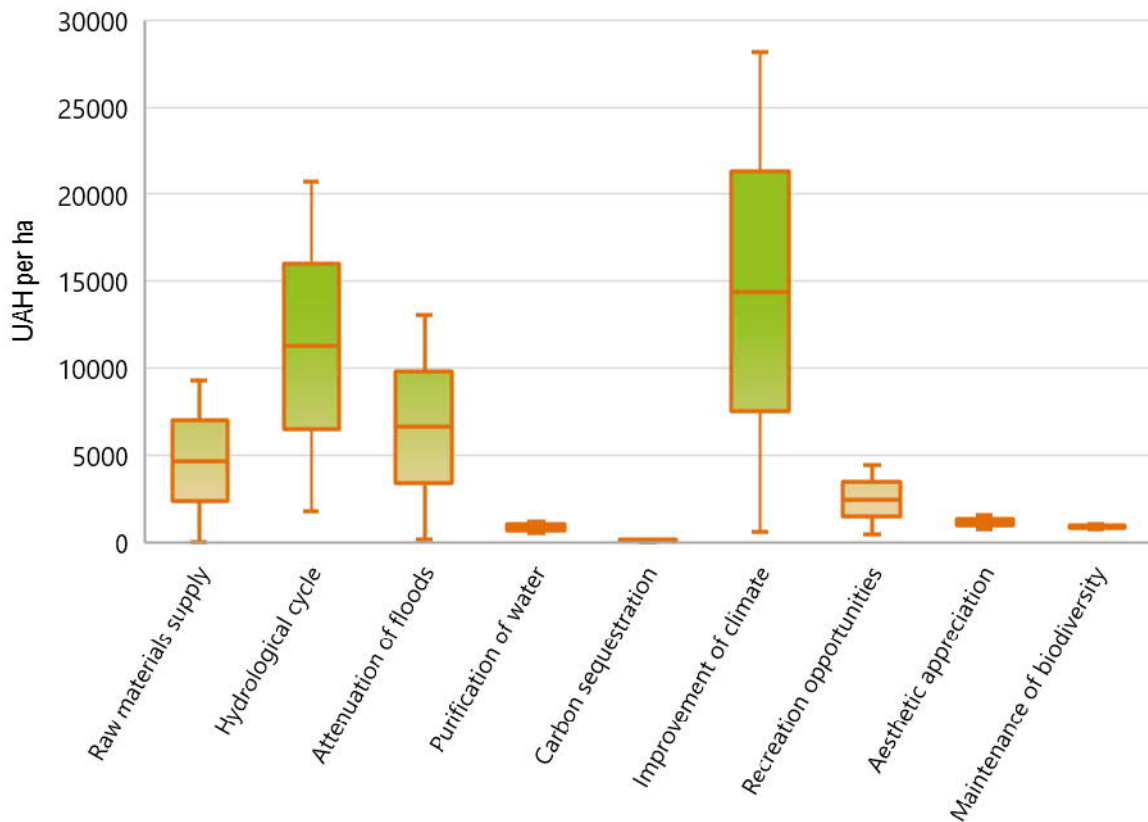


Fig. 4. Assessment of ecosystem services and socio-cultural benefits of floodplain and wetland forests (UAH/ha).

The socio-economic benefits of nature-based solutions can grow over time if these solutions are adequately planned and managed. It is known that NbS managed in a natural resource-efficient manner through strategic and safe environmental practices, provides people with benefits that can increase over time. This is explained by the fact that the natural ecosystems on which the NbS relies will become complete, more stable, and more resistant to external interventions and climatic factors and, therefore, more productive in providing ecosystem services. At the same time, the costs of maintaining the NbS are likely to decrease over time for the same reason – a well-established and sustainable ecosystem basis of NbS requires less and less effort to support it. As a result, NbS is more cost-effective in the long perspective. For example, a traditional way of farming aimed at short-term crop maximization will gradually reduce agricultural land's productivity and, consequently, its future value. At the same time, resource-saving agriculture may not have significant gains from the outset but will maintain the vital ecosystem functions of farmland for longer, creating greater cumulative benefits in the long-term perspective (fig. 5).

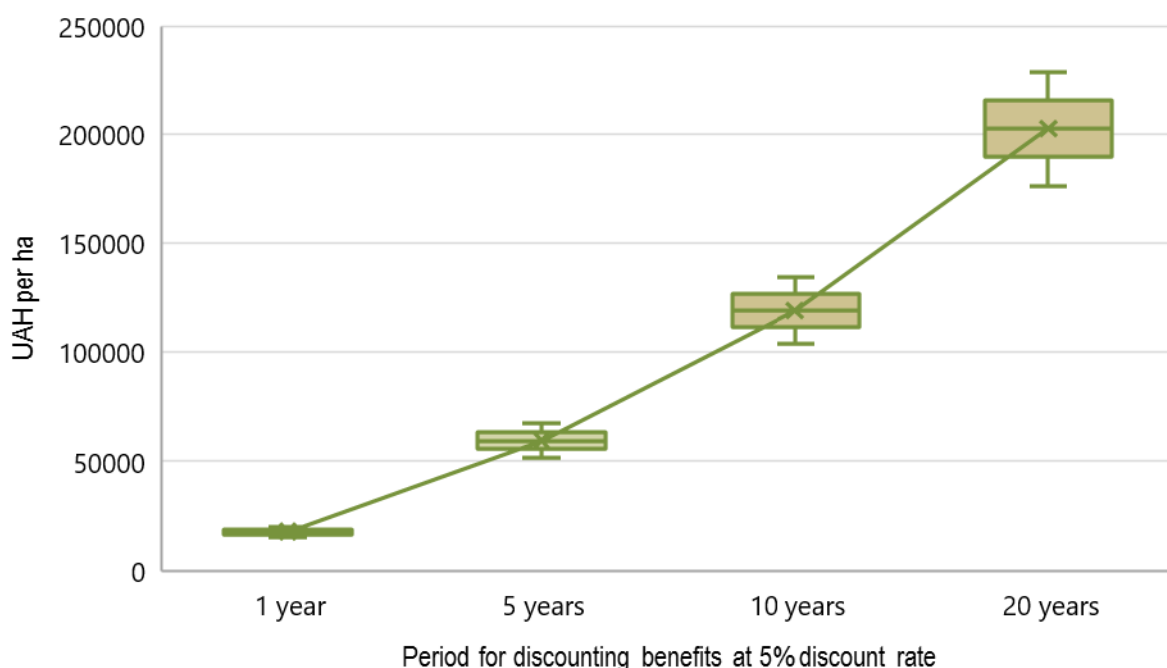


Fig. 5. The total cost of ecosystem services of resource-saving agricultural practices in time retrospective (UAH/ha).

Nature-based solutions can create opportunities for the involvement of local communities, social and economic development, and restoration of the country's natural capital and landscape. Local communities can contribute to the reclamation and restoration of degraded ecosystems through the NbS based on their local knowledge, culture, and traditions. This is especially relevant for rural areas and damaged and/or degraded areas, including those affected by military operations. For example, the restoration of peatlands that were massively drained or used for peat extraction in the last century may enable the local communities to engage in paludiculture (swamp farming), ensuring the raw materials (biomass for biofuels) and some food products (edible plants and berries) supply, and, at the same time, preserving these unique ecosystems. In turn, the restoration of swamps and peatlands will protect communities and their property from possible floods or droughts and provide other benefits related to preserving the natural environment and climate (fig. 6).

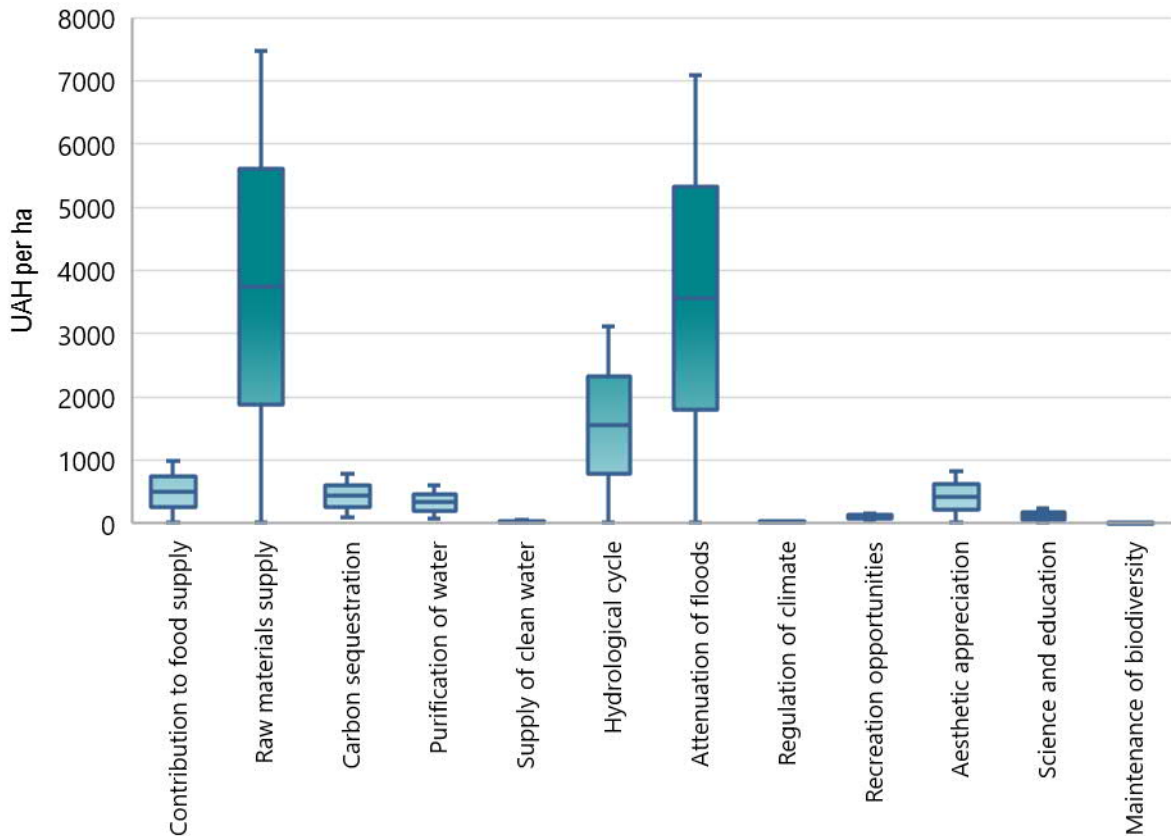


Fig. 6. Assessment of ecosystem services of peatlands and paludiculture (UAH/ha).

Considering the above, NbS is a valuable and cost-effective option for the post-war restoration of disturbed natural complexes and landscapes, which will simultaneously contribute to Ukraine's social and economic development. In particular, the implementation of NbS can:

- create a variety of important and valuable benefits not only within the territory of their implementation and not only for the people who live there but also for Ukrainian society in general;
- ensure long-term socio-economic gains, which increase over time both in value and in scale, supporting the sustainable development of post-war Ukraine;
- involve local communities in the restoration and rehabilitation of disturbed lands, thus providing them with employment and livelihood opportunities, as well as a chance to play an important role in the revival of Ukraine;
- improve the adaptation of Ukraine and its population to the negative consequences of climate change and natural disasters, especially in the territories where the war has weakened this adaptation potential;
- revive authentic landscapes and natural ecosystems, thereby helping to return Ukraine to its unique natural beauty;
- assist Ukraine in fulfilling its obligations under international agreements related to the natural environment and climate, such as the Paris Agreement [15] and the Kunming-Montreal Global biodiversity framework [16];
- contribute to progress on the path to European integration of Ukraine.

4 NATURE-BASED SOLUTIONS IN INTERNATIONAL AND NATIONAL POLITICAL PROCESSES

In March 2022, the 5th session of the UN Environment Assembly (UNEA) [17] adopted resolution UNEP/EA.5/Res.5 [1] (an unofficial translation is given in Annex 1), which contains the first official definition of the "nature-based solutions" term.

"Nature-based solutions are actions aimed to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience, and biodiversity benefits, and recognizes that nature-based solutions".

At the same time, the Resolution recognizes that the NbS:

- (a) respect social and environmental safeguards in line with the three "Rio conventions" (the Convention on Biological Diversity, the United Nations Convention to Combat Desertification and the United Nations Framework Convention on Climate Change), including such safeguards for local communities and indigenous peoples;
- (b) can be implemented in accordance with local, national and regional circumstances, consistent with the 2030 Agenda for Sustainable Development, and can be managed adaptively;
- (c) are among the actions that play an essential role in the overall global effort to achieve the Sustainable Development Goals, including by effectively and efficiently addressing major social, economic and environmental challenges, such as biodiversity loss, climate change, land degradation, desertification, food security, disaster risks, urban development, water availability, poverty eradication, inequality and unemployment, as well as social development, sustainable economic development, human health and a broad range of ecosystem services;
- (d) can help to stimulate sustainable innovation and scientific research.

Among other provisions of the resolution, UNEA recognizes that NbS can significantly contribute to the fight against climate change while acknowledging the need to analyze their impact (including in the long term) and realizing that they do not replace the requirement for rapid, profound, and sustainable reductions in greenhouse gas emissions, but can improve climate change adaptation, resilience, and mitigation of its consequences.

This definition was formed as a result of reaching a common understanding by the participants of the meeting of the NbS potential for the successful implementation of the goals of international conventions and agreements aimed at sustainable development and environmental protection. This was facilitated by the conclusions of international environmental protection institutions and organizations, including the joint conclusions of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [18] and the Intergovernmental Panel on Climate Change (IPCC) [19], which emphasized the interdependence between biodiversity loss, environmental pollution, climate change, desertification and land degradation with people's well-being and health. In particular, the joint scientific report of the IPCC and IPBES states: "Nature-based solutions are active strategies to rebuild or increase measures of intact nature that enhance provision of one or more benefits to people. Reflecting the broad scope and multifunctionality of NbS, multiple definitions have emerged for varied purposes, such as of carbon sequestration to address climate change, disaster risk reduction in relation to natural hazards, and provisioning of benefits by green spaces in cities, among others. A major concern about NbS developed for single purposes has been the growing evidence of the potential for perverse or negative impacts. For example, plantation forests may be efficient for carbon sequestration, but harm biodiversity; afforestation of natural savannas and peatlands has been shown to result in degradation of ecosystem and community structure and function and the loss of distinctive species, including endemics. In order to avoid this kind of unintended consequence, in the context of the biodiversity-climate nexus, NbS for climate mitigation or adaptation must also be positive (or at least neutral) in

terms of biodiversity benefits. In many cases additional nature's contributions to people might be generated by the action, adding to the total value of NbS for biodiversity, climate and people" [20]. This report proves that the fulfillment of the goals of the Paris Agreement, in particular in adaptation to climate change, is possible not only at the expense of technological solutions and emission reductions, which are undoubtedly necessary elements of achieving carbon neutrality. Nature also plays an essential role in mitigating climate change. In the international and business environment, there is a growing understanding that climate, biodiversity, and human well-being are inextricably linked. Therefore, stabilizing the climate in a state that supports life and protecting biodiversity are mutually reinforcing goals.

The participants of the 26th Conference of the Parties to the UN Framework Convention on Climate Change (COP26), held in November 2021 [21, 22], made ambitious commitments: to stop subsidizing fossil fuels, to solve the problem of methane emissions, to stop deforestation, and to support indigenous peoples; and the final text of the agreement for the first time recognizes *the critical role of nature in achieving the goal of keeping the increase in the global average temperature at the level of 1.5°C*. NbS were included in the draft agreement but were removed at a later stage. However, the text of the COP26 decision emphasizes the interconnectedness of the global crisis of climate change and biodiversity loss and the critical role of protection, preservation, and restoration of nature and ecosystems for adapting to climate change and mitigating its consequences, and simultaneously provision of social and environmental guarantees.

For the first time, the NbS was included in the final decision of the 27th Conference of the Parties to the UN Framework Convention on Climate Change (COP27) [23], which took place in November 2022. The inclusion of NbS in the text of the COP27 decision is a step that many organizations have been working on, and its importance is related to implementing a mechanism to prevent the use of NbS for "green PR", violation of human rights, or damage to biodiversity.

In particular, in the COP27 Implementation Plan [24], the term NbS is used in a special section on forests:

"XIV. Forests

47. (Conference of the Parties – ed. note) Recalls that, in the context of the provision of adequate and predictable support to developing country Parties, Parties should collectively aim to slow, halt and reverse forest cover and carbon loss, in accordance with national circumstances, consistently with the ultimate objective of the Convention, as stated in its Article 2;

48. Encourages Parties to consider, as appropriate, nature-based solutions or ecosystem-based approaches, taking into consideration United Nations Environment Assembly resolution 5/5, for their mitigation and adaptation action while ensuring relevant social and environmental safeguards".

COP27 "highlights the urgent need to address the interlinked global crises of climate change and biodiversity loss through synergy and a comprehensive approach in the broader context of achieving the Sustainable Development Goals, as well as the critical importance of the protection, conservation, restoration, and sustainable use of natural resources and ecosystems for effective and resilient actions to combat climate change". The text also emphasizes "the importance of protection, conservation, and restoration of natural resources and ecosystems to achieve the temperature goals of the Paris Agreement, including forests, and other terrestrial and marine ecosystems that act as absorbers and reservoirs of greenhouse gases, as well as protect biodiversity, and ensuring social and environmental guarantees".

Simultaneously with COP27, the 14th Conference of the Parties to the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) was held in Geneva [25], where parties noted the need to strengthen efforts to conserve wetlands for achieving the climate goals. The Parties to the Convention have decided to recognize wetlands as a potential NbS or an ecosystem approach to mitigating and adapting to climate change. The relevant resolution calls on the Parties to develop the knowledge and policies to conserve wetlands and improve their ecological condition and to the partnerships and cooperation to address issues

related to climate change as well as preserving biodiversity and benefits for human health and well-being.

In December 2022, the 15th Conference of the Parties to the Convention on Biological Diversity took place [27, 28], which approved the Global Framework Program on Biodiversity. The Framework Program established 23 objectives, for implementation of 2 of which it is proposed to use the NbS and the ecosystem approach [16]:

“Target 8. Minimize the impact of climate change and ocean acidification on biodiversity and increase its resilience through mitigation, adaptation, and disaster risk reduction actions, including through nature-based solution and/or ecosystem-based approaches, while minimizing negative and fostering positive impacts of climate action on biodiversity.”

“Target 11. Restore, maintain and enhance nature’s contributions to people, including ecosystem functions and services, such as regulation of air, water, and climate, soil health, pollination and reduction of disease risk, as well as protection from natural hazards and disasters, through nature-based solutions and/or ecosystem-based approaches for the benefit of all people and nature.”

The Parties to the Convention have also recognized the benefits of NbS, which are not only environmental but also social and economic. One of the reasons Parties to the Convention have set such targets is the understanding that more than half of the world's GDP depends on the ecosystem services provided by healthy and sustainable natural ecosystems.

Nature-based solutions are an approach that is already included in the policy documents of the European Union and relevant funding programs. In particular, the EU Biodiversity strategy for 2030 [29], the European Green Deal [30], the General Union Environment Action Programme to 2030 [31], etc., mention the need to implement NbS. The European Commission defines NbS as “solutions that are inspired and supported by nature, they are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions”. And also emphasizes that NbS must benefit biodiversity and support the delivery of a range of ecosystem services [32].

The European Union supports the development of NbS as an innovative approach, finances relevant measures, and develops policies aimed at developing science and providing evidence on the effectiveness of NbS, improving legislation, and increasing the scope of their application. Among the concepts and practices similar to NbS that can be considered for climate change adaptation are the following: ecosystem adaptation, disaster risk reduction, green-blue infrastructure, best management practices, water-sensitive urban design, sustainable urban drainage systems, and “ecological engineering”. Many analytical papers and reports have been prepared to date, designed to contribute to a better implementation of the concept of NbS in life, including in government programs and policies. For instance, Taking nature-based solutions up the policy ladder: from research to policy action [33], Evaluating the impact of nature-based solutions: a summary for policymakers [34], Nature-based solutions: State of the art in EU-funded projects [35], Nature-based solutions: Concept, opportunities and challenges [36], Powering Nature: Creating the Conditions to Enable Nature-based Solutions [37], Natural Solutions for Climate Change [38], Enhancing NDCs through nature-based solutions: 8 simple recommendations for integrating nature into NDCs [39], Nature-based solution in the Convention on biological diversity (CBD): Orientating an evolving concept towards achieving the CBD’s objectives [40], NDCs – a force for Nature? [41] and others. A lot of educational materials have also been developed on the implementation of nature-based solutions in Europe, for example, Evaluating the impact of nature-based solutions: a handbook for practitioners [42] together with the appendix of methods [43], Public procurement of nature-based solutions: addressing barriers to the procurement of urban NBS: case studies and recommendations [44], Nature hires: How Nature-based Solutions can power a green jobs recovery [45], Manual on the application of Standard for Nature-based Solutions [46] and others.

Despite the fact that there are many discussions and papers about NbS, there are a number of issues that each country should resolve independently at the policy and practical levels. One of the examples of national analytical and planning documents on the NbS implementation is the report prepared for the US National Climate Task Force Opportunities to Accelerate Nature-based Solutions: A Roadmap for Climate Progress, Thriving Nature, Equity, and Prosperity [47], which marked a change in national US climate policy. The roadmap recommends 5 priority strategic directions for federal agencies and the Office of the President for NbS potential realization. Essential that these recommendations position NbS as the most affordable way to combat climate change, nature loss, and inequality in the United States. These recommendations are addressed to federal agencies and call for updating federal laws and policies in order to facilitate the application of NbS, include them in financial support and incentive programs, implement NbS directly on the lands and through inclusion into the action plans of organizations on the federal level, advance in skills and conduct special training not only for their implementation but for the creation of better and equal working conditions and quality of life, to develop research, innovation, and knowledge to fill the gaps in the understanding of NbS and their application.

Another example of the NbS implementation in national policies is the German Federal Action Plan on Nature-Based Solutions for Climate and Biodiversity [48], which proposes 64 actions in 10 areas. The Action Plan emphasizes that only healthy and resilient ecosystems can make a long-term contribution to climate change mitigation and focuses on both traditional environmental protection measures (such as preserving peatlands, restoring the natural balance in water bodies, implementing sustainable practices in agriculture and forestry, urban greening) and cross-sectoral management measures (such as knowledge development, monitoring, and communication).

5 REVIEW OF LEGAL REGULATION IN UKRAINE'S ENVIRONMENTAL PROTECTION, WATER, FORESTRY, AND AGRICULTURAL SECTORS – PREREQUISITES FOR INTRODUCING NATURE-BASED SOLUTIONS IN POLICY AND PRACTICE

Since the declaration of independence, Ukraine has recognized that its natural resources and environmental protection issues are important priorities for the public administration [49]. Article 16 of the Constitution of Ukraine stipulates that Ukraine ensures ecological balance and environmental safety. Furthermore, Article 66 of the Constitution imposes on every citizen the obligation to preserve the environment [50]. However, in the 31st year of independence, 9 oblasts of Ukraine are under the influence of military operations. Despite this, the nature protection sphere of Ukraine is developing, and one of the promising directions of further development is integrating EU environmental legislation, particularly regarding NbS, into the national legislative framework.

