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COMPREHENSIVE REVIEW OF PROBLEMS, INTERNATIONAL TRENDS AND STRATEGIC APPROACHES TO SOLVING THE PROBLEM OF FORECASTING CLIMATE PARAMETERS IN THE CONTEXT OF ADAPTATION TO CLIMATE CHANGE

Myroslav Malovanyy[1], Mykyta Antonov[1]✉, Tetiana Shpyrko[2]

[1] Lviv Polytechnic National University,
12, S. Bandery str., Lviv, 79013, Ukraine
[2] Odesa National Technological University,
112, Kanatna str., 65039, Odesa, Ukraine,
mykyta.d.antonov@lpnu.ua

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Abstract. The article is dedicated to the current issue of forecasting climate parameters in the context of the regular trends of adaptation by all subjects to climate change. The work comprehensively investigates the existing problems in the realm of current climate changes, focusing on c ontemporary international trends and strategic approaches to addressing this issue, considering the implementation's state of the measures for climate change adaptation. The aim of the research is to draw attention to the escalating problem of accelerated climate change due to harmful anthropogenic impacts by humanity. The analysis has shown that humanity's ever-increasing harm to the environment disproportionately exceeds efforts for adaptation to climate change, which directly affects economic (industry, energy, trade), social (public health, food security and demographic sectors), and other critical areas of human activity. The article explores the main legal framework at both national and international levels, as well as enumerates global trends and tactical, strategic approaches aimed at reducing anthropogenic impacts on nature and implementing measures for climate change adaptation.

Keywords: international tendency, climate change, forecasting climate parameter, adaptation, conference.

1. Introduction

Speaking about the main global problems of the 21st century, one of the biggest unresolved ones, at the current stage of human development, along with the demographic crisis, is the problem of the climate crisis. It is characterized by a global nature, but we want to consider it in a regional context. Ecology and war have become constant topics for discussion in Ukraine. The second directly affects the state of the first, in particular through constant rocket attacks, damaged oil depots, burned farmland, mining of hundreds of thousands of hectares of land and the Black Sea, and the largest man-made environmental disaster of the 21st century − the explosion of the Kakhovka hydroelectric dam, which could potentially be considered a direct act of ecocide.

Serious climate change in recent decades, including due to harmful human influence, is a major problem, but not the only one. Among others, we can highlight the deterioration of atmospheric air quality, the state of waste management, and the irrational use of natural resources, which ultimately leads to an unstoppable loss of biological diversity.

2. Theoretical part

2.1. General overview of international climate change and issues

Despite the fact that today a huge number of publications and studies are devoted to global climate change as one of the most important environmental prob-

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lems, in particular by the Intergovernmental Panel on Climate Change (IPCC) (Verkhovna Rada of Ukraine, 2021), the issue of the climate`s change impact will always be relevant. In particular, this is due to the large anthropogenic impact and irrational exploitation of nature (Agency for Sustainable Development of the Carpathian Region "Forza", 2015). At the same time, it is necessary to understand the difference between nature and climate, since the concepts are not identical, because the first reflects the current state of the atmosphere (including indicators of humidity, temperature, cloudiness, pressure, wind force and speed, etc.), and the second is the long-term weather regime that is characteristic of a certain area or zone.

The Climat change, according to the United Nations Framework Convention on Climate Change (UNFCCC), is the observed change in the climate which resulted from direct or indirect human activities, which leads to a change in the global composition of the atmosphere and is additional to the natural climate change observed over a comparable time period. Thus, the UNFCCC distinguishes between climate change due to human activities that alter the composition of the atmosphere and climate variability due to natural causes (Glossary. IPCC, 2022).

When we talk about climate change, we need to take into the considiration that the most influential factors are quite young, around 100 years old. In 2013, in Stockholm, scientists from over 195 countries signed the Fifth Assessment Report on the State of Global Climate Change, prepared by the Intergovernmental Panel on Climate Change (IPCC). One of the most important conclusions of the Fifth Assessment Report is that scientists are more convinced than ever that human activities are the most significant factor in climate change since 1951 (International Climate Network, 2013).