"Nature-based solutions" is a relatively new concept for Ukraine, but it is already used in the scientific and environmental spheres, although it is still not mentioned in the legislation. A systematic analysis of legislative, environmental protection and other related norms (financial, budgetary, administrative and management) allows a conclusion on the existence of a legal basis in Ukraine for implementing measures that can be attributed to NbS, including the mechanisms of economic stimulation of their application. However, the legal instruments of such application are indirect norms, which differ depending on the sector and the purpose of NbS implementation.

The environmental legislation task is to regulate relations in the area of protection, use and reproduction of natural resources, ensure environmental safety, prevention and elimination the negative impact of economic and other activities on the environment, preservation of natural resources, the genetic fund of wildlife, landscapes and others natural complexes, unique territories and natural objects related to historical and cultural heritage.

The Law of Ukraine "On Environmental Protection" [51] among the main principles declared the greening of material production based on the comprehensive solutions in matters of environmental protection, use and restoration of renewable natural resources, the broad introduction of the latest technologies, and the combination of measures of stimulation and responsibility in the matter of environmental protection. An important role in the adoption of environmental management decisions is assigned to the state environmental monitoring to ensure the collection, processing, saving, and analysis of information on the current state of the environment, forecasting its changes, and developing scientifically justified recommendations for effective management decisions (Article 22). In terms of the economic mechanism of environmental protection, the Law, among other issues, regulates the functioning of Environmental Protection Funds (formed to finance environmental protection measures) [52] and incentive measures (provision of tax benefits, short-term and long-term loans at reduced rates, etc.).

The Water Code of Ukraine [53] regulates the legal relations for the conservation, scientifically justified rational use of water for the needs of the population and economic sectors, reproduction of water resources, protection of water from pollution, clogging and depletion, prevention of harmful effects of water and elimination of their consequences, improvement of the water bodies condition, as well as protection of the rights of enterprises, institutions, organizations and citizens to use water. Among the duties of water users in Art. 44, the Water Code stipulates that "water users are obliged to use water resources economically, take care of their reproduction and improve water quality". Water resources are managed according to the basin principle to achieve the ecological goals defined for each river basin area. The Code envisages tax, credit, and other benefits to water users implementing low-waste, zero-waste, energy- and resource-saving technologies and other measures that reduce the negative impact on water in accordance with the legislation (Article 29).

The Forest Code of Ukraine [54] stipulates the requirements for forestry management based on sustainable development principles, considering natural and economic conditions, intended purpose, forest growth conditions, species composition of forests, and the functions they perform. At the same time, a number of responsibilities are assigned to enterprises, institutions, organizations, and citizens, including (a) strengthening of water-protective, protective, climate regulating, sanitary and hygienic, recreative and other beneficial properties of forests; (b) non-exhaustive and rational use of forest resources; (c) reproduction of forests; (d) increasing productivity, improving the qualitative composition of forests and preserving biotic and other natural diversity in forests, etc. (Article 64). A component of forestry organization is forest management, which includes a set of measures aimed at the effective organization and scientifically justified forest management, protection, conservation, rational use of forests, increasing its ecological and resource potential, the culture of forestry management, and obtaining reliable and comprehensive information about the Forest Fund of Ukraine. The Code also establishes that the state provides economic incentives for forest reproduction measures in three ways, including (a) compensation of costs to forest owners and forest users for implementing forest reproduction and forest management measures; (b) purchase of privately owned land plots for forestry purposes; (c) application of accelerated depreciation of fixed assets for land protection, forest protection, and nature protection purposes (Article 99).

The Land Code of Ukraine [55] establishes that land ownership should not aggravate the ecological situation and natural qualities of land (Part 3 of Article 1). And among the principles of land legislation, the Code states the principles of ensuring the rational use and protection of land and the priority of environmental safety requirements. Furthermore, the tasks of land protection include ensuring the preservation and reproduction of land resources and the ecological value of natural and acquired qualities of land (Article 163). At the same time, land protection includes a number of measures that can be implemented with the help of NbS or are NbS themselves: (a) justification and ensuring the achievement of rational land use; (b) protection of agricultural lands, forest lands and shrubs from unjustified removal for other purposes; (c) land protection from erosion, mudflows, flooding, waterlogging, secondary salinization, over-drainage (dehydration), compaction, contamination; (d) preservation of natural wetlands; (e) prevention of deterioration of the aesthetic condition and ecological role of anthropogenic landscapes; (e) conservation of degraded and unproductive agricultural lands (Article 164). The land management system regulated in the Law is of great importance in the ecological aspect, among the main tasks of which are the following: (a) creation of ecologically sustainable landscapes and agrosystems; (b) information support of the economic and ecological mechanism for the regulation of land relations at the national, regional, local, and economic levels by developing proposals for establishing a special regime and conditions for land use; (c) the organization of the territories of agricultural enterprises with the creation of spatial conditions that ensure the ecological and economic optimization of the use and protection of agricultural lands, the introduction of progressive forms of land use management, improvement of the ratio and placement of land plots, the system of crop rotation, haymaking and pasture rotation; (d) development of a system of measures to preserve and improve natural landscapes, restore and increase soil fertility, reclamation of disturbed and earthing of unproductive lands, protection of lands from erosion, flooding, dehydration, landslides, secondary salinization and waterlogging, compaction, contamination by industrial waste and chemical substances and other types of degradation, conservation of degraded and unproductive lands, prevention of other negative phenomena (Article 183). Mandatory components of land management include drawing up land management projects that provide ecological and economic substantiation of crop rotations, arrangement of land plots, and the development of land protection measures (Article 184). The Land Code establishes that the state carries out economic incentives for the rational use and protection of land through (a) the provision of tax and credit benefits, (b) the allocation of funds from the state or local budget for the restoration of the previous condition of the land, (c) exemption from payment for land plots, (d) compensation from budget funds for a reduction in the income of land owners and land users due to the temporary conservation of degraded and unproductive lands (Article 205). In addition, the provision is made for the possibility of compensating agricultural and forestry production losses (Article 207). At the same time, it is

specified that compensation is subject to losses in connection with the exclusion of agricultural lands, forest lands, and shrubs from economic circulation due to the establishment of protective, sanitary zones and other protected areas.

Law of Ukraine “On the Key Principles (Strategy) of the State Environmental Policy of Ukraine until 2030” [56] contains 5 strategic goals in the context of NbS implementation. Among the tasks aimed at achieving the Strategy goals, are the following: assessment of the attitude and raising the level of awareness of society regarding the importance, benefits and tools of sustainable consumption and production, the condition and values of biodiversity and the measures that must be taken for its preservation, restoration and sustainable use; reducing the negative impact of urbanization processes on the natural environment, stopping the destruction of it within the city, in particular, preventing the unjustified destruction of green spaces in the cities during construction or other works, the illegal allocation of land plots occupied by green spaces for construction; ensuring sustainable management of water resources following the basin principle; ensuring the sustainable use and protection of land, improving the condition of affected ecosystems and promoting achievement of a neutral level of land degradation, awareness raising among the population, landowners and land users regarding the issues of land degradation; climate change prevention and adaptation; implementation of sustainable low-carbon development of all economic sectors in Ukraine; improving the quality of soils and implementing an effective system of increasing their fertility; development and improvement of environmental legislation and raising the level of compliance with it, including approximation of Ukrainian legislation to the law (acquis) of the European Union; ensuring scientific and informational, and innovative support for the process of management decision-making; provision of targeted budget financing of environmental protection measures and non-governmental investment of environmental protection projects.

One of the main documents of state planning on climate issues is the Concept of State Climate Change Policy Implementation Until 2030, approved by the Decree of the Cabinet of Ministers of Ukraine No.932-p, dated 07.12.2016 [57]. Among the ways and methods of its implementation are close to NbS concepts and related measures that can stimulate the introduction of the following solutions: increasing the volume of greenhouse gas absorption through the implementation of actions in the area of forestry and land use; creation and implementation of the internal system of trading greenhouse gas emissions quotas in accordance with the Directive 2003/87/EC [58]; introduction of market and non-market mechanisms aimed at reducing anthropogenic emissions or increasing the absorption of greenhouse gases; development and implementation of effective measures to adapt to climate change and increase resilience to climate-related risks and natural disasters, development and implementation of a mechanism for the adaptation policy based on the principle ‘from the local (regional) to the national level’, giving priority attention to the actions of those communities and sectors of the economy, which are most vulnerable to the impacts of climate change; definition and implementation of approaches and technologies that provide for balanced management of natural ecosystems; implementation of transboundary projects on adaptation to climate change together with neighboring partner countries.

The updated nationally determined contribution of Ukraine to the Paris Agreement, approved by the Decree of the Cabinet of Ministers of Ukraine No.868-p, dated 30.07.2021 [59], sets an ambitious goal – to reduce greenhouse gas emissions to the level of 65% compared to 1990 by 2030 (taking into account all sectors of the economy). At the same time, the document notes that Ukraine has already made a significant contribution to reducing global greenhouse gas emissions, and as of 2019, greenhouse gas emissions in Ukraine have decreased by 62.4% from the 1990 level, taking into account the sector "Land use, changes in land use and forestry".

Another important document of state planning on climate change is the Strategy of Environmental Safety and Adaptation to Climate Change Until 2030, approved by the Decree of the Cabinet of Ministers of Ukraine No.1363, dated 20.10.2021 [60], sets 12 strategic goals until 2030. These goals include the following related to NbS: ensuring rational use of natural resources; achieving a "good" ecological condition of waters; ensuring sustainable forest management and increasing the

ability of forest ecosystems to adapt to climate change; preservation of biodiversity; strengthening the adaptive capacity and resilience of social, economic and ecological systems to climate change; stabilization of the ecological balance on the temporarily occupied territories. Among the main tasks aimed at achieving the defined strategic goals, the following are indicated: achievement of a "good" ecological condition of the Black sea and the Sea of Azov and river basin areas; increasing the resistance of forest ecosystems to pests and new climatic conditions; reduction of clearcutting logging system in the Carpathian region; development of organic agriculture, the application of careful land cultivation practices with the preservation and increase of soil organic matter; development of action plans for adaptation to climate change in the area of water resources management (within the river basin management plan), preservation of biodiversity, forest fund, energy, public health, agriculture and soils, transport and infrastructure, tourism. Among the results expected to be achieved by 2030, the following are declared: the country's forest cover will increase to 18% through the use of state and communal lands, self-seeded forests, the restoration of forest strips, and a mechanism for stimulation of the afforestation of degraded, unproductive lands; the transition to close-to-nature forestry will be ensured, environmentally friendly logging technologies will be introduced, the resistance of forests to climate change will be increased, and the incidence of forest fires will be reduced; achieving a neutral level of land degradation, reducing the biodiversity loss, ensuring the preservation of bio- and landscape diversity, forming a coherent and representative network of environmental conservation areas, increasing the state's protected areas.

The basic sectoral document of state planning in the forest sector is the State Forest Management Strategy of Ukraine until 2035, approved by the Decree of the Cabinet of Ministers of Ukraine No.1777-p, dated 23.12.2021 [61]. The Strategy does not directly mention the NbS, but uses the wording "close to nature forestry methods", which, in fact, are one of the varieties of such solutions. The Strategy aims to ensure effective forest management based on sustainable management, preservation of biodiversity in forests, and forest management adapted to climate change. Ways to achieve strategic goals include: changing the rules of forestry activities, which are aimed at forestry methods that are close to nature and gradual refusal of clearcutting logging; reforestation due to the natural regeneration of indigenous tree species; increasing the area of forests, their sustainability and productivity, their ecological and resource potential (at the same time, it is determined that (a) "increasing the forest area will occur, in particular, through afforestation on degraded and unproductive lands of all forms of ownership with mandatory consideration of natural conditions of the site and the refusal of afforestation of unique steppe areas"; (b) "in order to increase the forests productivity and their ecological and resource potential, it is necessary to transform artificial and derivative forests of the same age into multi-aged mixed multi-tiered forests, the composition and structure of which correspond to optimal close to the natural parameters"); increasing the level of carbon absorption and retention through sustainable management of forest resources; adaptation of forests to climate change, in particular by switching to close-to-nature forestry methods with the formation of forests of natural composition and structure; protection of land, soil and water, preservation of biodiversity in forests; preservation of naturally grown forests on agricultural lands that are not cultivated and on all other categories of land, creation of productive stands with high protective properties and agroforestry; reduction of introduced species of tree and plant capable of invasion.

The basic sectoral document of state planning in the water sector is the Water Strategy of Ukraine Until 2050, approved by the Decree of the Cabinet of Ministers of Ukraine No.1134-p, dated 09.12.2022 [62]. This document clearly states that "the main cause of the negative impact on the hydrological regime of water bodies in Ukraine is unjustified, from the environmental point of view, drainage reclamation activities in the northern and central regions, cases of ecologically unjustified regulation of river flow by means of ponds and reservoirs creation, and improper agricultural and industrial production practices, the negative impact of which is significantly increased by the consequences of climate change. The vast majority of natural disasters are connected with such factors as hydrological (floods and landslides), climatic (droughts, heat waves, and extreme temperatures), and meteorological (wind storms, showers, hail). Climate change creates additional risks of long-term droughts interrupted by heavy showers, which lead to the risk of flooding. Most

climatic and meteorological natural disasters lead to the absence, insufficiency, or excessive amount of water resources". A clear formulation of the causes and consequences of anthropogenic activity and climate change for water bodies, as well as the interrelationship of the water resources condition and economic activity, in particular agriculture, public utility sector, and industry, allows for the formation of appropriate strategic goals, ways, and performance indicators. In particular, among the tasks defined for the achievement of strategic goals, there are activities that can be implemented with the help of NbS, or where the prerequisites for their implementation are created: reducing the share of arable land in the total territory of the country to 47% by 2030; review the feasibility of the drainage melioration activities and the initiation of permanent actions on water conservation in natural landscapes; restoration of the most valuable natural and minimally disturbed by anthropogenic factors complexes, in particular river basins, forests, wetlands and peatlands; reconstruction of drainage systems in the drainage-irrigation ones and improvement of the efficiency of drainage reclamation measures; penalties for violators of the coastal protective strips and water protection zones usage regime; ensuring the landmarking in nature of coastal protective strips and riparian zones, and compliance with their protection regime; ensuring restoration and proper arrangement of riparian zones, including through their planting with meadow vegetation and/or afforestation; introduction of a system of activities to prevent the erosive and hydrological processes; restoration of the hydromorphological condition of water ecosystems and floodplains within the framework of river basin management plans by reproducing the continuity of the flow, oxbow lakes and meanders, retention improvement, prevention and elimination of water bodies silting, gradual elimination of dams, ponds, service life of which has ended; inclusion of drought risk management measures for river basin areas into river basin management plans, and ensuring their further implementation; development and inclusion of climate change adaptation measures into river basin management plans, taking into account medium and long-term climate change scenarios; development of easy-to-use algorithms for calculating and justifying socio-economic feasibility (benefits) during the implementation of water policy tasks, in particular the achievement of water policy goals and quantitative assessment of the expected environmental effect from its further implementation; improvement of cooperation between the state, business and science for the introduction of innovations, enhancement of scientific research, expansion of their targeted financing and implementation of the results obtained during the implementation of this Strategy.

The mission of the National Economic Strategy Until 2030, which was approved by the Resolution of the Cabinet of Ministers of Ukraine No.179, dated 03.03.2021 [63], is the realization of the available geographical, resource, and human potential of the country to ensure the appropriate level of well-being, self-realization, security, rights and freedoms of every citizen of Ukraine through innovative and proactive economic growth, considering the Sustainable Development Goals and the need to achieve climate neutrality no later than 2060. The Strategy aims to create opportunities for Ukrainians as citizens and Ukrainians as entrepreneurs and investors. Among the benchmarks, principles, and values in economic policy are the following: (a) decarbonization of the economy (increasing energy efficiency, development of renewable energy sources, development of circular economy, and synchronization with the European Green Deal initiative); (b) European and Euro-Atlantic integration (realization of the state's strategic course for full membership of Ukraine in the EU and the North Atlantic Treaty Organization). Essential that the Strategy defines a number of those unacceptable steps and prohibited directions, which are critical obstacles to the development of the economy ("red lines"), including (a) deterioration of the environment; (b) non-fulfillment of the Association Agreement between Ukraine and the EU. Among the tasks for achieving strategic goals are those that create prerequisites for the implementation of the NbS, in particular: the introduction of economic incentives for the use and protection of land and increasing soil fertility, reducing the level of pollution of water and other environmental components from agricultural sources, improving the structure of land and the agricultural land plots of the country, the restoration of anthropogenically modified ecosystems, the introduction of sustainable land use and the achievement of a neutral level of land degradation; promotion of sustainable agricultural production, protection of the natural environment, extension of organic production methods and the use of biotechnology, "climate-smart" agriculture and forestry with reduction of greenhouse

gas emissions and adaptation to climate change, sustainable management of natural resources, preservation and increase of biodiversity; improvement of the institutional and technological capacity of environmental impact assessment and strategic environmental assessment of the introduction of state environmental regulations and environmental protection requirements into new economic activities and into state management and planning; development of Ukraine's attitude regarding participation in the European Green Deal and adaptation of state policy in accordance with it; reforming the system of calculation and distribution of rent payments, environmental tax and fines related to the violation of environmental protection legislation, in particular ensuring the direction of 100% of the income from the environmental tax and at least 15% of the income from rent payments for the use of natural resources to finance environmental protection measures and environmental projects; extension of the list of types of activities that are considered nature protection measures and can be financed from special funds of the state and local budgets; creation of an environmental fund as a separate legal entity with the involvement of additional funds for financing environmental protection measures and implementing environmental investment projects; introduction of a forestry management system based on the balanced provision of economic, ecological, and social functions by forests, taking into account the need for adaptation to climate change, preservation of biodiversity, public participation in decision-making and transparency; improvement of measures to eliminate the land degradation and desertification; identification of zones vulnerable to (accumulation of) nitrates; strengthening activities in the areas of preservation, restoration and sustainable use of peatlands, wetlands, meadows, steppes and other valuable ecosystems; ensuring the transition to the principles of ecologically balanced land use; transition to integrated management of water resources according to the basin principle; approval of the integrated plan for combating climate change and energy development until 2030.

Among other legal documents that were analyzed within the framework of the project and can be a basis for the NbS implementation or require priority improvement to ensure support for the NbS, it is worth noting the Laws of Ukraine "On Land Protection" [64], "On Land Management" [65], "On Land Reclamation" [66], "On pesticides and agrochemicals" [67], "On agricultural cooperation" [68], and "On collective agricultural enterprise" [69], "On basic principles and requirements for organic production, circulation and labeling of organic products" [70], Decree of the President of Ukraine "On Sustainable Development Goals of Ukraine until 2030", No.722/2019, dated 30.09.2019 [71], State Regional Development Strategy for 2021-2027 [72], Concept for the Implementation of State Policy to Promote the Development of Social Responsible Business until 2030 [73] and Action Plan for the implementation of this Concept [74], Concept of agroforestry development in Ukraine [75] and the Action Plan for the implementation of this Concept [76], Concept of Combating Land Degradation and Desertification [77] and National Action Plan for Combating Land Degradation and Desertification [78], Rules for development of land use planning projects [79], Land Conservation Procedure [80], Procedure (detailed rules) of Organic Production and Circulation of Organic Products [81], List of Activities Related to Environmental Protection Measures [52], Rules for Ensuring Soil Fertility and the Use of Certain Agrochemicals [82], Rules for Maintaining and Conservation of Field-Protective Forest Strips Located on Agricultural Land [83], Procedure for Maintaining an Agrotechnical Field Passport of a Land Plot [84], Procedure for Selecting Environmental Protection Measures through the Mechanism of Discounting Loans from Commercial Banks [85], Methodology of Regulatory Monetary Valuation of Land Plots [86], etc.

The analysis of the above legal norms, codes, and strategic documents showed a fragmented regulation of the possibility of implementing certain types of NbS. It indicates the need to improve the legal framework for wide implementation of NbS in environmental protection, forestry, water management, and agricultural sectors. Fixing of "nature-based solutions" definition and identification of rules or other provisions regarding their implementation is necessary to ensure sustainable post-war recovery and further development of the mentioned sectors in the conditions of climate change.

Although the legislation does not directly contain provisions regarding NbS, the List of activities related to environmental protection measures (approved by the Resolution of the Cabinet of Ministers of Ukraine No.1147, dated 17.09.1996) [52] and the Rules for development of land use planning projects (approved by the Resolution of the Cabinet of Ministers of Ukraine No.86, dated 02.02.2022) [76] listed measures that can be implemented with the help of NbS, or considered as NbS if planned and implemented in accordance with the criteria of IUCN Global Standard for NbS [8].

5.1 Prospects for nature-based solutions implementation following the List of activities related to environmental protection measures

The specified List of activities related to environmental protection measures contains 85 types grouped by topic [52].

Protection and rational use of water resources – this group of environmental protection measures includes the following types of NbS: the creation of riparian areas with a complex of agrotechnical, forest reclamation, hydrotechnical (water engineering), sanitary, and other measures aimed at preventing pollution, clogging and depletion of water resources; measures to restore and maintain a good hydrological regime and sanitary conditions of rivers, measures to combat the harmful effects of water (biological reclamation of water bodies, the landmarking of riparian zones in nature, regulation of springs).

Atmospheric air protection – this group of measures contains a list of engineering approaches only to prevent and control air pollution and does not include those aimed at improving the condition of the atmosphere through the use of "useful" features of nature. However, the development of NbS for atmospheric air protection, such as urban forests, green/blue infrastructure, protecting vegetation areas, etc., can contribute to implementing EU air quality regulations. A number of international and European documents can be supportive of developing this direction, among which are Directives 2008/50/EC on ambient air quality and cleaner air for Europe [87], A Clean Air Programme for Europe [88], the EU Biodiversity Strategy [29], Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change [89], Green Infrastructure (GI) — Enhancing Europe's Natural Capital [90], and the Sustainable Development Goals, in particular, goal 11 "Make cities and human settlements inclusive, safe, resilient and sustainable" [91]. The approved Standards for Environmental Safety of Atmospheric Air, a group of standards, the observance of which prevents the hazards to human health and the state of the natural environment from the influence of harmful factors of atmospheric air, also requires revision and inclusion of some NbS [92].

Protection and rational use of land – this group contains a number of NbS and measures that can be implemented, in particular, with the help of the soil protection systems in farming with contour and melioration arrangement of the territory; implementation of measures to regulate arable lands by excluding riparian zones, lands subject to erosion, and other unsuitable for plowing lands from the pattern; reproduction of forests, creation of new and restoration of existing field protection forest strips and other protective plantations on degraded, low-yielding and erosive lands, and along surface water bodies; conservation of degraded, low-yielding and industrially contaminated lands; improvement of low-yielding land; restoration of steppe, meadow, wetland and other anthropogenically modified natural landscapes, creation, and restoration of hayfields and pastures. It also presents types of activities that can harm natural ecosystems, thus, should be removed from the list of environmental protection measures. For example, the filling and laying of ravines and gullies with drainage arrangements should be excluded if such actions are not related to counteracting the latest erosion processes.