One of the "best" examples of human influence on the climate is the gradual increase in average annual temperatures. According to the report of the IPCC, scientific studies indicate that only about a third of the climate change resulting from anthropogenic influence since the end of the 19th century is due to natural changes, and two thirds are due to human activity, in particular the increase in the concentration of greenhouse gases in the atmosphere (Ivaniuta et al., 2020).

According to the United Nations, instead of limiting global warming to 1.5 °C under the 2015 Paris Agreement, the world is currently on track to warm by 3.2 °C by 2100, Fig. 1 (UN Environment Programme, 2019).

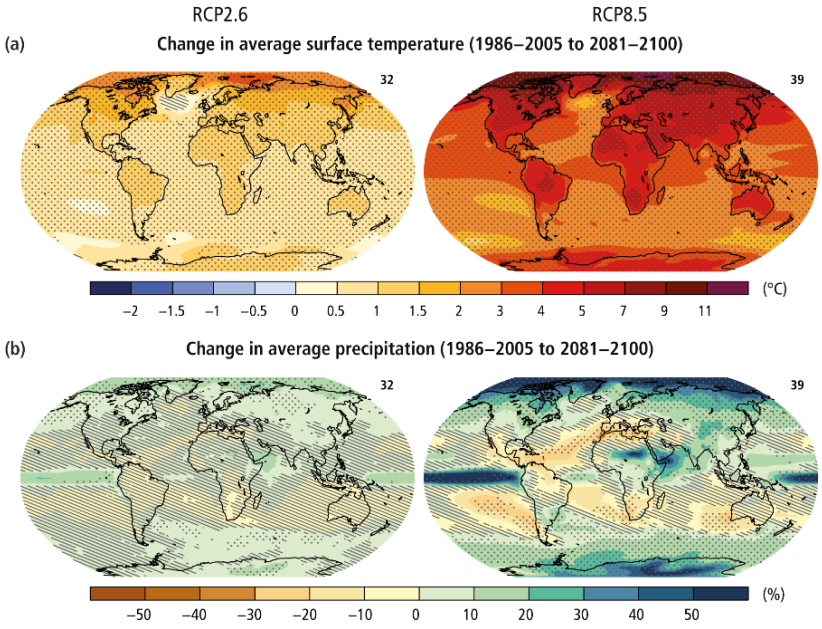

Fig. 1. IPCC forecast on average annual temperature rise (Climate Change Synthesis, 2014)

In August 2021, the IPCC published a new report dedicatecd to the planet's global climate change and the consequences that these changes will have for humanity. The report shows that the responsibility for greenhouse gas emissions lies, first of all, with humans and their activities. Average annual temperature of each of the following forty years has been warmer than any decade that preceded it since 1850. The global surface

temperature of the planet in the first two decades of the 21st century (2001–2020) was 0.99 °C higher compared to 1850–1900. And during 2011–2020, this temperature was already 1.09 °C higher than in 1850–1900, the document states. – "Human influence is increasing the temperature of the planet's climate at a rate unprecedented in the last two thousand years" (IPCC et al, 2021).

The loss of forests and wetlands, which would otherwise sequester CO_2, also exacerbates the warming effect. Over the past 300 years, almost 1.5 billion hectares of the world's forests have been cut down. Out of the total 2 billion hectares destroyed over the past 10,000 years, the world has lost a third of its forests, which is almost two billion hectares of forest. In the long term, this may not seem like such a serious problem, but a closer look at this issue shows that 1.5 billion of the 2 b illion lost were cut down over the past 300 years.

More over, it is estimated that 80,000 acres of tropical forests are cut down daily for the logging industry or to make way for agriculture (EkoEnergy).