Protection and rational use of mineral resources involve implementing environmentally safe technologies for extraction and preventing the loss of mineral resource reserves. This section does not currently contain environmental protection measures that could qualify as NbS. At the same time, the World Bank report indicates the possibility of NbS implementation in the extraction industry [93]. The extractive companies (based on the business reasoning for the existing

landscape) can help overcome the financing gap through investments in large-scale NbS, which can contribute to increased business sustainability and the fulfillment of obligations regarding the closure of mines and pits, reclamation of quarries and excavation dumps. For example, Art. 50 of the Subsoil Code provides for the reclamation of damaged lands and ecosystems [94]. Therefore, it is necessary to create conditions and strengthen the mechanisms for stimulating NbS use in the mining industry, which affects landscapes, water, land, and other natural resources.

Protection and rational use of natural plant resources section includes a small list of measures that can be implemented with the help of NbS, namely prevention and response to the forest, steppe, and peatland fires and liquidation of their consequences; measures to prevent the introduction and spread of invasive (alien) plant species that threaten natural ecosystems; and measures for the urban greening. At the same time, this section can be expanded by such measures as the restoration of the natural vegetation on swamps or the creation of paludiculture on exhausted or disturbed peatlands; the implementation of various measures to preserve and restore biodiversity on agricultural land; the restoration of natural vegetation for improving the carbon absorption by soils; the creation of green spaces in urban settlements, etc.

Protection and rational use of wildlife resources section currently contains only one measure that can qualify as NbS if it is planned and implemented per the IUCN standard criteria: construction, widening, and reconstruction of fish channels. The expansion of this section and the inclusion of the NbS in it requires a separate scientific justification and agreement; however, it should undoubtedly contain measures to restore natural territories essential for the reproduction of hunting and other wild animal species, restoration of the rivers' capacity for the reproduction of fish stocks, preservation, and creation of feeding areas for migratory birds, etc.

Preservation of the natural reserve fund (NRF). It is worth noting that the conservation of valuable natural territories, their protection from anthropogenic impact, and the creation of areas and objects of the NRF are not NbS by themselves. However, activities within the NRF aimed at simultaneously preserving biodiversity and taking advantage of the various opportunities for its sustainable use, particularly for recreational needs, secondary use of non-timber forest products, or other ecosystem services, can be interpreted as NbS. Also, this section can be supplemented with a range of measures to adapt protected ecosystems to climate change.

Rational use and storage of industrial and household waste section is focused on "grey" infrastructure and needs to be expanded to use nature's properties for waste disposal. Composting organic residues or using bioplateau for post-treatment of wastewater from small wastewater treatment plants can be examples of NbS in this section. Complex systems used for solid and liquid waste management and treatment may not always be available, mainly due to high costs and sophisticated technology. Interest in the development of alternative NbS in this field is growing all over the world. The most crucial task is implementing systems with equivalent performance but less cost and high benefit to nature.

Nuclear and radiological safety measures involve developing and implementing state targets and regional environmental programs of priority measures to protect the population from radiation pollution. At first glance, there is no place for NbS here, but it is worth following global trends and developments. In addition, the nuclear sphere requires significant volumes of water resources, which are not always in abundance, and which can be preserved or increased, including with the help of NbS.

Science, information and education, personnel training, environmental impact assessment, strategic environmental assessment, labor organization, ensuring participation in the activities of international environmental protection organizations, and implementing an economic mechanism for environmental protection measures allow the dissemination of knowledge and indicate the possibility of NbS implementation during the state target and regional environmental programs development, environmental impact assessment and strategic environmental assessment, development of environmental standards and regulations. In addition, the section provides opportunities for training, professional development, knowledge exchange, and international activities, which can also contribute to NbS implementation in national policy and practice.

5.2 Prospects for nature-based solutions implementation following the Rules for development of land use planning projects

The Rules for development of land use planning projects determine the possibility of designing and fixing in land documentation design decisions for a set of measures as well as the scope of works for land protection, reclamation of disturbed land, conservation, improvement of the condition of agricultural and forest land, protection of land from erosion, flooding, waterlogging, secondary salting, dehydration, landslides, compaction, acidification, contamination by industrial and other waste, radioactive and chemical substances [79]. Among the mentioned in the Rules measures, which can be attributed to NbS, the following are indicated: renaturalization of lands by restoring peatlands, wetlands, meadows, steppes, and other valuable natural ecosystems, creation of the nature reserve fund areas, afforestation and planting with meadow vegetation of lands removed from the agricultural designation, renaturalization and rehabilitation by converting arable land into fallow, hayfields, and pastures. Thus, the following measures can be foreseen in the land management detail design to improve the condition of low-yielding agricultural and forest lands: cultivating green manure; improvement of hayfields and pastures; introducing the plowless soil tillage; earthing and slitting of arable land, hayfields, pastures. In addition, design tasks for planning the soil protection from water and wind erosion and crops from adverse climatic factors can include measures to create an integrated system of forest and field protection strips; forest strips along irrigation and discharge channels; flow-regulating forest strips; protective forest strips in gardens, vineyards, and berry orchards; forest strips around bams and ravines; water protective forest plantations along rivers and around reservoirs; strip, clumping and massif plantations in mountainous areas; forest strips on drained lands; plantations in ravines and steep slopes on rocky soil; belt, clumping, and massif forest plantations on the sands; protective and decorative plantings in rural settlements, around farms and production centers; plantations on reclaimed areas.

5.3 Funding opportunities for nature-based solutions implementation according to the law

Now businesses and authorities do not pay enough attention to environmental protection measures required by national legislation. The reason is the lack of knowledge about their benefits for the economy, well-being, and health of people, especially in preventing costs for liquidation of the consequences of natural disasters, as well as the lack of the opportunity to receive appropriate funding. At the same time, the planning of NbS activities following the abovementioned criteria shows economic and social benefits and stimulates the attraction and allocation of funding for their implementation.

The analysis of the legislation indicates the possibility of financing NbS as environmental protection measures from the general fund of the state and local budgets, special funds of the state and local environmental protection fund, and international technical aid, including from the funds of enterprises-polluters of the environment. Implementing environmental protection measures through the NbS activates the attraction of funds both from polluters and those who desire to independently improve their living conditions, volunteers, activists, and communities.

The State Environmental Protection Fund (hereinafter – the Fund) is a component of the State Budget of Ukraine [95]. Financial resources of the Fund are directed based on the budget programs in accordance with the environmental protection and resource-saving plans and estimates approved by the leading managers of budget funds (hereinafter – the leading managers) following the procedure established by law. The order for planning and financing environmental protection measures is approved by the Order of the Ministry of Environment No.194, dated 12.06.2015 [96]. The environmental protection measure is considered and included in the plan upon the customer's request "for the allocation of funds according to the budget program" submitted to the Ministry of Environment Protection and Natural Resources. According to the Order, the customer of the environmental protection measure can be a legal entity of all forms of ownership. The following are attached to the request: a cost estimate for the environmental protection measure implementation; an environmental conclusion of its feasibility, issued by the structural unit for environmental protection of regional state administrations and Kyiv city state

administration (except for enterprises, institutions, or organizations belonging to the MinEnv management sphere). The responsible executors select environmental protection measures based on the information specified in the requests and documents according to the following criteria: compliance with the general purpose, budget program tasks, and areas of activity that ensure the implementation of the program; readiness of the environmental protection measure at the time of request submission; environmental protection effect; economic efficiency (payback period); availability of own funds as a source of financing; availability of guaranteed financing from other sources; the term of implementation. The adequately developed environmental protection plans are approved by the Minister of Environmental Protection and Natural Resources with the approval of the Ministry of Finance.

The Law of Ukraine "On State Aid to Business Entities" [97] provides for the possibility of receiving aid in the event of compliance with the criteria for assessing the admissibility of state aid to economic entities for the environmental protection [98] and financing of any actions aimed at eliminating or preventing damage to the environment or natural resources as a result of the aid recipient activities, reducing the risk damages, and effective use of natural resources.

The procedure for selecting environmental protection measures through the mechanism of discounting loans of commercial banks provides the possibility of obtaining reimbursement of funds taken as a loan for implementing an environmental protection measure. During the competitive selection, legal entities that plan to implement environmental protection measures and have the best indicators according to the following criteria will be recognized as winners: compliance of such measures with the list of activities related to environmental protection; compliance with the general purpose and tasks in the field of environmental protection; the scale of environmental impact; environmental protection effect; readiness of the environmental protection measure at the time of request submission; availability of resource and energy saving indicators; the timeframe for the implementation; payback period; completeness of payment for environmental pollution by enterprises (institutions, organizations), where environmental protection measures are planned [85].

Planning and financing of environmental protection measures and NbS implementation at the level of the local budget is possible based on approved local action plans for environmental protection. For example, these plans are prepared according to Methodical recommendations for the development, agreement, and approval of Local Action Plans for Environmental Protection (LAPEP) [99]. The experience of implementing similar plans in a number of Central and Eastern European countries and the USA demonstrates their effectiveness as a tool that allows for environmental planning at the local level with the participation of the public, local authorities, and specialists. The preparation method of LAPEP, problems identification and ranking, search and evaluation of possible solutions, is generally consistent with the approaches outlined in the IUCN Standard for Nature-Based Solutions [8].

5.4 Restoration of land and natural resources in the post-war period through the implementation of nature-based solutions

Following the procedures and methods of calculating the damage caused by war to the environment [100-106], the cost of restoration measures, which may also include NbS, should be included in the damage cost. Recovery polygons (zones) in accordance with the Law of Ukraine "On the State Regional Policy Principles" are micro-regions and territorial communities where hostilities took place, and/or which were temporarily occupied, and/or the territories suffered the destruction of critical infrastructure, social infrastructure, and residential properties, as well as those characterized by a rapid deterioration in the level of socio-economic development and a significant movement of the population to other regions and/or other states [107].

The procedure for developing, conducting public discussion, and approving programs for the comprehensive restoration of the region, the territorial community (or its part), and making changes to them, approved by Resolution No.1159 of the Cabinet of Ministers of Ukraine, dated 14.10.2022 [108], assumes that the Program for the Comprehensive Restoration of the

Region/Community (or its parts) includes sections on “restoration of the natural environment, preservation and development of nature-protected territories and objects” and “general approaches and proposals for comprehensive restoration and development of the territory of the territorial community (its parts) and measures for their implementation and prioritization, considering norms and regulations on spatial planning and land use, protection of the natural environment and natural resources, providing the population with facilities and their services, cultural heritage protection, and transport and engineering infrastructure development, etc.” These provisions create a basis for appropriate planning of measures considering their environmental and economic feasibility.

Thus, NbS for Ukraine in the post-war period can help solve the problems of restoring the lands and natural complexes disturbed and contaminated by the war. And although NbS implementation requires certain efforts and joint actions from the community within the framework of all applicable norms, it is the tool that will help to find the only correct solution for further sustainable development, allow to change approaches to decision-making that have an impact on the environment to ecologically safe and focused on the balanced coexistence of man and nature.

6 UNDERSTANDING NATURE-BASED SOLUTIONS AT THE COMMUNITY LEVEL

6.1 Summarized results of interviews with representatives of local and regional authorities and business

Acceptance of the new state policy on adaptation to climate change with the help of NbS and their practical implementation depends, first of all, on the perception of these ideas at the level of local communities, the awareness level of decision-making responsible at the local level, and the understanding of NbS benefits for the community. Therefore, given the novelty of the NbS concept for Ukraine and to understand the issue of their implementation at the local level, and to ensure the preparation of correct recommendations, specialists from the Ukrainian Public Data Center conducted a series of semi-structured interviews within the framework of the INSURE project in October-November 2021. Representatives of state and local authorities in forestry, water and agriculture, business, and farmers in Lviv, Odesa, Rivne, and Vinnytsia regions were invited for interviews. These regions represent different natural and climatic zones with different levels of climate change impact, water security, and agricultural traditions. However, the respondents' responses did not demonstrate the expected difference in views caused by natural or cultural regional differences. Instead, they showed the difference in the experience of participation in environmental protection projects and similar interviews, the level of the position held, or belonging to business structures.

Environmental issues are important, but their solution is possible only after solving the economic ones. The respondents put the resolution of the economic problems of the state, people, or businesses in the first place, and only after that see it possible to tackle the challenges related to the environmental situation. A significant part of respondents does not connect ecology and economy. In general, it can be safely asserted that such a perception is dominant among the vast majority of representatives of the United Territorial Communities (UTC) and authorities.

Landfills, rivers drying up, and monoculture are the top three environmental problems. Thus, the respondents most often noted the problem with waste disposal and landfills, which increase over time and occupy new areas, as well as the issue of their impact on pollution and the condition of water resources. This further affects the quality of human life and agriculture. In addition, the respondents noted the problems associated with rivers that are polluted, silted up, drying up, and disappearing, further affecting the ecosystem and land management at the same high level of threats. As a result, water shortages and accompanying droughts have been noted, undermining traditional agricultural crop yield, causing the latter to change to less demanding ones. Respondents also indicated that cultivation of the same super-profitable crops in monoculture also causes environmental problems related to water and soil conditions. Among the other major environmental issues, especially noticeable at the local level, the following were also voiced: the prevalence of the harmful practice of burning plant residues (stubble) in the fields, the poor condition of forest strips, and the difficulty of identifying those responsible for their care, deforestation and forest drying, the appearance of new pests in the fields, the use of uncertified pesticides and fertilizers, which can be a threat not only to the environment and economic activity but also to human health.

Water-related problems are the most anticipated environmental problems. Regardless of the industry in which they work, the interviewees mostly pay attention to the fact that the most significant environmental problem in the future will be the lack of water, its pollution, and the struggle for water resources. The respondents note that water is necessary for any industry and all Ukrainians, so the greatest interest is expected in the issue of water resources. As a result, the polemic on the NbS implementation can be started by discussing ways to solve problems related to water resources and water ecosystems.

Climate change does not depend on ordinary people. Among the respondents, there is a widespread opinion that individuals have almost no influence on climate change and that climate change results from the activities of big business, not small entrepreneurship and individual

people. It follows from the answers that, in the opinion of the interviewees, the climate exists by itself. However, the global anthropogenic factor is not excluded, but it is not dominant, as the respondents do not transfer responsibility for climate change to themselves, their activities, and other "ordinary" people.

The cause of climate change is industrial activity, ozone holes, and deforestation. Most respondents noted that the main reason for climate change is industrial activity, which emits greenhouse gases. Ozone holes are in second place of "culprits" among the answers. The destruction of forests – the planet's lungs – takes third place. Even the respondents whose activities are related to environmental protection issues are mostly aware of climate change issues mainly thanks to the information disseminated through the mass media, which indicates possible effective ways of popularizing information about NbS.

The rise in temperature affects the agricultural sector. All interviewed farmers and agro-entrepreneurs noted the change in the temperature regime as the main problem associated with climate change. They often face this consequence of climate change, try to adapt to its impact, and introduce new technologies into their activities while not excluding the NbS introduction in the future. They also note the importance of water resources and their interrelationship with the temperature regime.

The Kyoto Protocol and the Forest, Water, and Land Codes of Ukraine. Among the documents related to climate change, respondents mentioned only the Kyoto Protocol. The Water, Forest, and Land Codes are among the most known by the respondents national legislative documents. The interviewees remarked that these documents contain relevant provisions on climate change while noting a lack of awareness and the need for adequate information.

The new law on NbS will not have an effect due to the generally low compliance with the environmental protection legislation requirements. The respondents noted the legislation's importance but the usual practice of its non-implementation. Representatives of local authorities do not see a need for new legislation and note that various resolutions, instructions, and orders exist in respective fields. The new law on NbS in a situation of general non-implementation of legislation will not bring improvement. Thus, it was proposed to ensure the implementation of already adopted laws. At the same time, the respondents shift the responsibility for this to the higher level of state management. Among the possible ways of ensuring the implementation of environmental legislation at the local level, suggestions were made regarding introducing authorized representatives or creating environmental services that would deal with local environmental problems in each regional area/region/community. Entrepreneurs noted that it is important that the new legislation does not distract them from their work, including by requiring the implementation of the NBS or other environmental initiatives they are already ready to implement.

The need for NbS concept definition. The respondents noted an issue the lack of a common definition of NbS. Even those who practice NbS in one form or another could not fully formulate an appropriate definition. It was observed that during the conversation, the interviewees were discussing or deliberately confusing the NbS with environmental protection initiatives and measures. The NbS interpretation resulted more from specific examples and experience of NbS usage in practice. Respondents perceive NbS as something fragmented and directed at specific good ideas and actions but did not demonstrate a holistic picture and understanding that such solutions are essential and capable of mitigating the impact or adapting to climate change.

The NbS topic is at an early stage of understanding and is not on the current agenda of farmers and business people. Farmers or agro-entrepreneurs do not associate NbS with opportunities to solve their problems. They cannot reflect on how NbS applies to them personally or how they, as a business, are related to NbS. It is easier for them to talk about this topic at the macro level – the level of the state, or even more broadly – the planet.

The need for verified information that can be found on the Internet. Respondents noted that they most often look for the necessary information on the Internet in case of need. Therefore, it would be most convenient for them to go to the official website with up-to-date, verified information for

Ukraine. In particular, information on monitoring data on climate change and its impact on Ukraine by region, problems arising in connection with climate change, possible solutions, including NbS, verified information on their effectiveness, etc., is desirable.

An information website is essential; its presence is necessary for modern communication and access to data. The interviewees expressed a desire to create an information website with examples of NbS implementation in various regions of Ukraine and other countries similar to Ukraine in terms of natural conditions. In addition, it would be helpful if it would be possible to enter questions and receive answers (how it was before and what happened now), what to focus on, with what to compare own problems, etc.

There is a need for honest reviews of new technologies. Farmers and agro-entrepreneurs noted the need for relevant information, as it is difficult to find. In addition, there is no understanding of whether the new technology will work or whether it is an advertising stunt that will not be effective. In this section, the topic of certification of new technologies or practices was raised indirectly. It is important to demonstrate what is real and what is not when promoting NbS; what should be introduced, and what contradicts or is not supported by the current norms.

The step-by-step system of NbS implementation is important for the respondents. A problem that respondents often faced was that they saw many good initiatives that were started but did not come to a successful conclusion. The participants understand that solving environmental issues can have a long-term perspective but would like to see changes at each stage. Such information may be disseminated through seminars, reports, or other means. New initiatives must be divided into steps, each with an actual result that would be appropriately covered.

The success of the region is important for residents. As the discussion deepened into environmental issues, respondents wanted to show what they could be proud of in the region. Even if the respondents were unaware of the NbS, they still wanted to praise their region and celebrate its successes in environmental issues. The presence of well-known nature conservation areas in the region, such as nature reserves, was noted as a huge success.

Communities want more land rights or influence over land use. In particular, the respondents gave examples of when the land remains in the forestry department and not in the communities. Each of them may have different goals, which are sometimes not aligned with the needs of the residents. The respondents would like to understand in more detail the algorithm of actions in the event of a desire to implement the NbS for the community's needs.

Cooperation between regions is at a very low level or absent at all. Survey participants drew attention to the fact that the state structure is currently built so that there is no communication between adjacent areas. At the same time, their problems and solutions may be correlated with each other.

A clear division of responsibilities and powers is needed. Respondents noted that after the creation of amalgamated territorial communities, the division of responsibilities remains unclear: who is responsible for what at the local level? Who can or should implement NbS, care for, maintain, and monitor its effectiveness? For example, suppose there is an initiative; it cannot always be implemented due to a lack of understanding of which body or organization is authorized to make the relevant decision.

State leadership. Respondents asked the reverse question, and one of the most frequent is which Ministry should be responsible for the NbS? They expressed their desire to place the responsibility for the NbS implementation on a specific state authority.

The need for access to financial resources. Most interviewees noted that the implementation of the NbS, like other reforms and innovative ideas, depends on available funds on the ground and financial support from the state. The respondents expressed their expectation of implementing programs and concepts, particularly the NbS, only if appropriate funding exists.

6.2 Summarized results of the survey of local communities representatives within the framework of the small grants program

As part of the small grants program, a questionnaire of representatives of local communities from the Rivne, Lviv, and Odesa regions, who were involved in the implementation of small projects, was conducted in October 2022 to determine their understanding of climate change and NbS.

The vast majority of respondents state that the weather in their area is changing and that they have heard about climate change. However, only a few people can confidently point to the main cause of climate change, although most still attribute it to human activity. Therefore, it is worth raising awareness about the main causes of climate change.

Women more often indicated that they feel the effects of climate change through health, and men – through the impact on their field of activity.

The majority (70%) of respondents indicate that climate change is important or very important to them. 60% indicate that they have experienced its effects personally through health impacts, availability of water resources, droughts, or reduced yields. Most also believe that climate change can be influenced and are ready to act. The willingness of people to take responsibility and the emphasis on the local consequences of climate change can be used as a resource in working with the community.

Most of the respondents have heard about nature-based solutions but still have problems defining what is and what is not such a solution. Therefore, more educational actions are needed in this direction. Similarly, more needs to be said about the benefits of such solutions as restoring or preserving swamps, peatlands, and other wetlands, demolishing dams, and outdated hydrotechnical structures. The benefits of agro-nature-based solutions (crop rotation, reduction of synthetic fertilizers) are better understood among respondents, as evidenced by a higher assessment of their potential.

Respondents are ready to implement solutions in their community but lack state or financial support and knowledge. However, checking the statements shows that the respondents still place greater responsibility for mitigating the impact of climate change and adapting to it, including through NbS, on the government, significantly less on the industry, and the least on communities. Therefore, it is necessary to raise communities' awareness about the role of industry and other sectors of economic activity in the problem of climate change and the possibilities and ways for communities to solve the issue of adaptation to climate change at the local level.

7 INTEGRATION OF NATURE-BASED SOLUTIONS INTO POLICY: LESSONS LEARNED FROM THE EXPERIENCE OF THE EUROPEAN UNION, THE UNITED KINGDOM, GERMANY, SWITZERLAND, AND THE USA

Along the way of formulating the definition, analyzing its essence, and the history of the inclusion of NbS in EU policies and the legislation of individual countries, many lessons have been learned that can help Ukraine build a strategy for developing NbS policies and legislation. As part of the INSURE project, this analysis was prepared by Rolf Hogan, an expert of Earthmind⁴, based on the results of original interviews with politicians and activists involved in the relevant processes in the EU, the United Kingdom, Germany, Switzerland, and the USA. Below is a summary of the main responses of the interview participants.

Harmonization of terminology and standards. Participants noted the need to agree on definitions and standards for NbS at the global level. This is especially important for increasing the confidence of private sector representatives and investors in broader involvement in projects using NbS. For example, it was noted that without a clear definition of the concept of "NbS", the latter could be perceived as receiving the maximum benefit from nature. As a result, this will lead not to strengthening natural systems but to their exhaustion and degradation. Furthermore, a project that involves the use of NbS, but is poorly managed, can also cause negative consequences, for example, the outflow of people from rural areas or the use of non-native species during the NbS implementation. Accordingly, it is extremely important to communicate the NbS definition and its implementation goals.