Global sea levels have risen by 15–20 cm over the past 100 years. About a third of this rise is due to thermal expansion of ocean water as it warms, and about two-thirds is due to meltwater returning to the ocean as glaciers and ice sheets melt on land. The consequences are catastrophic: A) sea level rise impacts everyone living on the coast through flooding, higher storm surges, extreme tides, and increased vulnerability to tsunamis; B) loss of coastal ecosystems; C) decline of crop yields; D) damage to ports that leads to disruption of the maritime trade.

Climate change is one of the greatest threats to humanity, with far-reaching impacts on society, the environment, and the economy. Climate change affects all regions of the world and all segments of the population. Research data indicates that without adaptation measures, climate change could reduce global agricultural growth by up to 30 % by 2050 (Munich Security Conference, 2020). Rising sea levels and increased storms could force hundreds of millions of people in coastal cities to leave their homes, while total damages in coastal urban areas could exceed $1 trillion annually by 2050 (Ivaniuta et al., 2020). UN data shows that climate change will have devastating consequences for people living in poverty (Alston, 2011).

The terrible state of atmospheric air quality and the growing threat of the consequences of global warming are not the only environmental problems that can cause serious harm to humanity. One of the key sectors of the domestic and foreign economy of most countries in the world is agriculture. The previously mentioned fifth conclusion of the IPCC indicates that there is an urgent need for significant and sustainable decarbonization and climate change adaptation measures in the field of ensuring food security (Verkhovna Rada of Ukraine, 2021).

The conclusions' forecasts demonstrate the negative impact of climate change on *crop yields*, especially in regions with tropical and temperate climates, where a 2 °C increase in temperature without adaptation will negatively affect the yields of wheat, corn, soybeans, and rice, and the general trend of increasing global temperature, accompanied by a reduction in water resources and increased competition for them, is becoming a risk factor for food security on a global scale (Ivaniuta et al., 2020).

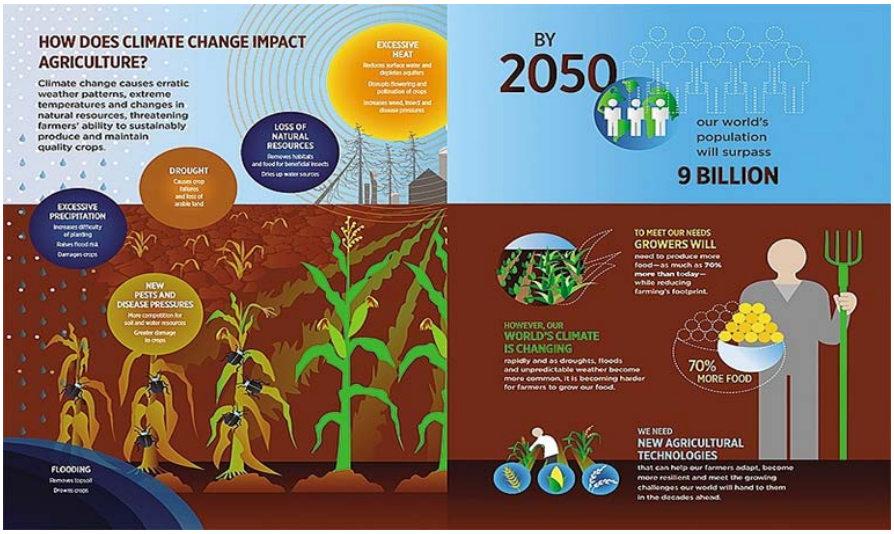

Fig. 2. The presentation of how does climate change impact agriculture (Vietnam Investment Review, 2018)

The situation is not getting better for Ukraine either. As noted by Vira Balabukh, Ukrainian Hydrometeorological Institute of the State Emergency Service and the National Academy of Sciences of Ukraine, in the work "Regional Manifestations of Global Climate Change in the Transcarpathian Region", one of the main manifestations of regional climate change against the background of global warming processes is a significant increase in air temperature, a change in the thermal regime and precipitation structure, an increase in the number of natural meteorological phenomena and extreme weather conditions (Balabukh, 2013).