Coordination of the objectives of NbS implementation and the objectives of national policies. Most participants emphasized the need to align the objectives of the NbS implementation with national policies and goals. It is important to demonstrate how they can contribute to achieving state priorities and use scientific evidence as an additional argument. The participants cited as an example the Climate Action Plan of Germany for natural climate protection, where investments in NbS are considered the third essential element after ensuring energy efficiency and the use of renewable energy sources. NbS can be promoted as a simple carbon sequestration solution that provides a good economic model, the savings from which can be compared to the effectiveness of other approaches to combat climate change and provides other positive aspects for the conservation and sustainable use of nature. Another example is the National flood and coastal erosion risk management strategy for England [111], which provides for applying NbS alongside infrastructure development issues. The Strategy was developed to deal with the severe flooding in the UK over the past 15 years, and NbS was proposed as a way to achieve the Strategy's objectives. At the same time, the proposed NbS is based on the analysis of practical cases and scientific evidence provided by state agencies and non-governmental organizations.

Respondents also pointed out that it is necessary to talk about private sector investment in NbS to achieve the government's goals in the climate and biodiversity area, where public funding is often insufficient. The private sector can invest considerable funds, but the government must establish effective policies, safeguards, and incentives.

Some participants pointed to the need for more effective involvement of landowners, while others emphasized the need to have clearly developed policies to enable farmers to make the long-term commitments required for NbS. At the same time, NbS application in agriculture was identified as a serious challenge due to the reluctance of farmers to abandon traditional approaches of "maximum" production. However, the EU's new approaches to promoting the use of NbS and improving the environment in the agriculture and land-use sectors are consistent with changing approaches to compensation payments to farmers under the EU's Common Agricultural Policy and the Environmental Land Management Scheme.

⁴ <https://earthmind.org/>

Holistic solutions and benefits. Respondents emphasized that coverage of a wide range of economic issues is highly desirable from the point of NbS implementation, as well as for aligning these decisions with national policy. NbS focusing on one specific goal can contribute to several national goals, so it is important to ensure cross-sectoral cooperation to demonstrate benefits. For example, the United Kingdom's Nature for Climate Peatland Grant Scheme [109] primarily concerns carbon sequestration, but the implemented measures also provide additional benefits, including flood prevention and improved air quality. Often, NbS projects can use funding from one area, such as the UK's Net Zero Strategy: Build Back Greener [110], but at the same time have a positive impact in other areas, such as improving water quality.

Policymakers focusing on specific goals often fail to consider the broader social and environmental benefits. National governments can achieve more effective results with a holistic approach. However, governments often have administrative constraints and separate operation processes that shape project-related policies and funding criteria. Different authorities may also lack understanding of the full range of issues and benefits associated with NbS, or officers may have time and resource constraints. Interviewees recommended bringing together representatives of different government sectors to discuss solutions to common problems. As one respondent noted, "it is necessary to have a discussion", and changing the mindset takes a lot of time. Collaboration between biodiversity experts and climate modelers was given as an example, leading to a better understanding of how biota can contribute to the mitigation of climate change impact or adaptation to the climate change effects.

Remember the need for stakeholders engagement. A critical aspect of the successful implementation of NbS is the engagement of all stakeholders. As one of the participants noted: "at the government level, we talk a lot about what we want to get from land management, but we don't talk about it with land owners." Changing farming practices is challenging, and it was noted that this is not only an economic issue but also a cultural one. Despite the economic incentives available, farmers often say they grow food crops and are unwilling to convert to other land use types. Such situations can occur even in those territories that are practically not used in agriculture. Often, national governments do not realize the importance of involving farmers in dialogues.

Awareness of NbS limitations. It was noted at the forums that there is a need to realize the limitations of NbS implementation opportunities. Often, such solutions are considered a panacea in solving the problem, but this is not always the case. For example, there is evidence that NbS can be effective in mitigating the effects of small floods in small river basins, but when it comes to their effectiveness in preventing the negative consequences of floods in large river basins, the question remains open and requires scientific study and justification. And while scientists try to solve these scientific gaps, it is necessary to be very careful in applying untested solutions.

Establishing effective partnerships at an early stage of NbS implementation. Many respondents emphasized the importance of building effective partnerships to promote NbS and cited examples of broad coalitions being formed to join efforts in the fight against climate change. Employees of state institutions emphasized the important role of non-governmental organizations in providing pressure for action and evidence of the effectiveness of NbS; instead, representatives of non-governmental organizations stressed that it is crucial for them to work with "educated civil servants" who understand the advantages of such approaches.

It has been suggested that an advocacy campaign on NbS should begin with a stakeholder analysis to identify key individuals and organizations that can guide and support work in this area from the outset. The findings of such a group can then be presented to the government and other stakeholders in financial institutions and the private sector who may be interested and provide funding support. Creating such partnerships early in advocacy campaigns is considered the key to success.

Capacity building of authorities. Representatives of state authorities often lack the understanding and personnel to work with NbS. Participants noted the importance of investing in seminars and other educational activities to educate government organizations. For example, in the United Kingdom, organizations working to attract private investment in projects where NbS are used have held a number of informational and educational seminars to raise awareness and improve information dissemination among employees of government bodies and institutions, which contributed to increasing support for the development of relevant policies. They talked about the possibilities of private financing of NbS, the obstacles to investment, the incentive policies necessary to attract investments, etc. It was about the policy of "bottom-up" support for developing projects suitable for investment, as well as "top-down" state financing to reduce risks for investors.

Implementation examples and scientific evidence of performance. All the participants who were interviewed noted the importance of data, evidence, and performance analysis of the NbS implementation. It was pointed out that there might be difficulties with the presentation of such projects compared with "traditional" infrastructural ones, for example, the use of dams for flood control and not the use of appropriate NbS. And there is an explanation for this: in the case of technical infrastructure, engineers can build models to demonstrate the likely impact, but in the case of NbS, it is more challenging to do this since such decisions can use different approaches and depend on many (natural) factors. And accordingly, it is much more difficult to model their impacts. But the solution to this problem is possible. For example, in the United Kingdom, in the process of development of the National flood and coastal erosion risk management strategy for England [111], a number of practical approaches were prescribed to demonstrate the effects of projects using NbS to reduce floods and to present such results to engineers. There was also a presentation of the evidence base, for example, emphasizing the benefits of NbS: comparing cities that have already experienced the cooling effect of nearby tree plantations with cities in a similar area where there are no such plantations.

Proposals for promoting NbS in Ukraine in the context of joining the EU. Given the size of the agricultural sector, Ukraine's accession to the EU will be difficult for the EU's Common Agricultural Policy [112]. However, given the large area of agricultural land, Ukraine has significant carbon sequestration potential through improved agricultural practices and forest restoration/maintenance. Is it possible to envisage a "partnership to achieve the goals of 1.5 degrees" between the EU and Ukraine? Will carbon sequestration in Ukraine help EU countries achieve their goals in the fight against climate change?

8 ORGANIZATION AND RESULTS OF THE NATIONAL POLYLOGUE "THE PLACE OF NATURE IN UKRAINE'S ADAPTATION TO CLIMATE CHANGE"

8.1 Discussion of problems in the water, forestry, and agricultural sectors caused by climate change and the search for solutions

During the online meeting within the framework of the National Polylogue "The Place of Nature in Ukraine's Adaptation to Climate Change", which took place on December 1-2, 2021, about 150 representatives of authorities, science, business, and the public discussed the problems caused by climate change in the water, forest and agricultural sectors of Ukraine, as well as possible solutions by which people and nature can adapt to it. Before the meeting, the participants were provided with basic information about the manifestations of climate change in Ukraine, and the possible impact on the water, forest, and agricultural sectors, prepared by INSURE project experts Svitlana Krakovska and Lidia Kryshchuk (Annex 2 and 3), and the IUCN Standard on NbS. For a fruitful discussion, the meeting participants were divided into working groups, formed based on participants' previous applications and taking into account their professional interests.

The group that considered the issues of the water sector and adaptation to climate change highlighted several clusters of problems: a water level change, in particular a rise in the sea level, will lead to the flooding of adjacent territories, an increase in river flow in some regions in certain periods of the year. For example, in Zakarpattia and Polissia, it will cause sudden and catastrophic floods; sudden heavy rains or their long-term absence will lead to deterioration of water quality, eutrophication and silting of rivers, as well as an increase in catastrophic events of the negative impact of water; the water resources issues will affect the urban infrastructure and may cause the degradation of water bodies within settlements, problems with wastewater treatment plants, water supply and water security, flooding of cultural and tourist monuments. The following significant impact of the climatic situation on aquatic ecosystems and biodiversity is expected: the disappearance of many species of aquatic inhabitants, degradation of wetland ecosystems, latitudinal migrations of biota, and the spread of invasive species. The state of water resources will reflect on the country's economy, particularly water-dependent areas of economic activity, such as energy and agriculture.

The "Water" group proposed a number of various solutions, among which there are both highly specialized and suitable for solving several problems from different clusters. For example, the following solutions were noted in this regard: the need to improve and develop legislation, conduct regular assessments of risks and vulnerability to climate change, make strategic decisions taking into account the climate change impact on the water sector, model the climate change impact at the level of water management areas, ensure that the interests of communities and international trends are taken into account. Compliance with the norms of existing legislation and conducting a reasonable environmental protection fiscal policy are the essential components for solving urgent problems. One of the proposed approaches was measures to increase the reuse and recycling of water by enterprises, limiting groundwater use (in particular, by large facilities), construction and reconstruction of treatment facilities, treatment of all discharges, restriction (up to a complete ban) of phosphates use by households, development of engineering networks, modernization, and adaptation to new climatic realities of land reclamation systems, construction of protective reinforcement to prevent the possible increase in the water level of reservoirs and watercourses (where it is predicted). At the same time, the proposed NbS are related to the revitalization of water ecosystems, dismantling of dams, restoration of the water content of rivers and their headwaters and sources, and restoration of the natural structure of coastal protection strips. Furthermore, it is important to consider the regional needs that arise with climate change, install or create water pressure and regulating tanks, update the warning system, and construct or reconstruct water supply and drainage facilities. According to the participants of the seminar, the implementation of such nature-based solutions as afforestation and planting of coastal protective strips, stopping their plowing, restoration of wetlands, in particular, peatlands, revitalization of the entire river, rather

than individual sections, development, and usage of modern techniques for moisture maintaining and underground water reserves replenishment will prevent the deterioration of water quality and contribute to adaptation to climate change.

The group that considered the issue of the forest sector noted the key factors of climatic influence that can cause the deterioration of forest ecosystems and will affect the forest sector as a whole: average temperature, extreme heat, redistribution of precipitation, aridity, droughts, the amount of atmospheric CO₂ in the surface layer. The shifting of natural zones will lead to a change in forest climatic conditions to non-forest ones. The current climate is changing faster than the cycle of forest rotation, which means that modern newly established forests will mature in other climatic conditions, leading to fragmentation and the disappearance of less mobile species of flora and fauna. Other critical environmental consequences include forest degradation, reduced boreal and humid forest types areas, and the disappearance of associated biodiversity. A change in the species composition of forests will also lead to adverse economic and social consequences. Under such conditions, the role of forests in greenhouse gas emissions is likely to increase. No less important is the preservation of self-seeded forests, the uprooting of which causes emissions of greenhouse gases, as well as protective forests (field protection forest strips), which are closely related to the agricultural sector.

The main approaches to preventing the harmful impact of climate change were determined based on the review of possible solutions for adaptation to climate change in forestry. In particular, to increase the resilience of forest ecosystems, forestry enterprises are proposed to introduce the cultivation of resistant species and plantations with an appropriate forest protection system, which should be scientifically justified with further integration into legislative documents. Close-to-nature forestry with the restoration of the complex natural structure of forest ecosystems, environmentally safe technologies and a landscape approach in land use is another promising measure. It is also important to carry out forest inventory and monitoring. To improve forest growth conditions, it is proposed to apply forestry management according to the catchment principle, taking into account the forest typological bases, to plan the comprehensive restoration of forest landscapes, and, accordingly, to prevent negative changes in the hydrological regime of the territories. At the stage of reforestation, it is emphasized the need to abandon monocultures and give priority to the creation of mixed forest plantations corresponding to forest growth conditions. It was also noted the need to increase the green areas in settlements and formulate recommendations for their care considering urbanization rates. To preserve biodiversity, the group members identified the most urgent need for limited and controlled use of non-native (alien, introduced) species and the prohibition of invasive species for forest reproduction, as well as an increase in the area and the number of nature conservation areas. Solving economic problems with the help of NbS is possible due to the development of a system of payment for forest ecosystem services (for example, in the framework of carbon management or the use of non-timber forest products), the introduction of benefits for forestry enterprises, and incentives for private owners to carry out afforestation. Increasing wood use efficiency also allows for extending its life cycle and depositing carbon.

In the group that considered the issue of agriculture and its adaptation to climate change, the participants identified a number of problems that could affect the sector. Water-related challenges, such as changing rainfall distribution (decreasing in one area and excess in another) and decreasing available water for irrigation, were considered among the most serious. Further identified problems were related to the increase in temperature (which will affect the length of the growing season) and a possible increase in the frequency of abnormal heat periods. Combined with reduced precipitations and water availability, the latter will negatively affect crop yields. The increase in pests and diseases caused by rising temperatures will also reduce yields and increase the vulnerability of domestic animals to new diseases. In addition, an increase in temperature will negatively impact the number and structure of fish populations and the distribution of alien species of hydrobionts. Negative socio-economic consequences were outlined as another important group of problems, such as increased costs for the construction of irrigation systems, loss of markets, reduced productivity and quality of products, reduced availability of food products, and migration of the rural population.

Among the possible ways of adapting agriculture to climate change, the participants noted a number of NbS. The following approaches were proposed: integrated landscape planning of land use, agroforestry, conservation and restoration of forest strips, minimum tillage, mulching, use of cover crops and other soil moisture conservation practices, creation of biodiversity-rich areas in agrolandscapes, conservation of peatlands and restoration of wetlands. In addition, there was mentioned the use of crop rotations with consideration of the water availability, maintenance and preservation of crop varieties adapted to local conditions, planting of new heat- and drought-resistant crops, polyculture (polycrop) cultivation, and adjustment of sowing time to new temperatures and water regimes. The importance of maintaining biotic diversity in agrolandscape and returning to livestock breeding systems integrated with crop production was also separately noted. The group also mentioned agro-technological solutions: new genetically modified and gene-edited crops, digital technologies (use of satellite data), development of the grain micro-germination system, and vertical gardening. Another important element of adaptation to climate change is the economic and legislative mechanisms: advisory system, financial mechanisms to stimulate "environmentally friendly" methods of farming, support of traditional sustainable agricultural practices, development of local small-scale agricultural production, and rural ecotourism.

The analysis of the working group discussion results revealed common problems and solutions in the forest, water, and agricultural sectors. For example, the water scarcity topic was cross-cutting across all sectors, and the need to conserve wetlands was also emphasized in all three groups. Common is the problem of preserving biodiversity as one of the key factors in adapting to current and future climate changes. All groups noted the need to improve legislation, introduce socio-economic incentives, and the importance of transitioning to balanced resource use practices that would consider the local, regional and national context, as well as the interconnectedness of the forest, water, and agricultural sectors.

ПРОБЛЕМИ, ПОВ'ЯЗАНІ ЗІ ЗМІНОЮ КЛІМАТУ

- Підвищення вразливості до шкідників та хвороб
- Зниження стійкості екосистем
- Зниження врожайності
- Зменшення біорізноманіття
- Зниження якості води
- Зміна кількості води
- Негативні соціальні наслідки
- Зростання кількості стихійних лих
- Негативні економічні наслідки

РІШЕННЯ: ЛІС

- Зміна економічних практик та законодавства
- Контроль використання чужорідних видів
- Збереження старовікових та самосійних лісів
- Розширення мережі ПЗФ та виведення деяких с/г земель для відновлення природи
- Збільшення зелених зон у населених пунктах
- Відновлення лісових ландшафтів
- Відновлення природної структури лісів за складом та формою
- Зміна похідних деревостанів та монокультур на мішані ліси
- Запровадження наближених до природи методів лісництва
- Запровадження наближених до природи методів лісництва

РІШЕННЯ: АГРО

- Запровадження регенеративних с/г практик
- Підтримка та висаджування лісосмуг та агролісомеліорація
- Смуги біорізноманіття в агроландшафтах
- Інтегрована з рослинництвом система вирощування худоби
- Підтримка та збереження сортів, адаптованих до локальних умов
- Полікультурне вирощування
- Підтримка традиційних невиснажливих методів с/г
- Відновлення пасовищ

РІШЕННЯ: ВОДА

- Демонтаж гребель та відновлення проточності річок
- Збереження та відновлення прибережних територій, зокрема захисних смуг та насаджень
- Ревіталізація річок та їхніх заплав
- Припинення розорення прибережних смуг
- Відновлення джерел і витоків
- Обводнення торфвищ

8.2 Creating a vision for the development of Ukraine taking into account climate change through the prism of water, forestry, and agricultural sectors

The next stage of the polylogue took place on January 27, 2022, with about 50 representatives of central executive bodies and public organizations, science, business, and youth. The plenary part of the meeting was dedicated to the progress review of the first polylogue stage on climate issues, considering the climate scenarios for the future, presentation of the results of interviews with local communities and representatives of authorities, familiarization with the methodology for forming a vision of the desired future.

To organize a further discussion and form a vision of the future of Ukraine through the prisms of sectoral development, the participants were divided into groups on a random basis and with diverse interests and cross-sectoral representation. The groups were given a series of questions designed to encourage the participants to imagine the transformation of natural and climatic conditions and the desired future, as follows:

- What kind of Ukraine do we want to see?
- How does nature impact the climate, and how does climate change affect nature in Ukraine?
- How does a man (economic activity) affect the climate of Ukraine and the natural condition?
- What will the balance between nature and economic activity in the agricultural, forestry, and water sectors look like, considering the need to adapt to climate change in Ukraine?
- What components of the vision of balanced development of Ukraine and its achievement, taking into account climate change, can be brought by the agricultural, forestry, or water sector?

The groups were given the task of presenting the results of the discussions (sectoral visions) in three components: express the vision in one to three sentences; provide a broader explanation in text format (up to one page); present it visually (with the help of a drawing, collage or scheme prepared with the scribes). Groups were recommended to use innovative practices and ideas that already exist or are being implemented today but are not widespread; traditional practices and initiatives that were used in the past and now need additional support or are not widely used; strategic decisions that will lead to the desired result. At the same time, the members had to take into account the following: the well-being of people through the improvement of economic and socio-demographic processes; equal access to resources and decision-making of all population groups, regardless of gender, age, financial status, place of residence, education, etc.; balance of trade-offs, cross-sectoral interactions, and interdependence; roles and interaction of authorities, society, and business; adaptive management and the possibility of changing production technologies; the interconnectedness of ecosystems and socio-economic activity at different levels; restoration and preservation of biodiversity.

To ensure a balance of views and cross-sectoral issues, the preliminary results of the working groups were discussed with "sectoral consultants" selected from among the representatives of the central executive body, science, and business participants and accordingly revised before being presented to all other participants. Finally, based on the results of four hours of discussions, the participants presented draft visions for the development of the water, forestry, and agricultural sectors.

Forest sector in Ukraine of the future

“Integrated landscape management in the forest, water and agricultural sectors, which is achieved through the application of best practices in close-to-nature forestry and expanded forest restoration, including agroforestry. The implementation of integration is supported by a new economic model based on ecosystem services. Decisions in the forest sector are made with the priority of biodiversity conservation and activities are accompanied by a transparent monitoring system with feedback.”

Integrated landscape management in the forest, water, and agricultural sectors involves the following:

- landscape approach in the massif and mosaic reproduction and management of forests, including according to the catchment principle;
- implementation of agroforestry practices and close integration of agriculture and forestry;
- approbation and use of the best management practices in the forests of Ukraine;
- close-to-nature forestry with the formation of complex-shaped and mixed-species plantations;
- use native species for the reproduction of forests.



The economic model accompanying the integrated approach is based on ecosystem services and the sustainable cascading use of wood.

Such a model sets priorities: first is the fee for ecosystem services (including the fee for absorbed carbon and recreational potential), then value-added products, and finally – the source of forest raw material.

Forest biodiversity is preserved by protecting natural forests, creating a genetic bank, and increasing the share of protected areas under international obligations.

The increased reproduction of forests and maintaining a stable supply chain of products for business must compensate for the increased share of protected areas.

The transparency of the forest sector is ensured by introducing an open system of permanent monitoring and response to anthropogenic and natural risks, raising awareness about climate change and its impact on forests, and the culture of stakeholder consumption.

Such a system (based on online platforms) must have a feedback mechanism, i.e., both the public can monitor actions in the forest sector at various levels, and representatives of the forest sector can detect and respond to violations, fires, etc. promptly. In addition, educational activities are carried out as one of the directions of communication with users (between foresters, businesses, environmental protection organizations, and communities).

Agriculture in Ukraine of the future

“The agricultural landscape of Ukraine is close to nature – with a well-balanced ratio of agricultural lands, forests, forest belts, steppes, and other natural elements. Such balance is achieved by the application of nature-based practices, environmentally conscious consumption, and effective cooperation of the state, communities and businesses, science, and education. The agricultural and food sector in general is climate-neutral, where greenhouse gas emissions do not exceed the absorption. An effective architecture of climate governance is in place, and sustainable supply chains with strong ties between the elements have been built.”

Achieving this vision is possible through three elements:

The effective architecture of climate self-governance and sustainable supply chains with strong connections between elements have been built in the agricultural sector of Ukraine. To implement the above, it is necessary to switch to agroecological approaches to agricultural production using NbS through the following actions:

- implement a system of rewards for providing ecosystem services and creating habitats for wildlife. For example, creation, maintenance, and restoration of forest strips; landscape approach to land use and planning (terracing, decreasing runoff with newly created plant cover to prevent water erosion and accumulation of water in the soil, taking wind rose into account during land cultivation to prevent wind erosion of soils);
- improve the condition of lands exposed to erosion, and use their ability to sequester and store carbon;
- implement cost-effective land reclamation from surface sources;
- observe the management regime and the boundaries of water protection and coastal protection strips.

Effective interaction of state management at the national level, local self-government, and business, in particular through:

- state subsidies to producers who use climate-friendly approaches (risks are included in the price);
- "green" taxation;
- issuance of green bonds and the active transparent market of carbon credits;
- insurance;
- different incentive mechanisms;
- strengthening control over compliance with legislation.

Transition to sustainable consumption:

- national "dietary" recommendations;
- standardization and certification of products and production processes;
- "clean" government purchases of food products;
- tax benefits;
- legally binding emission reduction goals;
- education – promotion policy, labeling, marketing standards, ethical business code.



Ukraine's vision of the future

The final part of the meeting was the discussion of the presented "sectoral visions" and developing a "climate-smart" vision for Ukraine in a round table format. Among the proposals regarding the elements essential for Ukraine of the future, the following were voiced: prioritizing the preservation of biodiversity in decision-making – stopping the loss and starting the restoration by 2030; implementation of best water/forestry/agricultural/environmental practices; sustainable [balanced] landscape; integrated management; establishing fees for ecosystem services (as part of the state's fiscal policy, tax, subsidies and insurance) and other financial mechanisms (ecological, climate fund); creation of means to stimulate the implementation of NbS; sustainable consumption and tracking of consumer chains; monitoring; control and the equal penalty for all; transparency; communication and awareness raising, education and change of worldview orientation (climatic/environmental/ecological topics in education, update of educational programs for the development of environmental competences, integration/strengthening of the practical component in education); circular [cascade] economic model; climate neutrality in 2060; cooperation of the state, communities and business [architecture of climate self-governance]; inclusiveness and involvement; harmonization of legal requirements and international obligations; scientific support (guiding). Based on the results of the open discussion, the following thesis was determined:

“In 2100, Ukraine is a thriving, nature-positive, carbon-neutral and climate-resilient society where natural resources are sustainably used, preserved and restored.”

Візія України Майбутнього
 В КОНТЕКСТІ АДАПТАЦІЇ ДО ЗМІНИ КЛІМАТУ

📍 КИЇВ
 📅 27.01.22

У 2100 РОЦІ Україна
 процвітаюча, дружна до природи,
 вуглецево-нейтральна, стійка до змін
 клімату, де природні ресурси використовуються
 у збалансований спосіб, зберігаються
 та відновлюються

ЗБАЛАНСОВАНИЙ ЛАНДШАФТ
 ОСВІТА
 МОНИТОРИНГ
 СТИМУЛИ
 ЗАКОНИ ТА МЕХАНІЗМИ
 КОМУНІКАЦІЯ І ПІДВИЩЕННЯ ОБІЗНАНОСТІ
 СТАЛЕ СПОЖИВАННЯ
 ПРОЗОРИСТІТЬ
 РАЦІОНАЛЬНЕ ВИКОРИСТАННЯ ТА ВІДНОВЛЕННЯ РЕСУРСІВ
 КЛІМАТИЧНА НЕЙТРАЛЬНОСТІ

INSURE | Запровадження природоорієнтованих рішень у Порядок денний реформи в Україні

Швеція Sverige

8.3 Discussion of prospects and obstacles for the implementation of nature-based solutions in the water sector for adaptation to climate change and post-war recovery

The seminar for the water sector, jointly organized with the Center for professional development of Water Management Workers⁵, took place on February 16, 2022, with the participation of more than 130 representatives of the eight Basin Water Management Departments and regional water offices⁶, the Interregional office of protective massifs of the Dnipro reservoirs. In addition, the experts of the Ministry of Environment, the State Water Agency, the Bavarian Environment Agency (Germany)⁷, and the public sector representatives also were invited as speakers. The plenary part of the seminar included presentations by Ukrainian and international experts, an overview of the previous stage of the polylogue and Germany's experience in implementing the NbS for water resources management, consideration of the impact of climate on the water sector, the sectoral and general vision of Ukraine's development, taking into account adaptation to climate change.

The feasibility of sectoral vision and ways to achieve it was debated through a facilitated discussion in working groups using the adapted methodology of three horizons, where the first horizon is the current state of water management and water ecosystems, the third – is the desired state of the water sector in the future (in 2100), and the second horizon – ways to achieve the desired state of the water sector [2]. The results of the discussions around the "horizons" generally coincided with the results of the "water" working groups of the previous polylogue meetings, as follows: a confirmed and clarified list of water sector problems and possible ways to solve them and the notice on feasibility and relevance of the sectoral vision. An essential result of the sectoral seminar is the defined list of NbS in the water sector that can be implemented in Ukraine. In particular, the following are defined as critical for the preservation of biodiversity:

- removal of water barriers (dams, dykes);
- restoration and proper management of riparian strips;
- meandering rivers;
- restoration of springs and headwaters of rivers.

In order to achieve a good state of aquatic and related ecosystems, the need to restore the river's natural flow, in particular, by dismantling dams, was noted. To increase the efficiency of the water resources management system, the shores need to be protected from the disturbance of the natural vegetation cover. To counteract the pollution of water ecosystems, the following are recommended: restoration of wetlands, implementation of river revitalization projects, and dismantling of old dams. To mitigate the impact of climate on the state of water resources, the following are recommended: restoration/revitalization of small rivers; reduction of regulation of rivers; preservation of forests (regarding water content and riparian strips).

The first sectoral working group was dedicated to the review of successful examples of NbS implementation in the water sector in Ukraine and took place on May 30, 2022. The meeting participants noted the novelty of the NbS concept. They recommended formalization of this term in the Laws of Ukraine "On Environmental Protection" [51] and " On the Key Principles (Strategy) of the State Environmental Policy of Ukraine until 2030" [56], which will contribute to its implementation in the sectoral policy and relevant legal acts. Also, the participants discussed existing examples of implemented measures that can be defined as nature-based. It was noted the need to include the following provisions regarding the dismantling of dams and other hydrotechnical structures in the Water Strategy of Ukraine [62] (as of the time of the meeting, the draft strategy had already been developed) and to provide for the implementation of such measures in River Basin Management Plans and other state, regional and local planning documents (strategies, programs, etc.): restoring the free flow of rivers and meandering, wetlands, springs, and headwaters of rivers/small rivers, counteracting the drainage of river valleys and rivers

⁵ <https://vodacpk.com.ua/>

⁶ <https://mozmdv.gov.ua/>

⁷ <https://www.lfu.bayern.de/wir/index.htm>

revitalization. It is also necessary to adopt regulatory legal acts at the national level regarding the procedure and requirements for implementing the measures mentioned above. The participants emphasized the need to create financial mechanisms at the level of legislation for stimulating NbS implementation and strengthening responsibility for the destruction and damage of water ecosystems (resources) and wetlands. NbS implementation must occur on a scientifically justified basis, with appropriate dissemination of information and communication activities regarding the clarification of the causes and consequences of climate change, changes in the ecological state of aquatic and related ecosystems, and the promotion of NbS as an approach to solving specific problems, in particular for local communities.

The second working group of the water sector took place on June 21, 2022. For the most part, it was devoted to the best international experience in implementing NbS for solving issues related to aquatic ecosystems and water, particularly in the urban space. Project experts presented various examples of the creation of bioplateaus, rain gardens and canals, biodrainage systems, natural "reservoirs" and water collection and storage methods, and illustrations of prevention of "harmful effects of water" in cities. The meeting participants noted the growing interest in such NbS in populated areas of Ukraine and their relevance in the recovery and reconstruction of residential areas in the post-war period. Furthermore, NbS plays an important role in greening cities and improving the physical and mental health of the population. At the same time, the participants of the meeting admitted the significant legislative gaps regarding NbS and the need to renew the requirements for urban planning documentation and planning of settlements, the need for relevant knowledge and technologies, the need for cross-sectoral cooperation, and solving land issues.

The third working group meeting took place on July 1, 2022, and was dedicated to the possibility of using NbS in the water sector to overcome the consequences of hostilities. Invited speakers and experts of the project presented a number of examples of the hydrotechnical structures destruction, flooding of river valleys, pollution of water bodies caused by hostilities, as well as risks associated with both the restoration of hydrotechnical structures and the hydrological regime and the use of alternative solutions, including NbS. They emphasized the need to comply with the legally established environmental impact assessment [113] and strategic environmental assessment [114] procedures, improve the legislation taking into account international practices and obligations, and conduct monitoring and scientific evaluation of the changed water bodies condition. The meeting resulted in recognizing a certain potential of NbS for restoring aquatic ecosystems after the impact of military actions and their ability to self-recover. At the same time, the participants expressed caution about the unwise use of NbS or the restoration of hydrotechnical structures, the existence of which is not ecologically justified. In addition, they noted the cost of measures related to water NbS, expressing the hope for introducing special financial mechanisms, including international financial assistance, to recover Ukraine in the post-war period.

8.4 Discussion of prospects and obstacles for the implementation of nature-based solutions in the forest sector for adaptation to climate change and post-war recovery

The workshop for the forest sector held on February 15, 2022, was attended by 72 participants, including representatives of the Ministry of Environment, the State Forestry Agency, the World Bank, the Departments of Ecology and Natural Resources of the Lviv, Odesa, and Rivne Regional State Administrations, the State Service of Ukraine on Food Safety and Consumer Protection, the Dniester BUVR, and the Western Bug and Sian River BUVR, regional forestry and hunting departments, forestry enterprises and woodworking industry, Lviv State Forest Management Expedition, international organizations and projects, educators and scientists, public organizations and youth. The meeting participants got acquainted with the materials developed within polylogue, the sectoral vision, the vision of a "climate-smart" future of Ukraine, and with international initiatives for the implementation of the NbS – the "UN Decade on Ecosystem Restoration"⁸.

⁸ <https://www.decadeonrestoration.org/>

The ways to achieve the forest vision were preceded by determining the limitations and drivers for NbS implementation in the forestry of Ukraine today and in the future, previously prepared according to the PESTE analysis method [115]. Thus, according to the results of the survey of the meeting participants, the following most important industry solutions were listed:

- close-to-nature forestry;
- preservation of primeval and old-growth forests;
- agroforestry;
- carbon management in forestry;
- management of self-seeded forests.

The restoration of floodplain forests as climatically sensitive is another type of NbS proposed by participants. It was noted that the development of urban forests and green areas is one of the global trends and requires special attention for implementation in Ukraine. The participants also formulated the first recommendations for supporting NbS implementation, which consist of the development of legislation, science and education, economic mechanisms, and the social sphere, and have their specifics for each of the NbS types. Thus, there are perspectives on introducing close-to-nature forestry and preserving primeval and old-growth forests through developing territories and objects of the nature reserve fund. Cross-sectoral cooperation is also needed to successfully disseminate agroforestry practices, preserve self-seeded forests, and protect forests in riparian zones. The participants emphasized that successful carbon management in forestry requires scientifically justified developments in soil preparation and planting establishment.

The first working group of the forest sector met on July 14, 2022, and discussed the issue of close-to-nature forestry for both post-war forestry recovery and adaptation of forests to climate change. The experts of the project presented an analysis of international trends, national legislation, and the possibility of introducing close-to-nature forestry, in particular within the boundaries of the nature reserve fund. The participants of the working group noted the complexity and controversy of legislative requirements for close-to-nature forestry, existing gaps and contradictions in the application of legislation in practice, and the need for further development of Ukrainian legislation considering the best cases from other countries (for example, Slovakia) and the EU Forestry Strategy [116]. Furthermore, the following significant problems for the widening of close-to-nature forestry practices have been recognized: insufficient development of science in this direction and the need to take into account the features of forestry management in various biogeographical and climatic zones of the country, the insufficient economic justification of close-to-nature forestry management and the need for an appropriate assessment of their ecosystem services, the need to reorganize large areas of monoculture and even-aged plantations, development of the forest road system, which requires significant capital investments. On the other hand, it was noted that continuous clearcuttings and main-use loggings are prohibited in large areas, particularly within the territories and objects of the nature reserve fund, which can serve as a basis and impulse for conducting close-to-nature forestry. Participants identified insufficient policy will and lack of state support in developing this scientific area and forest management practice as one of the main obstacles to introducing close-to-nature forestry.

The second working group, held on July 21, 2022, focused on self-seeded forest preservation. The experts of the project presented an overview of the possibilities of the self-seeded forest as NbS to meet the needs of communities, sequester carbon and provide other ecosystem services, increase the area of forests and achieve the climate goals of the state. An analysis of current and proposed legislation in this area was also conducted. The meeting participants discussed in detail alternative options, the pros and cons of proposals for legislation, and ways to preserve self-seeded forests. They emphasized the difficulty of preserving self-seeded forests and outlined the conflict of interests with the agricultural sector, reinforced by imperfect land and tax legislation and the controversial position of the Government and central executive authorities responsible for the forest sector. The species composition and the potential predominance of invasive tree species in

self-seeded forests, especially in the south of the country, also attracted the participants attention, noted the need for the development of scientific research and the regulation of the issue of invasive species in general, and in such forests in particular. The complexity of assessing the ecosystem services of such forests and the need to develop regulatory and methodological approaches was also mentioned. At the same time, the participants considered the possibility of preserving self-seeded forests at the initiative of local communities, in particular by transferring such forests for maintenance and use to communal and state forest and hunting enterprises, introducing changes in legislation to simplify and stimulate private forestry on self-forested agricultural plots, and use of international climate mechanisms to obtain financing.

The third working group was held on August 3, 2022, and was devoted to forest conditions and forestry management in war and climate change conditions. The project experts presented proposals regarding their vision of solving the problems faced by Ukraine because of war, thereby offering the Ukrainian draft Strategy of Forests and Forestry Adaptation to Climate Change, which was generally accepted favorably. They voiced the research results in NbS for managing carbon sequestration in the forests of Ukraine and the issues of carbon credits trading. They also outlined the practical challenges of forest management in wartime and post-war conditions. The participants discussed the issue of sanitary logging and the feasibility of introducing the concept of "salvage logging" in Ukraine, the need for which is caused by large-scale disturbance of forest ecosystems, including as a result of climate change and destructive processes due to hostilities. A practical example was the experience of large-scale fires in the Luhansk region in 2020, where such logging would contribute to the prompt liquidation of the consequences of fires. In the context of forest degradation, the working group discussed the potential of introducing an integrated plant protection system as part of sustainable management, which would prevent the weakening of stands and the need for sanitary logging. Another issue for discussion was the need for modeling and forecasting the development of stands, environmental impact assessment of clearcuttings, designing measures to eliminate the consequences of military operations in forests, and the lack of qualified personnel and knowledge to perform such activities. Attention was also paid to the problem of reforestation after the war and the possible use of introduced species (including invasive species) traditionally cultivated in forestry.

8.5 Discussion of prospects and obstacles for the implementation of nature-based solutions in the agricultural sector for adaptation to climate change and post-war recovery

The seminar for the agricultural sector took place on February 18, 2022. It was attended by 48 participants, including representatives of the Ministry of Agrarian Policy and Food of Ukraine, the Ministry of Environment, the State Service of Ukraine on Food Safety and Consumer Protection, the departments of agro-industrial development of the Lviv and Volyn Regional State Administrations, the Department of Ecology and Natural Resources of the Lviv Regional State Administration, and business and the public sector. During the plenary part the participants listened to reports on agroforestry, the geosystem approach to NbS in agriculture, agrobiodiversity and ecosystem services, as well as the Ukrainian green path "from farm to fork". The panel discussion was dedicated to the following topic: "Agriculture on the way to transformation in response to global environmental challenges – climate change, biodiversity loss, and food security." The participants discussed the possible contribution of agriculture to adaptation to climate change of Ukraine, the current situation in the agricultural sector, what needs to be changed, and which NbS can be applied to adapt to climate change and achieve carbon neutrality.

The discussion of agrovision was performed according to the adapted method of three horizons [2]: the third horizon is the distant future, the first horizon is the present, and the second horizon is the near future. The dispute results have deepened and expanded the work done for the agricultural sector in the previous stages of the polylog. In particular, proposals were made regarding the following:

- supplement the sectoral vision with the need for the state strategic vision dominance over the interests of the community and business;

- clarify the sentence about climate neutrality or replace the expression "climate-neutral" with "climate-positive" concerning the agricultural sector;
- the need for clarification or replacement of the term "climate self-governance architecture" with a clearer one.

An important part of the discussion was awareness of practices that harm the environment and the need to abandon them. Among the ecologically friendly approaches and NbS proposed for use in the agricultural sector, the following are noted:

- integrated livestock and crop production;
- pasture livestock breeding;
- agroforestry (bioenergy plantations, field protection forest strips);
- increasing the area for organic production;
- rewilding – returning low-yielding and degraded lands to natural landscapes.

In addition, the following NbS have been recognized as beneficial for biodiversity: providing a place for wildlife in agro-landscapes; diversification of agricultural landscapes; strips of wild plants that are not plowed, except for introduced species; limited mowing of field borders; methods of biological control over the number of weeds and pests; protection of self-seeded forests, wetlands and other natural ecosystems; reclamation of plowed riparian strips. Furthermore, the following measures are proposed to preserve the soil: cover crops for fields and gardens; mulching; organic fertilizers, composting; polyculture cultivation; no-tillage technologies; crop rotation. The necessary steps for the spread of NbS practices in the agricultural sector are the establishment of nature protection goals and determination of agroecosystem conditions indicators, the development of stimulating mechanisms and state regulation, the improvement of farming culture, the development of science and methodology for NbS implementation, and popularization and dissemination of information about positive examples and advantages of NbS.

The meeting of the first working group of the agricultural sector, which took place on June 9, 2022, was dedicated to the cross-sectoral NbS – agroforestry. The meeting participants noted a small range of agroforestry approaches traditionally used in Ukraine and the existing potential for expanding the practices of combining forestry crops and agricultural land to obtain agricultural products and increase the climatic stability of agroecosystems. The discussion mainly revolved around the legislative provisions regarding field protective forest strips, agroreclamation, assigning responsibility for the care of forest strips to local communities, and introducing the rules for the maintenance of forest strips. Particular attention of the participants was drawn to the issues of scientific approaches, determination of priorities for the functioning of agroforestry plantations to maintain biodiversity, adaptation to climate change, and increasing agricultural land productivity. They talked about the historical practice of creating such plantations from introduced and invasive species, the threat of their further spread, and the need to introduce appropriate management or replacement with local species. It is also stated that a large part of the forest strips in the combat zones are used by the troops and will suffer significant damage and require demining and restoration in the post-war period. The participants noted the need to improve the legislation for a more precise definition and strengthening of responsibility for improper care of agroforestry plantations, to introduce fees for ecosystem services, develop the financial and fiscal mechanisms to stimulate the new forest strips and other agroforestry plantations creation, to determine the range of local tree species that can be used in agroforestry, adopt the appropriate rules for dealing with invasive species, and to disseminate knowledge and new methods among farmers and local communities.

The second working group, which met on June 30, 2022, was devoted to sustainable agricultural practices to ensure the sustainability of agroproduction and adaptation to climate change. The participants discussed the state and prospects for developing legislation and the scientific basis for some sustainable farming practices, particularly the need to return mandatory crop rotation or

introduce mechanisms to encourage farmers to use crop rotation. It was emphasized that scientific research on crop rotation and alternative soil conservation practices in Ukraine is already outdated, and the existing system of natural-agricultural zoning does not correspond to the current climatic situation. Therefore, it is proposed to focus on specific conditions of aridity to adapt agricultural systems. It is also necessary to create a convenient resource to ensure farmers' access to climate information, introduce educational specialization in soil science, and restore the soil condition control service. Speakers and participants agreed on the possibility of using the EU experience for the implementation of sustainable agricultural practices, as well as the assessment of biodiversity in agricultural land, in particular for obtaining subsidies and certification of products as organic. At the same time, it is recognized that currently, during the war, the state does not have sufficient capacity and finances to support the implementation of innovative approaches and compensatory payments during the transition to sustainable practices. Therefore, it is proposed to continue working on the mentioned issue by increasing the awareness and knowledge of farmers and representatives of authorities regarding the potential and methodologies of applying sustainable agricultural practices. The separately discussed topic is the reduction of arable land both as a result of hostilities and as the potential of degraded lands conservation and achieving the necessary ecological balance in using land resources.

The third working group meeting, which took place on August 25, 2022, considered the possibility of using carbon farming and other practices that contribute to carbon sequestration for the recovery of the agricultural sector in the post-war period and adaptation to climate change. Along with considering the potential of the agricultural sector to achieve carbon neutrality due to various opportunities and practices, the participants noted the shortcomings and difficulties associated with the methodology for calculating carbon (humus) emission/sequestration by soils, their cost, and labor intensity. They discussed the possibility of using carbon credits, international investments, and other financial mechanisms to encourage farmers to conduct economic activities contributing to carbon sequestration and the need to develop national legislation for this purpose. In addition, a separate discussion concerned the possibility of restoration of natural vegetation cover on arable land and pasture management. The latest research and experiments indicate the relevance of this measure, in particular in arid areas in the south of the country, where the restoration of steppe vegetation will contribute to the preservation of soil moisture and the adaptation of the region to climate change. Furthermore, it is noted that the restoration of free-range livestock will contribute to the stabilization of restored grassland ecosystems and food security of the country and the protection of the cultural heritage and cuisine of the regions traditionally associated with cattle breeding. The rationale for popularizing this approach to soil recovery was noted in connection with the development of post-war recovery plans for communities in the southern and eastern parts of the country and with the need to change the taxation system, which currently encourages farmers to convert natural areas into arable land.

8.6 The main results of the gender analysis of the meeting participants within the INSURE project

The analysis of all participants in the project events showed an almost equal number of men and women (48% women and 45% men). Men are predominant among the participants representing some branches (for example, in forestry), and women – in others (for example, in water). Therefore, men have a more significant role in managing forest resources and women – in water resources. It is hard to tell whether such a distribution results from the natural tendencies of different sexes or system and historical factors. It is probably the result of both of them. Therefore, it is worth expanding the opportunities for women's participation in managing forest resources and men's involvement in the water sector in future projects.

A slightly larger number of women (60% of the total number) than men took part in the online component of the national polylogue. Women more often indicated the agricultural sector as their field of interest (by 7% more), and men – the forest sector (by 4%). Regarding the distribution by area of activity, men more often represented institutions of the nature reserve fund and women –

public organizations and management bodies (mainly at the level of specialists and heads of departments).

The offline part of the national polylogue gathered a slightly larger number of women than men (59% against 41%). Women were more represented in the public sector, but if the representatives of international institutions and national public organizations are combined, the difference between men and women disappears. Public administration and science represented an almost equal number of women and men. Other areas (business, facilitators, and scribes) were represented by less than three people, which does not allow for a clear conclusion due to the possibility of error due to the small number of participants.

163 unique participants took part in the online workshop and working groups dedicated to NbS in the forest sector, of which 62 (38%) were women, 78 (48%) were men, and 23 (14%) participants did not indicate their gender. Thus, in general, there is a certain predominance of men in the forestry industry. 174 unique participants took part in the seminar and workgroups dedicated to NbS in the water sector, of which 124 (71%) were women, 47 (38%) were men, and 3 (6%) did not indicate their gender. Thus, there is a significant predominance of women in the water management sector. Finally, 93 unique participants took part in the seminar and working groups dedicated to NbS in the agricultural industry, of which 50 (54%) were women, 43 (46%) were men, and 4 (4%) did not indicate their gender. Thus, there is an almost equal number of male and female participants in the agricultural sector.

74 people (19 offline and 56 online) took part in the final meeting of the polylogue held in a hybrid format. So, women represented somewhat more than half – 59%. And women mainly represented regional management bodies and public organizations, while men represented science.