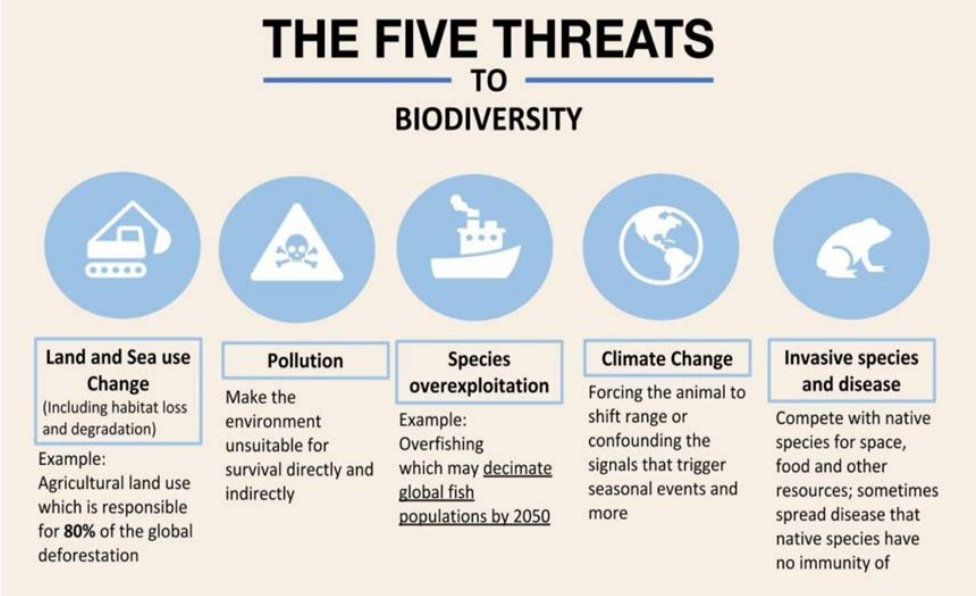

Fig. 3. The Five threats to biodiversity (Mulnern, 2020)

Changes in weather conditions (increased air temperature, uneven distribution of precipitation, which is torrential in the warm period, inefficient accumulation of moisture in soils) lead to an increase in the number and intensity of droughts. Together with other negative factors of anthropogenic impact, this can lead to an expansion of the zone of risky agriculture and desertification in the southern regions of Ukraine (Prokopenko, 2024).

Another problem is the state of water resources. Ukraine has one of the lowest indicators of its own water resources security among European countries, which is only 1 thousand cubic meters of local runoff per capita, while in Canada this indicator is 94.3 thousand m^3, in Russia – 31 thousand m^3, in the USA – 7.4 thousand m^3, in Germany – 1.9 thousand m^3. At the same time, the security of local water resources in individual regions of the country differs by dozens of times: from 0.14 km^3/year in the Kherson region to 7.92 km^3/year in the Transcarpathian region. Climate change also negatively affects the state of groundwater, which is due to a significant decrease in infiltration recharge due to the progressive increase in total evaporation (Information and analytical report, 2020).

The fuel and energy industry is traditionally considered as the one with the most significant impact on climate change as the main source of greenhouse gases. But the energy sector is also the most vulnerable to climate change due to the peculiarities of its functioning, which are associated with natural and climatic conditions and the need for significant transformation to ensure the adaptation of the fuel and energy complex. The issues of the climate's change profound impact on the energy sector of countries such as Argentina, Slovenia and Pakistan, as well as recommendations for the energetic's branch adaptation to the inevitable negative consequences of global warming are considered in the IAEA reports (Impact of climate change on the energy sector).

Due to significant and abrupt climate change, a large part of natural systems will be threatened, which may be particularly sensitive due to limited adaptive capacity, and some of these systems may be significantly damaged. To a large extent, this also applies to many species of living organisms that live in the natural environment under familiar conditions. Individual species may increase their numbers or areas of habitat in new conditions, but climate change will

increase the existing risks of extinction of some more vulnerable species and significantly increase the threat of biodiversity loss (Ivaniuta S. P. et al., 2020).