Analysis of the gender distribution of participants in the small grants program by region showed that in one region (Lviv), most participants were women. This can be explained by the war: men are at the front line, and women are additionally moved to this safer region. Since almost a third of Ukraine's population has relocated due to the war, it is important to take into account the gender structure of each region in future activities. In total, 57 people from three pilot regions (Lviv, Odesa, and Rivne regions) took part in the survey – 40% women and 59% men. The majority of respondents (71%) belonged to the age group of 25-64 years; 76% of respondents had a higher education (bachelor's, master's, specialist, or vocational-technical education), another 31% have/or are obtaining a scientific degree, and only 7% indicated general secondary education. As for employment, educators (16%) and local self-government (11%) prevailed.

9 RECOMMENDATIONS ON THE INTRODUCTION OF NATURE-BASED SOLUTIONS INTO UKRAINE'S REFORM AGENDA FOR POST-WAR RECOVERY AND FURTHER DEVELOPMENT CONSIDERING THE CLIMATE CHANGE

9.1 Nature-based solutions in water ecosystems management: water and food security and natural disasters mitigation

The water bodies of Ukraine cover 4.0% of its total territory. In 2020, 9.6 cubic meters of freshwater were collected (90% from surface water bodies, 10% from underground sources), and the primary consumers of water resources are industry and agriculture. The overexploitation of water resources and drainage of peatlands causes a decrease in water levels, fires on agricultural lands, and degradation of natural ecosystems [62].

The war exacerbated the situation by destroying the critical infrastructure of centralized water supply and drainage of cities, flood control structures, and irrigation and drainage infrastructure. Moreover, the aftermath of hostilities caused crises in some places, with people losing access to drinking water and water supply – because of the war, more than 6 million Ukrainians have no or limited access to clean water.

According to the Association Agreement between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community, and their member states [117], Ukraine took the responsibility to implement six EU water resource management directives and amend legislation accordingly. Such implementation will ensure the formation of an updated water policy in Ukraine, particularly in managing rivers, urban sewage, marine environment, contamination of water by agriculture and seasonal floods, improvement of drinking water quality, etc. The implementation of an integrated approach to water resources management following the EU Water Framework Directive [118] has already begun in Ukraine. It is based on the principles of basin management, balancing the interests of water users, achieving a good ecological state of waters, preventing threats to water ecosystems and emergencies, and payment for the use of water resources, including following the "polluter pays" principle.

The restoration of water ecosystems through the implementation of environmental protection measures and NbS can be an essential step for the restoration of the water sector of Ukraine in the post-war period and will contribute to increased resilience and adaptation to climate change, as well as European integration processes. The developed initiative on the watercourses renaturalization and the related road map for the next 10 years is worth noting among the recent positive actions taken by Ukraine [119].

Restoration and regulation of springs and river sources

The water discharge of rivers can rise due to the restoration of springs and headwaters.

The Water Code of Ukraine defines springs as water bodies; however, it does not specify their role and the role of headwaters of rivers for the river water discharge. As a result, river sources and springs often remain unidentified, plowed up, littered, and disappear. However, the arrangement of sources is considered a nature protection measure, and there are about 100 sources that are annually managed by the local authorities and enthusiasts. Thus, to preserve places where rivers "are born", it is necessary:

- To consolidate and introduce data on all the springs and river sources into the State Water Cadastre, including those which are not sources of drinking or medicinal waters;
- To include activities on restoration and preservation of all the springs and river sources of the basin into river basin management plans;

- To initiate amendments to the Water Code of Ukraine regarding expanding the established water-conservation zones (primarily riparian zones) and strengthening restrictions of economic activities there to preserve springs and river sources;
- To create financial mechanisms to ensure the preservation of springs and headwaters of rivers at the community level.

Floodplains restoration and management

An undisturbed floodplain is key to the “health” (natural functioning) of the river and a necessary condition for achieving a good ecological status of waters. The Water Code of Ukraine refers to floodplains as riparian areas that may be flooded or inundated during a river flood (seasonal flood), but contains precise requirements only regarding the preservation of small river floodplains. Preservation of floodplains of medium and large rivers can be implemented through compliance with the regime of water protection zones and the implementation of river basin management plans. Intensive development of river valleys and catchment areas mostly does not allow to designate of the entire floodplain as a water protection zone. It often prevents the designation of even much narrower riparian zones, where the protection regime is stricter. To preserve the floodplains, it is necessary:

- To take the location and functioning of the floodplain into account when drafting the strategic and spatial development planning documents of the communities, land and urban development documentation, and flood management programs;
- To ensure compliance with the legal requirements in terms of the prohibition of plowing up the floodplains of small rivers and the use of chemicals there, and to ensure that this legislative provision applies to the floodplains of medium-sized rivers;
- To provide nature-based solutions to restore and preserve natural floodplain complexes and establish procedures for their use in the river basin management plans.

Restoration and protection of riparian zones

The designated riparian zones along the rivers, lakes, reservoirs, water protection areas, and the seas protect these surface water bodies from pollution and littering and preserve the water quantity. The width of such zones varies from 25 meters along small rivers to 2 kilometers along the sea coast. The plowing of land, gardening and horticulture, storage and use of pesticides and fertilizers, construction, including recreation centers, cottages, garages, and parking lots construction, the arrangement of garbage dumps, and the burning of dry vegetation is prohibited within these zones. However, in practice, riparian zones rarely have the required width, and there is a lack of control over prohibited activities. Therefore, for riparian zones to provide their services, it is necessary:

- To enforce the obligation of relevant organizations or local authorities to plot the boundaries of riparian zones and to enter them and respective use restrictions into the State Land Cadastre of Ukraine and land management documentation of communities and private owners;
- To amend the national legislation regarding the increase in the width of riparian and coastal zones and their differentiated definition to ensure that they protect the water ecosystem from man-made activities;
- To enforce compliance and requirements for the use and protection of riparian and coastal zones, as well as proper monitoring of their status and trends, and to develop appropriate recommendations for managing such areas.

River restoration

According to various data sources, the number of rivers in Ukraine ranges from 25,000 to 63,197. There is no exact list of rivers less than 10 km long and a catchment area of less than 10 square

km. The current number of rivers with a catchment area from 10 square km to 100 square km needs to be updated [120]. At the same time, few of these rivers were unaffected by human activities and remained in their natural state. Most of Ukraine's watercourses moved from the category of "rivers" to the category of "significantly changed bodies of surface water": they were straightened, channelized, regulated, etc. Presently, the realization that rivers can produce many ecosystem services prompts the state and communities to look for ways of preserving or restoring their natural state. To this end, it is necessary:

- To update data on Ukrainian rivers in the State Water Cadastre and update or create, if absent, science-based "Passports" of the Rivers of Ukraine;
- To carry out evidence-based measures to restore and maintain the hydrological regime of watercourses in a way that will facilitate natural processes or processes close to them (ensuring the continuity of the free flow of rivers to support the natural functions of the watercourse and migration of aquatic organisms);
- To restore and protect natural components of biota (flora and fauna) both of the rivers and the floodplains through restoration measures;
- To raise awareness of governmental institutions responsible for decision-making affecting the environment, about the interdependence of good river conditions and sustainable economic development, particularly in energy and agriculture sectors;
- To include river-related nature-based solutions into strategic documents on various levels and river basin management plans and develop the state, local, and investment programs to provide funding.

Restoration and rewetting of peatlands

The developed peatlands in Ukraine currently cover an area of about 100,000 ha, and the peat-burned regions amount to about 3,000 ha [121]. 71% of peat-bog soils are concentrated in Polissya and the western regions of Ukraine. Peatlands and wetlands are traditionally of great importance for the preservation of biodiversity. They are places for growing and picking wild berries and medicinal plants and serve as pastures and haylands. But the most important function of peatlands and wetlands is water accumulation and its slow release in dry periods, which also minimizes the risks of catastrophic seasonal floods. Due to their high capacity to sequester and store carbon and absorb excess water, these ecosystems help mitigate the effects of climate change. EU countries are gradually banning peat extraction and developing plans for the restoration and conservation of peatlands, which is consistent with the resolution adopted in 2019 at the 4th session of UNEA "Conservation and Sustainable Management of Peatlands" [122]. Conversely, peat extraction and peatland drainage continue in Ukraine, which from the policy perspective, increases the threat of significant volumes of greenhouse gas emissions, the drop in river water levels, the destruction of rare habitats, and peat fires. To preserve peatlands and wetlands, it is necessary:

- To agree on the meaning of marshes, peatlands, and wetlands concepts for land, water, forestry, and agriculture sectors, as well as on the methodology of identification, maintenance, and enhancement of these natural objects;
- To ensure that the location data of the marshes, peatlands, and wetlands are included in the strategic and spatial development plans of the communities, in the Water and Land Cadastres, and urban planning documentation;
- To raise public awareness regarding the value of marshes and peatlands by spreading information on how these ecosystems function;
- To develop financial incentives, including carbon market mechanisms and mechanisms for local communities where the peat extraction industry generates 50% of income or more.

9.2 Recommendations on strengthening the opportunities for the implementation of nature-based solutions in the water sector

Key points

- Water is a natural resource we consume daily and use in all economic sectors.
- The state of water and wetland ecosystems is critical – pollution, human-made eutrophication, silting, river degradation, and peat fires are common in Ukraine.
- Water ecosystems are among those most sensitive to climate change, with simultaneous effects on other ecosystems and economic sectors, such as water and food security.
- Hostilities Due to Russian aggression led to water resources deterioration, such as pollution, damage to hydraulic facilities infrastructure, and direct water losses.
- European integration processes create an opportunity to introduce the latest approaches to water resources management, particularly NbS.
- Nature-based solutions in the water sector should be directed at restoring water ecosystems (environment quality, habitat structure, and biodiversity) and the related ecosystem services delivery.
- Nature-based solutions can address most water-related challenges; however, their implementation will require a cross-sectoral approach and institutional and financial support.

Institutional capacity building:

- To strengthen control over the State Water Cadastre and water resources accounting and create conditions for filling the cadastre with relevant information, in particular, to include information on all springs and river sources, including those that are not sources of drinking or medical water;
- To take into account the location and features of the functioning of water bodies and watercourses, floodplains, swamps, peatlands, and other wetlands in water and land cadastral and urban planning documentation, strategic and spatial planning documents of communities and programs related to flood management;
- To ensure compliance with the legal requirements regarding the prohibition of plowing the floodplains of small rivers and the use of chemicals on them and to extend the effect of this legal norm to the floodplains of medium-sized rivers;
- To organize effective control over compliance with the requirements for the use and protection of riparian strips, as well as proper monitoring of the dynamics of changes in their condition, and to develop appropriate recommendations for the modern management of such areas;
- To implement the basin approach of water resources management, including through the implementation of NbS. In particular, to include measures to ensure the restoration and preservation of all river sources and headwaters in the basin in the River Basin Management Plans;
- To form a positive perception of water bodies, also regarding the value of swamps and peatlands and related phenomena through popularization, increasing public awareness;

- To carry out educational activities on the management of water ecosystems with the help of NbS, also by including relevant information in educational programs within the framework of professional training for students and the general stakeholders;
- To develop practice and methodological recommendations regarding the NbS inclusion in measures to achieve good water status in River Basin Management Plans, Flood Risk Management Plans, etc.

A review of funding approaches

- To develop convincing arguments on the economic, social, and environmental benefits from NbS implementation in the water sector;
- To develop and apply financial and fiscal mechanisms to stimulate the land owners, land users, and community to implement NbS in the water sector and to encourage the implementation of environmental practices, mainly through the fee for ecosystem services;
- To improve the system of accounting and payment for water resources use, develop a differentiated system of payment for water depending on the purpose of its use and the impact of the type of economic activity on the water resources and water objects condition;
- To review the procedure for calculating damage caused by water and the process for its compensation. In particular, regarding the impossibility of compensation for damage caused to property located in risk zones and with violation of legal requirements.

Improvement of legislation:

- To establish legislative requirements regarding the prioritization of measures related to the mitigation of the negative impact and adaptation to climate change of the water sector, the preservation and restoration of water ecosystems and water resources, as important issues for national security and ensuring the sustainable development of all sectors of the economy;
- To develop terminology, tools, requirements, and standards to implement nature-based solutions into water resources and ecosystem management (for instance, to agree on the meaning of marshes, peatlands, and wetlands in the framework of land, water, forestry, and agriculture legislation, as well as on the methodology of identification, assessment, maintenance and enhancement of these natural objects);
- To initiate amendments to the Water Code of Ukraine regarding the preservation of springs and river sources, increasing the size of established water protection and riparian zones and their differentiated definition to ensure that coastal natural complexes fulfill the functions of protecting water ecosystems from the influence of anthropogenic activities and preventing the harmful effects of water, strengthening the requirements for restricting the economic activity within such territories and increasing responsibility for violations of the established regime.

9.3 Nature-based solutions for the effective post-war recovery of forestry, increasing the resilience of forests to climate change, and carbon sequestration

Prerequisites

The forests of Ukraine cover an area of 9.6 mln ha, of which more than 80 % are state-owned, while 38% are production forests. The forest sector generates around 1% of Ukraine's GDP and creates jobs for 68,000 Ukrainians directly in forestry and logging. Only thirty forest-forming tree species represent the diversity of Ukraine's forests, including pine, oak, beech, spruce, birch, alder,

ash, hornbeam, and fir. However, the high share of monoculture forests reduces the overall resilience of Ukrainian forests to climate change, forest fires, diseases, and pest outbreaks [61].

War has directly affected 3 mln ha of the forest ecosystem (30% of forest lands) and staffing in the male-dominated forest sector. Forestry faces new challenges, such as managing forests contaminated with landmines and all other types of unexploded ordnance, meeting increased fuel wood demand, and completing the National Forest Inventory. Restoring sustainable management in both state-owned and communal forests will take some time. First, forest areas near settlements and those where forestry activities are actively carried out will be demined. Demining the remote forest, areas located along the demarcation line for a long time, and in the occupied territories will remain a pressing issue. Linear protective plantations, particularly along roads and fields, ravine plantings are most affected by military operations and will probably remain areas with a high explosive risk for the longest time.

To ensure not only environmental but also national security, environmental management should be a priority in the process of the post-war economic recovery of Ukraine, and recovery programs must take into account the impact on the environment. Sustainable management of Ukraine's forest fund as a tool for carbon sequestration is critical for ensuring the fulfillment of obligations for mitigation and adaptation to climate change. The 2035 State Forest Strategy of Ukraine sets the goals of raising the level of greenhouse gas absorption by Ukrainian forests up to 75.6 mln tons of CO₂-equivalent through the introduction of sustainable forest management, increasing the forest cover by up to 18%, and transition to close-to-nature forestry approaches[61]. Statistically, the amount of greenhouse gas absorption in the forestry sector has almost not changed over the past decades, but emissions have increased (mainly due to changes in the land use type) [123]. Therefore, the key task of the industry is to increase the level of carbon absorption and retention, which can be achieved with the help of NbS. In addition, NbS contributes to expanding the area of forests, preventing the degradation of forest ecosystems, improving the resilience and quality of forests, and introducing saving logging technologies.

The Forest Code of Ukraine and Ukrainian nature conservation legislation contain a number of norms aimed at the organization of sustainable forest management and agroforestry practices that are of equal benefit both for the forest and water and agricultural ecosystems. This vision has already acquired a new sense and has prospects for implementation on a bigger scale both in terms of NbS in the forest sector and of “forest NbS” in the water and agricultural sectors. This is manifested in the accessibility and sustainability in contrast to engineering solutions that require considerable investment and ongoing energy costs.

Close-to-Nature Forestry

Zero forest cover losses are ensured by close-to-nature forestry approaches determined by the 2035 State Forest Strategy of Ukraine as the methods of effective management and adaptation of forests to climate change due to selective cuttings, intense carbon accumulation in phytomass and minimally disturbed forest soils [61]. The results of applying such methods can already be seen in the experimental sites in the Carpathian region. To disseminate the practice of close-to-nature forestry application, it is necessary:

- To encourage the synergy between science and practice in close-to-nature forestry, to ensure broader integration into professional education and advanced training programs for the forestry staff;
- To improve the regulatory and legal framework for the close-to-nature forestry transition, to achieve mixed and uneven-aged forests through using natural (local) species resilient to climate change, to gradually withdraw from clearcutting, to modernize equipment, first of all, at state-owned forestry enterprises and the relevant road network;
- To define forests that belong to the nature reserve fund (protected areas system) of Ukraine as a priority for the implementation of close-to-nature forestry.

Floodplain and wetland forests

Floodplain forests sequester twice the amount of carbon compared to terrestrial forests. The floodplain forest area in Ukraine covers 600,000 ha, and wetlands cover 550,000 ha. The Water Code of Ukraine and by-laws related to logging and forest management only partially back up appropriate management approaches for such forests. The following is required to preserve floodplain and wetland forests:

- To harmonize forestry, water, and land legislation of Ukraine by including provisions for appropriate management regimes of floodplain forests and wetland forests;
- To include floodplain and wetland forests in the categories of protective forests or nature conservation fund, as well as to ensure their differentiated management with the complete restrictions of forest management activities or partial limitations where it is impossible to implement any restrictions.

Primeval forests and other old-growth forests

1,000 km² of primeval forests and other old-growth forests store sequestered carbon and support genetic diversity. Preservation of primeval forests in Ukraine is enshrined in the legislation, and already some 70,000 ha have been given the status of primeval forests, quasi-primeval forests, and natural forests. But not all of them have been granted nature conservation status, and the following is required to successfully preserve them:

- In order to identify primeval forests and other old-growth forests, it is necessary to establish the appropriate protection regime by changing the forest categories and allocating specially protected forest areas, as well as to provide the status of primeval “nature monuments” to these territories or to include them to the natural conversation areas of natural or biosphere reserves and national natural parks;
- To complete identification and mapping of primeval forests and other old-growth forests, to integrate them into the forest inventory, and to prohibit forest management activities;
- To implement monitoring with appropriate funding for studying the mechanisms of adaptation of natural forests to climate change to apply this knowledge in managed forests.

Self-seeding forests

0.4-1.8 mln tons of CO₂-equivalent can be absorbed annually by 200,000 ha of self-seeding and non-registered forests. The recent legislative amendments determined the mechanism of self-seeding forest preservation and appropriate forest management practices on those territories. They also introduced the right of the state to buy out self-seeding forests. The preservation of self-seeding forests (except for forests with invasive species) is an important but complex issue that requires the following actions:

- Awareness-raising campaigns with communities, users, and owners of lands on which self-seeding forests are growing;
- Developing financial tools and tax incentives for self-seeding forest preservation;
- Transferring self-seeding forests located on the state-owned lands of agricultural designation to state forestry enterprises for permanent use;
- Simplifying and diversifying the possibility for developing forest management plans for non-state-owned forest lands.

Forest landscape restoration

166,000 ha of expanded reforestation during autumn 2021-spring 2024 as part of the “Green Country” Presidential program created the capacity for forest landscape restoration. This new approach envisages the revival of functionality and landscape sustainability by both massif and mosaic expansion of forest cover and coincides with the tasks set out in the 2035 State Forest Strategy of Ukraine. The restoration of forest landscapes can be interpreted as NbS, because it will contribute to the long-term process of regaining ecological functionality and enhancing human well-being across previously deforested and degraded forest landscapes, provided that the following will be introduced:

- Intersectoral engagement and coordination of forest landscape restoration measures considering sustainable use of land, water, and other natural resources and aiming to reach increased forest cover at the level of 18%;
- Updating Forest Reforestation Rules by listing invasive tree species prohibited for use during forest restoration;
- Community involvement in the preservation of self-seeding and floodplain forests, forest reclamation, agroforestry systems, etc., as well as their inclusion into spatial development plans;
- The introduction of the mechanisms stimulating expanded forest restoration by private landowners.

9.4 Recommendations on strengthening the opportunities for the implementation of nature-based solutions in the forestry sector

Key points

- Ukrainian Forests are unevenly distributed and cover only 15.9% of the country.
- 50% of forests are artificial, mainly monocultural and vulnerable to climate change, forest fires, diseases, and pests. Therefore, forests require sustainable forest management and restoration, considering adaptation to forecasted climate change.
- 30% of forest lands have been damaged due to hostilities.
- In 2020, Ukrainian forests sequestered 30 Mt of CO₂e (10% of the country's gross greenhouse gas emissions). Planting additional climate-resilient forests on 166,000 ha as part of the “Green Country” Presidential program allows for absorbing approximately 226,000 tons of carbon by 2030 and 2.5 million tons by 2050.
- Consistent application of biodiversity-friendly forest management practices, for instance, close-to-nature forestry as a nature-based solution can ensure an increase in the quantity and quality of forest cover for decades to come.
- Preserving self-seeding forests, shelterbelts, and floodplain forests as NbS requires intersectoral engagement and constitute a tool for complying with Ukraine's commitments to stop the loss of forests, increase carbon sequestration and facilitate adaptation to climate change by 2030.

Institutional capacity building:

- To change the approach to forest management, taking into account the strategic importance of forests for mitigation of adverse impacts and adaptation to climate change, their impact on the state of water and land resources, the importance of forests for meeting

the recreational needs of the population and an alternative resource of food and livelihoods through the use of non-timber forest products;

- To ensure forest inventory and monitoring of forest and forest-related (adjacent) ecosystems, including for scientific justification of NbS use to prevent or eliminate the consequences of natural and man-made disasters in forest and related sectors;
- To develop scientific recommendations for close-to-nature forestry management methods, management of floodplain and wetland forests, and self-seeding forests in different natural and climatic zones of Ukraine to achieve a balance between economic interests, climatic goals, and preservation of biodiversity;
- To integrate sustainable forestry topics into the educational programs of training and retraining of personnel for the forest industry, representatives of state administration and local self-government, taking into account climate change, in particular, the methodology of implementing forest and other NbS;
- To initiate information campaigns to increase public awareness of the achievements of forest science and practice, in particular, regarding the benefits of implementing NbS;
- To promote the development of intersectoral cooperation to increase synergy in the implementation of forest NbS to ensure a simultaneous positive effect for the water, forest, and agricultural sectors, rational use and reproduction of land, water, and other natural resources.

A review of funding approaches:

- To conduct an economic assessment of ecosystem services of forests and create mechanisms for their monetization, in particular through the creation of both new legal norms and improvement of existing ones;
- To create a system of financing the forest sector as part of an environmentally neutral economy, which, in addition to wood and non-wood forest products, will allow taking into account other ecosystem services of forests, including recreational, carbon storage, etc.;
- To establish cooperation between practice, science, and the public to implement joint projects and attract funds from international funds, particularly the LIFE program for environmental protection and climate measures, among which there is a place for nature-based solutions.

Improvement of legislation:

- To introduce the NbS concept in the Forest Strategy of Ukraine and integrate NbS application regulations into the forestry policy of Ukraine, where adaptation to climate change and application of the best forestry practices (in particular, close-to-nature forestry) would determine decision-making priorities.
- To harmonize the regulatory framework of Ukraine with the Forest Strategy, with periodic updating following the EU requirements and align all actions related to the management of the forest sector with its goals.
- To update the roadmap of Forest Strategy implementation that meets post-war recovery needs with the use of NbS.

- To coordinate the forest NbS implementation in the agricultural and water sectors and in amalgamated territorial communities through the development of relevant by-laws.
- To expand the list of scientific and design institutions authorized to develop forest management materials and/or simplify the requirements for such materials to increase the possibility of appropriate maintenance of forests, special purpose plantations, and linear type forest plantations located on agricultural lands or water fund lands and not provided for use to state forest and hunting enterprises.

9.5 Nature-based solutions for the effective post-war recovery of agriculture, sustainable agriculture, carbon-neutral future, and restoration of biodiversity

Prerequisites

Agriculture is important both for the Ukrainian economy and global food security since Ukraine is one of the top 5 world exporters of wheat, corn, barley, and sunflower oil. At the same time, Ukraine's agricultural sector accounts for 99 mln tons of CO₂-eq. (or about a third of total GHG emissions). The primary sources of such emissions are the loss of soil organic carbon by croplands and nitrogen oxide emission. High productivity and higher-than-average yield rates have been achieved at the expense of Ukrainian nature: arable lands cover 56% of Ukrainian land [124] and show an upward trend, reducing natural ecosystem areas. The percentage of arable land plots with eroded soils, according to different estimates, ranges from 20% to 40%, while 25% of pesticides on the market are illegal [125], and there has been a fivefold increase in the use of fertilizers per hectare over the past 20 years [126].

The war has seriously disrupted supply and production chains related to agricultural products in Ukraine, causing the losses of agricultural areas and their pollution by mines, unexploded ordnance, and toxic materials. One of the consequences is the destruction of field protection forest strips in the east and south of the country, reducing agroecosystem stability. In addition, climate change keeps affecting the producers: air temperature rising and decreasing soil humidity, extreme heat, and droughts increasingly causing restrictions in the use of water resources and yield losses. Returning to the old agricultural production model characterized by high agrochemical application, monocultural growing, poor soil management practices, and increasing cropland will contribute neither to the provision of Ukrainian and the global population with healthy food nor solve the problem of climate change and biodiversity loss.

Securing sustainable “climate-smart” agricultural production has been identified as the path to achieving the objectives of the 2030 National Economic Strategy, and respective approaches are mentioned in other strategic documents on the environmental policy and on combating land degradation and desertification, as well as in climate and land legislation. But the actual implementation of environmentally friendly practices will depend on adopting respective programs and financial support. For example, the Ukraine Recovery Plan presented in Lugano in July 2022 [127] declares sustainability as one of the seven recovery principles, but only 4% of all the finance in the agricultural package is allocated for the “green transition”. The analysis of the Recovery Plan and the agricultural legislation testifies to the prevalence of the limited vision of the agricultural and food sector as the source of economic growth, not as an activity aimed at providing people with healthy and nutritious food and decent existence in harmony with nature.

Carbon farming

Up to 6.6 mln tons of CO₂-eq. of carbon can be sequestered per year thanks to the restoration of strongly or moderately eroded soils using carbon storage management practices [128]. Increased carbon absorption and retention through applying the best agricultural practices adapted to climate

change are mentioned in the Action Plan for implementing the Updated Nationally Determined Contribution of Ukraine to the Paris Agreement until 2030. These practices may help agriculture adapt to climate change, reduce greenhouse gas emissions, and achieve carbon neutrality. This will be facilitated by introducing carbon farming mechanisms, and farmers can get money by selling carbon units. To implement the above, it is necessary:

- To develop the national mechanism for supporting carbon farming (for example, within the system of state support of agriculture or a special climate fund);
- To ensure access to available international mechanisms of voluntary projects aimed at the reduction of greenhouse gas emissions;
- To consider opportunities for supporting carbon farming within international cooperation following the market mechanisms of Article 6 of the Paris Agreement;
- To develop guidance on monitoring, reporting, and verification of greenhouse gas emission reduction in agriculture, in particular, the methodology of assessing carbon absorption and emission by soils;
- To approve the national soil fertility protection program, to create an effective and transparent system of soil condition and quality monitoring and control, and to ensure data accessibility.

Conservation agriculture and other agroecological practices

An additional capture of up to 2.4-7.5 mln. tons of carbon a year⁹ is possible if conservation or agroecological practices are applied to at least 30% of arable land. The conservation agriculture practices are mentioned in the 2030 Strategy of Environmental Safety and Adaptation to Climate Change and the Action Plan on implementing the Updated Nationally Determined Contribution of Ukraine to the Paris Agreement until 2030. However, as in previous years, the Plan mainly supports domestic machinery producers instead of directly subsidizing farmers for transition to nature-based practices. To achieve a wide-scale application of resource-conservation practices, it is necessary:

- To re-direct available state subsidies to support the implementation of conservation agriculture and agroecological practices (as one of the priorities);
- To make agricultural business lending dependent on appropriately assessing social and environmental risks associated with production and to increase insurance rates for high-risk businesses;
- To create tax incentives for encouraging the producers of environmentally clean and environmentally safe products;
- To approve the list of resource conservation and other agroecological practices (cover crops, crop rotation, minimum disturbance of soil, mulching, composting) and to develop an effective monitoring system;
- To promote sales and consumption of “environmentally clean” and environmentally safe products by raising public awareness of the benefits of sustainable consumption, setting rules for “green” public procurement, and supporting local consumption and markets.

⁹ На основі середнього показника секвестрації в 0,25–0,78 тонни вуглецю на 1 га на рік для ресурсозберігаючого землеробства, розрахованого організацією Project Drawdown, та площі орних земель в Україні

Returning the elements of nature into agricultural landscapes and rewilding

Up to 50,000 ha of agricultural lands were damaged due to the war, and other industrially polluted and low-productive lands (~0.6 mln. ha) can be used for nature restoration, promoting sequestration of about 1 mln. tons of CO₂-eq. of carbon per annum. The Concept of the General State Target Program of Land Use and Protection reduces the percentage of arable land to 44% by conserving degraded, low-productive, and polluted lands [129]. To achieve a balanced arable land ratio and to get additional benefits from nature restoration, it is required:

- To set the goal of allocating up to 10% of agricultural lands for natural and seminatural ecosystems (flower strips, forest belts, hedges, wetlands, meadows and steppe areas, etc.), as well as to introduce the integrated landscape approach to spatial planning;
- To identify degraded, polluted, or low-productive lands and to assess the economic, social, environmental, and cultural benefits (ecosystem services) of restoring native ecosystems through large-scale restoration projects and to envisage such projects through the development of land management schemes and feasibility studies for land protection by the local self-government;
- To develop financial compensation mechanisms, in particular, for land owners/ land users, in the form of carbon credits, pay for ecosystem services, preferential taxation, subsidies, or direct investment opportunities;
- To ensure the preservation of self-seeded forests, shelter forest belts, riparian buffers, coastal protection zones, meadows, and natural fodder areas by introducing adequate control of compliance with the Ukrainian legislation and targeted support for NbS implementation.

Agroforestry

474-869,000 tons of carbon per year [130] could be sequestered if the area of shelter forest belts were increased to 790,000 ha. In 2020 the rules for the maintenance and preservation of shelter forest belts located in the lands of agricultural designation were adopted. They enable farmers and local communities to create forest belts and care for them. Along with that, to ensure the successful conservation of currently available forest belts and further development of agroforestry, it is necessary:

- To ensure further evidence-based development of the shelter forest belts system to reach the area of 790,000 ha by 2030 (the current area is 350-440,000 ha);
- To conduct educational campaigns and promote the application of new and less common agroforestry practices in Ukraine (alley cropping, silvopasture systems, contour-amelioration systems);
- To reduce the level of tax load on owners/users of land plots of agricultural designation covered by shelter forest belts and other ameliorative plantations, as well as to simplify the mechanism of land plot allocation for such plantations;
- To introduce the requirements on field protection with forest strips into the Ukrainian legislation and to ensure their compliance.

9.6 Recommendations on strengthening the opportunities for the implementation of nature-based solutions in the agricultural sector

Key points

- Transformation of the agricultural sector is critically important for ensuring food safety, climate change mitigation, adaptation, and preserving the biodiversity of Ukraine.
- Financial incentives should encourage farmers to apply resource conservation and other agroecological practices since that will enable them to increase income, reduce costs, and adopt more sustainable and nature-friendly production methods.
- Returning “nature” elements to agricultural landscapes by restoring steppe, meadow, forest, and wetland habitats on war-impacted, degraded, or low-productive land plots will contribute to the restoration of biodiversity, sustainable agricultural development, and food security through the preservation of soil fertility and climate change adaptation.
- Carbon farming (particularly for the restoration of eroded soil) has a huge potential for industry decarbonization and improving soil conditions. The latter will improve the yield rate by up to 10%, according to different estimates.
- The development of the system of shelter forest belts that were significantly affected in war zones, and advanced methods of agroforestry that integrate trees into fields or pastures (alley cropping, silvopasture systems), will ensure soil protection, climate change mitigation and adaptation, and additional income.

Institutional capacity building:

- To supplement the legally defined list of socially-desired advisory services (funded by budgets) with consultations on agricultural NbS, to organize training sessions for the providers of advisory services, and to improve access to advisory services.
- To develop and approve educational programs on NbS, landscape planning, protection, and regulation, climate technologies, and consultancy in agriculture;
- To disseminate information on NbS among farmers through farming schools, training workshops, exchange programs, and web resources, and to improve farmer’s capacity to use digital technologies and state digital services;
- To organize equal engagement of all stakeholders in the development of agricultural policy and plans for post-war recovery – first of all, small and medium-sized farmers, owners of individual peasant farms, youth, women, communities, and users of water resources;
- To carry out proper monitoring, control, and supervision for standards of maximum allowable contamination of soil;
- To establish the procedure for scientifically justified crop rotation;
- To ensure access to existing international mechanisms of voluntary projects to reduce greenhouse gas emissions;
- To develop guidelines for monitoring, reporting, and verifying greenhouse gas emissions reductions in agriculture, particularly the methodology for assessing carbon absorption and emissions by soils.

A review of funding approaches:

- To refocus existing state subsidies and support schemes for agricultural producers to help those who adhere the sustainable farming practices, to make changes in the relevant procedures for the use of funds or to develop new ones;
- To create conditions for attracting international and private investments for the implementation of resource-saving practices and carbon farming;
- To create financial and fiscal incentive mechanisms at the local and state level for the spread of agroforestry practices and the return of the elements of nature into agro landscapes, including by assessing ecosystem services and introducing fees for them.

Improvement of legislation:

- To develop a national mechanism for supporting carbon farming (for example, within the framework of the system of state support for agriculture or the activities of a special climate fund);
- To develop by-laws for guaranteeing, defining, and observing standards of maximum allowable contamination of soils through agrochemical soil surveys;
- To approve a tentative list of sustainable agricultural practices (e.g., cover crops, crop rotation, minimum tillage, return of organic residues (mulching), sustainable grazing as a traditional practice, agroforestry) taking into account the specifics of Ukraine and create an effective mechanism for monitoring their implementation;
- To include advisory services concerning NbS to the list of socially oriented advisory services at the level of legislation;
- To adopt the draft law on soil conservation and protection of fertility and the relevant national program, create an effective and transparent system of monitoring and control of soil condition and quality, and ensure data availability;
- To set the goal of allocating up to 10% of agricultural lands for natural and seminatural ecosystems (flower strips, forest belts, hedges, wetlands, meadows, and steppe areas etc.), as well as to introduce the integrated landscape approach to spatial planning.

9.7 General policy recommendations regarding the introduction of nature-based solutions into the reform agenda of Ukraine

In recent years, Ukraine has taken significant steps to improve the situation in solving climate issues and has produced many analytical documents in the field of climate change. Ambitious climate goals are set by the National Economic Strategy until 2030, the Strategy of Environmental Safety and Adaptation to Climate Change until 2030, and the Updated Nationally Determined Contribution of Ukraine to the Paris Agreement until 2030, approved by the Cabinet of Ministers of Ukraine. It is worth noting separately the Low-Carbon Development Strategy of Ukraine until 2050 [123]¹⁰ which submission to the Secretariat of the UN Framework Convention on Climate Change was approved by the Cabinet of Ministers of Ukraine. Among the ways to achieve climate neutrality, all documents mention the need to reduce greenhouse gas emissions and increase the amount of carbon absorption and retention, in particular, by applying best practices in agriculture and forestry adapted to climate change, as well as appropriate water management. Unfortunately, the possibility of timely achievement of the goals established by these strategic documents is compromised by Russian aggression against Ukraine. However, we believe Ukraine should

¹⁰ <https://mepr.gov.ua/news/31815.html>

continue the path to climate neutrality and the introduction of sustainable management methods in the water, forest, and agricultural sectors, which will simultaneously serve for successful post-war recovery and achieving climate goals.

According to the latest scientific research and decisions of international bodies and organizations, including the UN Environment Assembly, the Conference of the Parties to the UN Framework Convention on Climate Change, the Convention on Biological Diversity, and the Convention on Wetlands of International Importance Especially as Waterfowl Habitat, it is recognized that promising ways to achieve climate goals are the use of ecosystem approaches and nature-based solutions.

Nature-based solutions are a relatively new concept for Ukraine, which is not mentioned in the legislation but is actually present there. Considering the content of the definition of "nature-based solutions" and recognition at the international level of the NbS potential for achieving climate goals, sustainable development goals, and biodiversity conservation, the introduction of NbS in the reform agenda of Ukraine is a necessary step. It is also extremely important in connection with the current challenges associated with Russian military aggression against Ukraine and the need for post-war recovery, considering the country's further development in the condition of climate change. This approach can be implemented both through changes in national policy and in sectoral policies. In particular, the water, forest, and agricultural sector policies need further improvement. The mentioned are not only directly related to the use of natural resources and dependent on climatic events but also can contribute to environmental protection, climate change impact mitigation, and adapting to it Ukrainian society, providing the introduction of sustainable management, the ecosystem approaches, and NbS.

A perspective list of NbS in the water, forestry, and agricultural sectors, which can contribute to the post-war recovery and sustainable development of Ukraine in the condition of climate change, includes the restoration and regulation of the springs and river sources, the restoration and management of floodplains, the establishment and protection of coastal protection strips and riparian zones, renaturalization of rivers, preservation and watering of peatlands, close-to-nature forestry, preservation of floodplain and wetland forests, primeval forests and other old-growth forests, self-seeded forests, restoration of forest landscapes, carbon farming, resource-saving and other agroecological practices, return of elements of nature to agroecosystems, agroforestry, etc. The specified NbS have a certain historical, scientific and legislative basis, but they need the support and development of both existing policies and the adoption of new ambitious policy decisions for their successful implementation on a large scale.

Key challenges for authorities at all levels in implementing nature-based solutions

According to the results of the legislative analysis and the meetings held within the framework of the national polylog "The place of nature in Ukraine's adaptation to climate change", a number of challenges facing Ukraine on the way to the implementation of NbS in policy and practice have been identified:

- lack of awareness of the general public regarding the possibility of NbS implementation;
- poor scientific research on the potential for NbS implementation and their effectiveness;
- lack of monitoring of the environment and its components prevents scientifically-based decision-making regarding NbS implementation and assessment of their effectiveness;
- lack of regulatory and methodological frameworks for NbS planning and economic evaluation of ecosystem services, which makes it difficult to justify the effectiveness and economic feasibility of NbS implementation;
- existing financial mechanisms are focused on environmental protection measures and need to be improved to ensure effective implementation of NbS with the participation of public organizations and businesses;

- EIA and SEA procedures do not take into account the potential of NbS as a technological alternative to the planned activity;
- insufficient coordination, cooperation, and consolidation of various state sectoral structures among themselves and with international institutions for the exchange of information, technologies, and implementation of joint solutions;
- weak institution of consultancy, methodological support, and assistance for the introduction of developed environmental programs, including mitigation of the impact of climate change and adaptation to its consequences, particularly in the water, forestry, and agricultural sectors.

The main changes that need to be implemented for the successful introduction of nature-based solutions in the reform agenda of Ukraine and their application in practice

Institutional capacity building:

- *To develop standards, guidelines, instructions, scientific descriptions, etc. for NbS implementation in different fields of economy, considering the best practices and relevant procedures of national and international environmental legislation.* The development of a national standard based on the IUCN one, considering the NbS definition approved by Resolution UNEP/EA.5/Res.5 [1], is a possible way to unify the approaches to NbS implementation. The majority of NbS are relatively new approaches for Ukraine that requires the appropriate development of science and a methodology for their implementation. For example, development actions are needed in agroforestry. Despite its long history in Ukraine, a limited range of agroforestry approaches, such as creating forest strips, are traditionally used. At the same time, alley farming and silvopasture still require the development of scientific foundations for their effective application. Another example is carbon farming and agroecological practices related to the carbon sequestration capacity of soils and the corresponding monetization of carbon units. This also requires the introduction of appropriate agricultural management methods and the assessment of their effectiveness.
- *To support scientific research on NbS implementation and assessment of their effectiveness in different climate and geographical zones and landscapes of Ukraine and economic sectors.* This can be done due to state financial support, cooperation with international scientific institutions, implementation of international programs and projects related to NbS, and provision of targeted funding of state scientific institutions. For example, it is recommended to use EU programs that promote the development of science and practice of the NbS implementation¹¹ to strengthen international and cross-sectoral cooperation and obtain additional funding. In particular, the Horizon and LIFE programs systematically finance the development of NbS in Europe and have now become available for Ukraine.
- *To ensure an advanced level of professional knowledge and increase the general awareness about ecosystem-based adaptation to climate change and NbS implementation,* which can be carried out following the provisions of the Laws of Ukraine "On Environmental Protection" [51] and "On Education" [131], the requirements of the Codes [53-55] and other legislation. In particular, improvements are needed in the educational programs of professional and higher educational institutions for training specialists with sufficient qualifications for implementing NbS. Relevant training courses can be developed considering the sectoral specifics and the appropriate professional activities of civil servants at all levels, employees of local self-government bodies, and water, forestry, and agricultural sectors. These training courses can be disseminated, in particular, through the Knowledge Management Portal¹² created by the National Agency for Civil Service, as well

¹¹ https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_en

¹² <https://pdp.nacs.gov.ua/>

as through relevant training centers, professional education institutions, etc. In addition, an advisory institute needs support and development, which can contribute to disseminating knowledge among farmers and agribusiness representatives. It is necessary to increase the awareness of experts who perform environmental impact assessment and strategic environmental assessment of methods for biodiversity assessment and ecosystem services assessment for consideration of NbS as a technological alternative to the planned activities. Raising awareness among the general population and stakeholders can be done by disseminating relevant information in the mass media and the Internet. In particular, WWF-Ukraine proposes to use the Knowledge NbS Platform (www.nbs.wwf.ua), created within the framework of the INSURE project.

- *To promote the establishment and support of existing public and professional associations focusing on NbS implementation* through the development of the open data system, the openness of state authorities, and the capacity and financial support following the Law of Ukraine "On Public Associations" [132].

A review of funding approaches:

- *To create mechanisms for evaluating and monetizing ecosystem services as a prerequisite for making appropriate policy and management decisions and determining their effectiveness.* This can be done through the application of methodologies already developed at the international level for the assessment of ecosystem services and the introduction of voluntary payment for ecosystem services, which will contribute to the preservation of water, forest, and land resources and stimulate the implementation of NbS. At the same time, the economic assessment of ecosystem services and implementation of payment for them require special attention from the state and relevant scientific ecological and economic institutions.
- *To develop the possibility for "greening" in the water, forest, agricultural and other sectors of the economy by creating access to "climate" funds, budget funds, tax relief, etc.* For example, the creation of mechanisms for the monetization of carbon units would allow agricultural producers and forestry enterprises to receive funds due to applying practices to manage and accumulate carbon. It is recommended to make changes to the Budget Code of Ukraine, providing the possibility of allocating funds for implementing NbS along with environmental protection measures from the state and local budgets. Furthermore, it is necessary to promote the development of financial and fiscal mechanisms for stimulating the implementation of NbS, mainly through systems of taxation, rent payments, insurance, and lending, as well as other instruments aimed at attracting investments, international grant programs, and providing state support.
- Following the Law of Ukraine "On State Special Programs" [133], *develop a state special program that will provide support for NbS implementation for achieving climate goals and preserving biodiversity* or several special programs aimed at providing support for the development of certain NbS, such as the revitalization of rivers, close-to-nature forestry, land conservation and restoration of pastures.

Improvement of legislation:

- *To incorporate the concept of nature-based solutions in the environmental policy of Ukraine and to determine conceptual grounds for their implementation in line with the definition approved by the UNEP/EA.5/ Res.5 Resolution.* The introduction of the concept of NbS and other relevant terms related to climate issues, currently absent in national legislation, can be implemented through the formulation of relevant provisions in new legislation on climate issues or through the introduction of changes to existing laws, in particular, to the Laws of Ukraine "On Environmental Protection" and/or " On the Key Principles (Strategy) of the

State Environmental Policy of Ukraine until 2030", which will create a precedent for making changes to other relevant regulatory and legal acts.

- *To amend the national legislation to ensure the introduction and implementation of NbS in all sectors of the Ukrainian economy for sustainable use, protection and restoration of the environment, compliance with environmental protection requirements, and achieving the Sustainable Development Goals.* The Water, Forest, and Land Codes of Ukraine and the corresponding by-laws need to be improved and supplemented by provisions that will contribute to the implementation of specific NbS, such as the following: restoration and preservation of springs and sources of rivers, restoration of rivers and their valleys through strengthening requirements and establishing a differentiated size and regime of riparian zones and coastal protection strips, conservation, re-watering, and sustainable use of peatlands, close-to-nature forestry and restoration of forest landscapes, implementation of carbon farming and widespread introduction of agroecological practices, restoration of pastures and pasture livestock, etc. Furthermore, it is possible to strengthen the positions contributing to NbS implementation by improving the List of activities related to environmental protection measures. In addition, it can also be achieved through the development of other by-laws, such as the Rules for the maintenance and preservation of field protection forest strips located on agricultural lands [83], which should be developed for each relevant NbS. At the same time, it is recommended to avoid excessive regulation and bureaucratization of the organizational bases for NbS implementation.
- *To include the requirement for NbS implementation into the strategic, programming, and planning documents of the national, regional, and local levels (both conceptually and with an indication of specific types of NbS).* It seems appropriate to amend the Strategy of Environmental Safety and Adaptation to Climate Change until 2030 to detail the measures needed to mitigate the impact of climate change and adapt to it and sequester carbon through natural ecosystems in various sectors through the implementation of NbS. The concept of NbS and the corresponding provisions on their implementation should be introduced into the regulatory legal acts that will be developed, in particular for pursuing the Biodiversity Conservation Strategy and the Action Plan (NBSAP), which is a requirement, in particular, of the decisions of COP15 to the Convention on Biological Diversity. It is recommended to improve the legal regulation on including NbS in strategic and urban planning documents at the regional and local levels. For example, amendments can be made to the State Regional Development Strategy for 2021-2027, relevant regional and local strategies, or it is worth considering the possibility of implementing NbS in such documents for the following period. Another step could be to introduce amendments to the Law of Ukraine "On Regulation of Urban Planning Activities" to ensure the inclusion of specific NbS in community development and restoration plans. An important step for the implementation of NbS is their inclusion in River Basin Management Plans, which will contribute to the fulfillment of Ukraine's obligations under the Association Agreement with the EU.
- *To ensure the improvement and implementation of legislation in terms of monitoring the state of the environment (atmospheric air, greenhouse gas emissions, climate indicators, water, forest and land resources, biodiversity, etc.), as a mandatory prerequisite for the development of scientific foundations for the sustainable use of natural resources for making appropriate policy and management decisions and evaluating their effectiveness.* It is recommended to develop and adopt relevant by-laws that will regulate the monitoring, collection, accumulation, and processing of data and their availability in accordance with the relevant provisions of the Laws of Ukraine "On Access to Public Information" [134], "On Environmental Protection" [51], "On Flora" [135], "On Fauna" [136], "On Official Statistics" [127], as well as the Water, Forest, and Land Codes [53-55], etc.

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**ОРГАНІЗАЦІЯ
ОБ'ЄДНАНИХ
НАЦІЙ**

UNEP/EA.5/Res.5



**Організація Об'єднаних Націй
Асамблея з питань навколишнього
середовища Програми ООН з
навколишнього середовища**

Поширення:
Загальне
7 березня 2022 р.
Оригінал: англійська мова

**Асамблея ООН з питань
навколишнього середовища
Програми ООН з навколишнього
середовища**

П'ята сесія
Найробі (гібридний формат), 22 та 23 лютого 2021 року
і 28 лютого-2 березня 2022 року

Резолюція, прийнята Асамблеєю Організації Об'єднаних Націй з питань навколишнього середовища 2 березня 2022 року

5/5 Природоорієнтовані рішення для підтримки сталого розвитку

Асамблея Організації Об'єднаних Націй з питань навколишнього середовища

Підкреслюючи важливість посилення заходів щодо природи для реалізації Порядку денного у сфері сталого розвитку до 2030 року та Цілей сталого розвитку, Декларації Ріо-де-Жанейро про навколишнє середовище та розвиток, Конвенції про охорону біологічного різноманіття та інших конвенцій, пов'язаних з біорізноманіттям, Рамкової конвенції ООН про зміну клімату та прийнятої відповідно до неї Паризької угоди, Конвенції ООН про боротьбу з опустелюванням у тих країнах, що потерпають від серйозної посухи та/або опустелювання, особливо в Африці, Сендайської рамкової програми зі зниження ризику стихійних лих на 2015–2030 роки, Програми ООН щодо Десятиліття відновлення екосистем на 2021–2030 років та десятиліття дій з досягнення Цілей сталого розвитку на 2020–2030 роки; очікуючи прийняття та впровадження амбітної, збалансованої, практичної, ефективної та надійної глобальної рамкової програми з біорізноманіття на період після 2020 року і відзначаючи Зобов'язання лідерів щодо природи: об'єднання для запобігання втрати біорізноманіття до 2030 року для сталого розвитку,

Вітаючи доповідь Міжурядової науково-політичної платформи з оцінки біорізноманіття та екосистемних послуг під назвою *Звіт з глобальної оцінки біорізноманіття і екосистемних послуг* (Global Assessment Report on Biodiversity and Ecosystem Services)[1] та внесок Робочої групи I під назвою *Зміна клімату 2021: основа фізичної науки* (Climate Change 2021: The Physical Science Basis) [2], та Робочої групи II під назвою *Зміна клімату 2022: впливи, адаптація і вразливість* (Climate Change 2022: Impacts, Adaptation and Vulnerability) [3], до шостого експертного звіту

Міжурядової групи експертів з питань зміни клімату, та приймаючи до уваги інші відповідні звіти,

Визнаючи взаємозалежність між втратою біорізноманіття, забрудненням, зміною клімату, опустеленням та деградацією земель та їх взаємозв'язок із добробутом людини, включаючи здоров'я, та важливість забезпечення цілісності всіх екосистем,

Визнаючи також, що ключові можливості для посилення дій щодо природи для досягнення Цілей сталого розвитку полягають у посиленні співпраці, впровадженні та масштабуванні природоорієнтованих рішень, забезпечуючи при цьому їхні соціальні та екологічні гарантії, враховуючи, що природоорієнтовані рішення є ефективними та дієвими, коли вони розроблені на основі конкретного контексту для досягнення декількох переваг та застосовуються відповідно до наявних наукових доказів,

Згадуючи рішення V/6, VI/12, VII/11 та IX/7 Конференції Договірних Сторін Конвенції про охорону біологічного різноманіття про екосистемний підхід та рішення 14/5 про питання біорізноманіття та зміну клімату і визнаючи, для Договірних Сторін Конвенції, беззаперечну роль Конвенції у збереженні, відновленні та раціональному використанні біорізноманіття і в комплексному управлінні природними ресурсами,

Визнаючи необхідність узгодженого багатостороннього визначення концепції природоорієнтованих рішень, усвідомлюючи важливість і гармонізацію з концепцією екосистемних підходів, а також у світлі занепокоєння щодо потенційного неправильного використання концепції природоорієнтованих рішень,

1. *Вирішує*, що природоорієнтовані рішення – це дії спрямовані на захист, збереження, відновлення, стале використання і управління природними або зміненими наземними, прісноводними, прибережними та морськими екосистемами, які у ефективний і адаптивний спосіб сприяють вирішенню соціальних, економічних та екологічних викликів, одночасно забезпечуючи добробут людини, послуги екосистем, стійкість та переваги біорізноманіття, і визнає, що природоорієнтовані рішення:

(a) Поважають соціальні та екологічні гарантії відповідно до трьох «Ріо-де-Жанейрських конвенцій» (Конвенція про охорону біологічного різноманіття, Конвенція ООН про боротьбу з опустелюванням та Рамкова конвенція ООН про зміну клімату), включаючи такі гарантії для місцевих громад та корінних народів;

(b) Можуть впроваджуватися відповідно до місцевих, національних та регіональних обставин, відповідно до Порядку денного сталого розвитку на 2030 рік, і можуть управлятися у адаптивний спосіб;

(c) Є одними з дій, які відіграють важливу роль у загальних глобальних діях щодо досягнення Цілей сталого розвитку, у тому числі шляхом ефективного та дієвого вирішення основних соціальних, економічних та екологічних проблем, таких як втрата біорізноманіття, зміна клімату, деградація земель, опустелювання, продовольча безпека, ризики стихійних лих, міський розвиток, доступність води, ліквідація бідності, нерівність та безробіття, а також соціальний розвиток, сталий економічний розвиток, здоров'я людини та широкий спектр екосистемних послуг;

(d) Можуть сприяти стимулюванню стійких інновацій та наукових досліджень;

2. *Визнає*, що природоорієнтовані рішення можуть суттєво сприяти боротьбі зі зміною клімату, визнаючи при цьому необхідність аналізу їхнього впливу, у тому числі в довгостроковій перспективі, і визнаючи, що вони не замінюють необхідність швидкого, глибокого та стійкого скорочення викидів парникових газів, але можуть покращити дії щодо адаптації та стійкості до зміни клімату та пом'якшення наслідків зміни клімату;

3. *Також визнає* потенціал стійких та екологічно чистих біологічних продуктів, інновацій та технологій, які є результатом природоорієнтованих рішень, коли вони сприяють сталому споживанню та виробництву та є корисними для природи і відповідають

міжнародним зобов'язанням та відповідним багатостороннім угодам щодо біорізноманіття, клімату, навколишнього середовища та сталого розвитку, при цьому усвідомлюючи потенційні пов'язані з цим ризики, у тому числі для місцевих громад та корінних народів;

4. *Визнає*, що концепція природоорієнтованих рішень враховує та узгоджується з концепцією екосистемних підходів, визначених у рамках Конвенції про охорону біологічно різноманіття та іншими підходами до управління та охорони природи, що здійснюються відповідно до національної політики та законодавчої бази, та які визначені в межах відповідних багатосторонніх екологічних угод;

5. *Звертається із запитом до* Виконавчого директора Програми ООН з навколишнього середовища, за умови наявності ресурсів та з метою подальшої підтримки впровадження природоорієнтованих рішень, як визначено в цій резолюції, скликати міжурядові консультації із дотриманням принципів прозорості, інклюзивності, регіонального та гендерного балансу, з метою здійснення наступного:

(a) Скласти перелік прикладів передових практик використання природоорієнтованих рішень, що базуються на результатах наукових досліджень;

(b) Оцінювати існуючі та обговорювати потенційні нові пропозиції, критерії, стандарти і настанови для вирішення розбіжностей з метою досягнення спільного розуміння серед держав-членів щодо впровадження природоорієнтованих рішень, включаючи підтримку держав-членів у розробці, впровадженні та оцінці природоорієнтованих рішень, спираючись на існуючу роботу, ініціативи та платформи, у відповідних випадках, і без шкоди для існуючих зусиль та ініціатив і нових пропозицій окремих держав-членів;

(c) Визначати варіанти підтримки стійких інвестицій у рішення на основі природокористування та поширювати інформацією про двосторонні та багатосторонні джерела фінансування, щоб дозволити країнам, що розвиваються, розробляти та впроваджувати природоорієнтовані рішення;

6. *Також закликає* Виконавчого директора, за умови наявності ресурсів, підтримати міжурядові консультації, включаючи забезпечення участі країн, що розвиваються, та відповідних партнерів та зацікавлених сторін відповідно до чинних правил Організації Об'єднаних Націй;

7. *Закликає* держави-члени та Виконавчого директора у співпраці з іншими відповідними підрозділами Організації Об'єднаних Націй підтримати виконання цієї резолюції у партнерстві з місцевими громадами, жінками та молоддю, а також з корінними народами, за їх вільної, попередньої та інформованої згоди, оскільки їхні знання та методи виявилися ефективними у збереженні, відновленні та стійкому використанні біорізноманіття;

8. *Закликає* держави-члени дотримуватися гендерно-орієнтованого, партисипативного та повністю прозорого підходу до розробки, впровадження та моніторингу природоорієнтованих рішень.

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- 1 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Global Assessment Report on Biodiversity and Ecosystem Services (Bonn, Germany, IPBES secretariat, 2019).
 - 2 Intergovernmental Panel on Climate Change, Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press, 2021).
 - 3 Intergovernmental Panel on Climate Change, Climate Change 2022: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press, 2022).

Climate Scenarios for Ukraine

By the middle of the 21st century, Ukraine's agricultural, forestry, and water industries will experience significant climatic impacts due to extreme and dangerous weather phenomena (seasonal (rain) floods, floods, strong winds, heavy showers, hail, droughts, heat waves, tropical nights, etc.). These negative impacts are already causing significant economic losses, which will only increase over time. Therefore, considering climate change for the formation of future policies and ways of developing the state and sectors of the economy is a necessary step and is encouraged by international processes, particularly the UN Framework Convention on Climate Change.

The tools for assessing future climate change are general circulation models of a planetary atmosphere and ocean and regional climate models that predict the state of the climate based on meteorological observations (temperature, precipitation, humidity, etc.) and data on altitude and landscape type (water area, land covered with grass, forest, buildings, etc.). Different scenarios of general climate models are built based on various assumptions about the socioeconomic development of humanity and the concentration of greenhouse gases.

The most used are 5 scenarios of "Representative concentration pathways" (RCP), which were presented in the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC) in 2013. They were used in the International initiative to reduce the scale of projections as initial and maximum conditions for RCP on all continents; in particular, calculations for Europe were carried out with a horizontal step on a geographical grid of 0.1° (~11km).

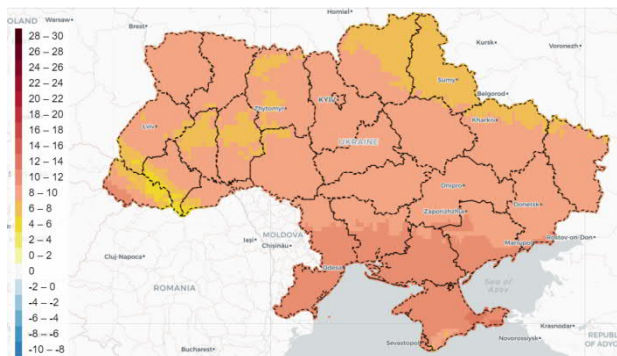
RCP1.9 and RCP 2.6	RCP4.5* and RCP 6.0	RCP8.5
Optimistic scenarios predict low emissions of greenhouse gases and, accordingly, the lowest level of global warming by 2100, which will correspond to the additional anthropogenic radiation impact of up to 3 W/m ² , which is foreseen by the Paris Agreement of 2015	Intermediate scenarios with radiation exposure values of 4.5 and 6.0 W/m ² . * for projections for the period 2081 - 2100 with a base period of 1991 - 2010 *	The most severe (pessimistic) scenario of the most significant emissions assumes the development of humanity according to the principle of "business as usual" without substantial transformations, which will cause an increase in radiation exposure by 8.5 W/m ² and above.

The RCP scenarios represent the final levels of greenhouse gas concentrations and all changes in these concentrations over time from year to year. Note that greenhouse gases have a radiation impact, i.e., they cause changes in the energy balance due to the redistribution of solar radiation flows at the upper limit of the atmosphere, which is measured in W/m² and, accordingly, on the surface of the planet. Climate projections until the end of the 21st century are calculated based on scenarios. Climate projections differ from forecasts precisely by using scenarios, and not other forecasting methods (inertial, climatic, analogs, etc.).

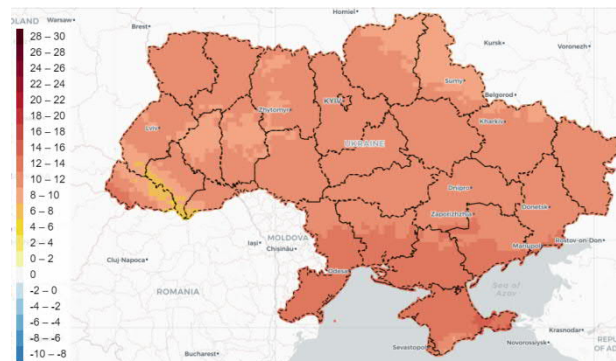
It was the RCP4.5*3 scenario that was used during the national workshop to analyze the situation in Ukraine in the period up to 2100 and assess the relevant climate threats to water, forestry, and agriculture.

TEMPERATURE

By the end of the century, the average air temperature is expected to increase by 1.8-2.3°C. Minimum, within the range of 1.8-1.9°C, the temperature will rise in the west (Zakarpattia, Prykarpattia (excluding Chernivtsi region), in the northwest of the Volyn and Lviv regions (except for the northeast). In the south – the Autonomous Republic of Crimea (except for the northeast and the sea coast), a center of elevated temperatures will form in the southeast of Odesa and the southern area of Kherson regions (without the coast). The maximum increase, up to 2.3°C, will be observed in the northeast of the country: in Sumy, in the northeastern part of Chernihiv, in the north of Kharkiv, and Luhansk (except for the south) regions. In the rest of Ukraine, the temperature will rise by 1.9-2.2°C.



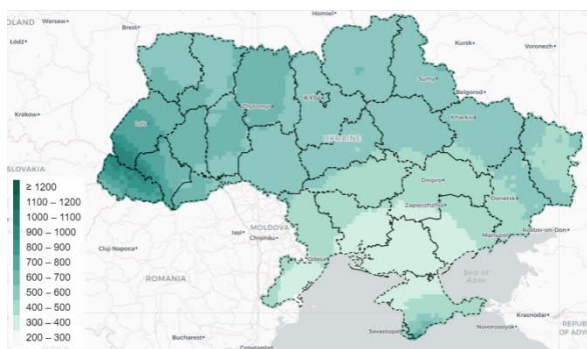
Average annual temperature for the period 1991 - 2010



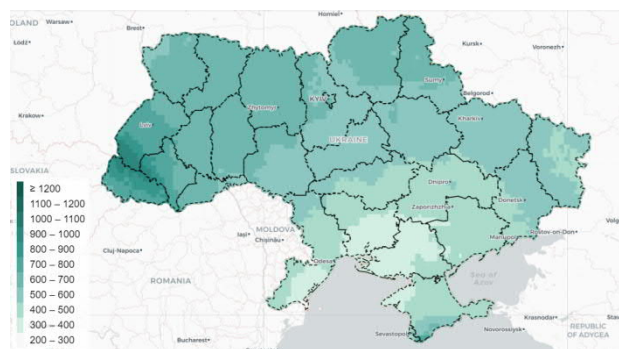
Projection of average annual temperature for the period 2081 - 2100 (RCP4.5)

PRECIPITATIONS

According to the RCP4.5 scenario, an increase in precipitation of up to 10% is expected throughout the country (mainly in Sumy, Chernihiv, Zhytomyr, Khmelnytskyi, Rivne, Volyn, Kirovohrad, part of Kherson, Zaporizhzhya, and Crimea), but with a decrease in precipitation in certain months of the year.



Annual precipitation for the period 1991 - 2010



Projection of annual precipitation for the period 2081 - 2100 (RCP4.5)

CONSEQUENCES

1. An increase in temperature will lead to:

1.1. Increased evaporation from the soil surface.

1.2. Increases in the energy of convection processes when overheated air masses and moisture rise more intensively, increasing the height where cumulonimbus clouds are formed, with a corresponding increase in precipitation intensity, thunderstorms, and the size of hail.

1.3. Increase in intensity and duration of heat waves in summer.

1.4. Increase in the probability of forest and other fires.

1.5. Increase in the number of tropical nights, when the temperature at night in summer does not fall below 20°C even in the north of the country.

1.6. Increase in the duration of the growing season and its heat supply.

1.7. Reduction in the duration of the cold period with temperatures below 0°C, days with ground frost, and the time of permanent snow cover.

2. A change in the precipitation regime will lead to:

2.1. Increase in droughts, mainly in the south of the country.

2.2. The arid climate will spread from the southern territories further to the north.

2.3. Redistribution of precipitation throughout the year with an increase in winter and a decrease in summer.

2.4. A decrease in the proportion of precipitation in the form of snow, but cases of extreme snowfall, especially at the end of the season, are not excluded.

2.5. Changes in the precipitation regime with a greater share of heavy showers can cause catastrophic floods, mudslides, and topsoil loss.

2.6. Changes in the feeding regime of rivers and other hydrological characteristics, including surface and groundwater runoff.

The most critical factors of climatic impact on the water, forest, and agricultural sectors

The main indicators by which the impact of climate change on agriculture, forestry, and water management can be determined are defined in the Report of the IPCC “On the physical science basis of climate change”¹³. Note that some of the factors listed in the report, such as the impact of the open ocean, will not directly affect the economic sectors in Ukraine (except fishing in the seas), while others may cause risks and lead to losses regardless of the industry and the location of the enterprise within borders of Ukraine.

Most of the factors proposed by the IPCC (8 out of 33) characterize humidity and aridity, six – snow cover and ice (also related to the solid aggregate state of water), and five – the open ocean, which also makes up the vast majority of the hydrosphere. In addition, four factors are defined for the characteristics of heat and cold, and four are for wind. Finally, three factors are attributed to coastal features, and three are to others. The water cycle suffers the most from climate change, which results in the most significant impact on economic, human, and ecosystem sectors.

The main factors of climate impact on agriculture, forestry, and water management in Ukraine are humidity and aridity. Aridity refers to the average climatic conditions determining the overall water balance in the soil and on the surface due to the precipitation amount and evaporation from the soil and plants' surface. Therefore, aridity is likely to affect all water resources and their conditions, except for water quality, where the impact is moderate.

Next in importance is average precipitation and flooding, which have high risks of adverse impacts on crop cultivation, river runoff, and surface water and moderate to high – on all other waters. Heavy precipitation, rain floods, and hydrological droughts have high risks of impact for the two mentioned assets and moderate – for others, except for forestry, where the impact of these factors is estimated to be insignificant. On the other hand, there is a high risk of forestry damage caused by fire-hazardous weather conditions, and for other sectors the risk is assessed as moderate (except for groundwater, where there is no or low risk). Extreme heat has high exposure risks for agriculture and forestry and moderate – for water quality. Agricultural and ecological droughts also pose high risks for agriculture and forestry, although these factors do not significantly impact the water sector.

Other factors in the category of heat and cold have the following effects: average air temperature significantly affects the forest sector and also has a moderate impact on agriculture and water quality; cold waves pose a high risk for livestock and a moderate one for crop cultivation and forestry; and frosts have a high risk of impact on crop production and moderate – on forestry and groundwater. Finally, in the snow and ice category, heavy snowfall, freezing rain, and hail have a moderate risk of negative impact on agriculture and forestry, except for a high risk from hail for crop cultivation.

Coastal flooding has a moderate risk of impacts on agriculture, forestry, and water quality. The high-risk impact of the relative sea level has been assessed for the quality of surface and groundwaters. In the wind category, moderate risks from sand and dust storms are expected for all asset sectors, except for forestry and groundwater; strong winds cause a moderate impact on agriculture and forestry, and medium wind speed only on crop cultivation and forestry.

Three factors from the “other” category, namely: weather conditions with air pollution, the ground-level concentration of carbon dioxide, and terrestrial solar radiation, have a moderate impact on agriculture and forestry, except carbon dioxide, which has a high impact specifically on crop cultivation and forestry.

The factors analyzed above, which have a climatic impact on the economic sectors in Ukraine, can be ranked according to the degree of importance for further assessments and the development of climate change adaptation measures:

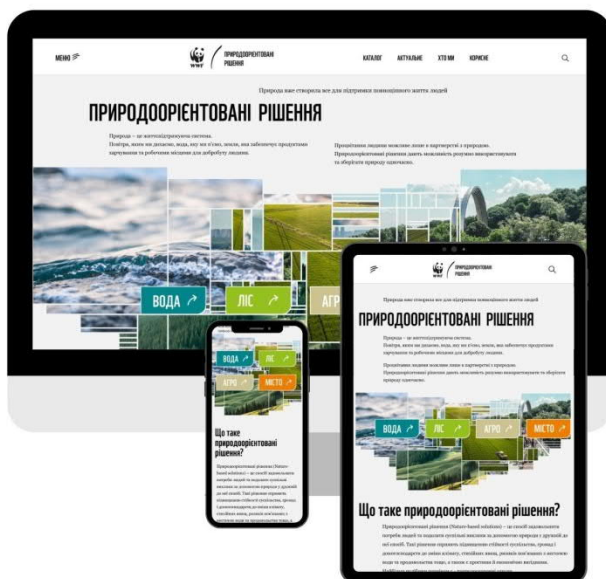
¹³ <https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/>

1. Aridity;
2. Average amount of precipitation;
3. River floods;
4. Heavy precipitation and rain floods;
5. Hydrological droughts;
6. Fire-hazardous weather conditions;
7. Extreme heat;
8. Agricultural and ecological droughts;
9. Average air temperature;
10. Waves of cold;
11. Frosty days;
12. Heavy snowfall and freezing rain;
13. Hail;
14. Coastal flooding;
15. Relative sea level;
16. Sand and dust storms;
17. Strong wind;
18. Average wind speed;
19. Ground-level concentration of carbon dioxide;
20. Terrestrial solar radiation;
21. Weather conditions under air pollution.



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