Experts from the World Wildlife Fund (WWF) have identified five groups of main environmental factors that cause global biodiversity loss (WWF, 2016):

1) loss and degradation of a species' habitat due to complete destruction or fragmentation of its habitat, as well as deterioration of its basic characteristics;

2) overexploitation of species (unsustainable fishing, mining or poaching, unintentional destruction of individuals of non-commercial species, etc.);

3) pollution that affects species directly, turning the habitat into an unfavorable one for their life, or indirectly, causing a decrease in the number of food species, reproductive activity and, ultimately, a decrease in the number of species;

4) alien species that can compete with native ones for territories or water areas, food or other resources and morbidity;

5) climate change, which can cause direct impacts (movement to areas with more favorable conditions) and indirect impacts, affecting the course of species life cycles (Ivaniuta S. P. et al., 2020).

All of the above-mentioned problems also directly affect *public health and migration processes*. According to the World Health Organization, in the period from 2030 to 2050, climate change will cause an additional 250 thousand deaths in the world annually, caused mainly by malnutrition, malaria, intestinal infections and direct negative effects of extremely high temperatures on the body. At the same time, additional costs for supporting public health (including additional costs for sectors that are decisive in shaping the medical and demographic characteristics of the population – agriculture, water purification and hygiene and sanitation) will reach approximately 2–4 billion dollars annually (World Health Organization, 2013).

2.2. Legal regulation designed to reduce human anthropogenic impact and adapt the world to climate change

2.2.1. International legal practice

The need to adapt to climate change and reduce anthropogenic impact on the environment requires consolidated efforts of the world community, including through the adoption of international treaties that define the main problems, their consequences, solutions and recommendations for signatory countries.

On May 9, 1992 was adopted an international environmental treaty called the *United Nations Framework Convention on Climate Change* (UNFCCC). It was designed to stabilize the problem of greenhouse gas emissions (hereinafter "GGE") the atmosphere and maintain it at such a level that would lower hardmful human's impact on the Earth's climate. The UNFCCC was discussed in Rio de Janeiro at the United Nations Conference on Environment and Development (UNCCD), unofficially known as the Earth Summit (United Nations Climate Change, 2024). Ukraine signed the Convention on June 11, 1992 and ratified on October 29, 1996.

One of the first tasks set by the UNFCCC was to establish national inventories of atmospheric GGE and removals, which is why *the Kyoto Protocol*, a commitment for developed countries to reduce such emissions, was concluded in 1997. The Protocol commits developed countries and countries with economies in transition to reduce or stabilize GGE by at least 5 % over the five-year period 2008–2012 compared to 1990 levels (UN Climate Change).

The next document under the UN Framework Convention on Climate Change was the 2015 *Paris Agreement* on regulating measures to reduce carbon dioxide emissions from 2020 (United Nations Climate Change, 2021).

When it comes to strategic framework documents of an international nature, it is worth mentioning the 2009 *White Paper*, which was intended to approve a framework for reducing the vulnerability of the EU to the impacts of climate change, building on the broad consultations launched in 2007 by the *Green Paper* on Adaptation to Climate Change in Europe and subsequent research efforts that identified actions to be taken in the short term (European Union, 2009).

The main outcome of the above-mentioned document was the creation of the European Platform on Adaptation to Climate Change (Climate-ADAPT), which was launched in March 2012. The platform contains the latest information on adaptation activities implemented in the EU, as well as some useful tools to support such policies. The White Paper contributed to the inclusion of such adaptation issues in EU strategies and relevant funding programmes (Agency for Sustainable Development of the Carpathian Region "Forza", 2015).

In April 2013, the European Commission published the *European Union Strategy on A daptation to Climate Change* (COM/2013/0216) (European Union, 2013). This strategy lists the effects of climate change

(hereinafter "CC"), as well as more specific measures and actions to adapt to the CC, and calls for specific comprehensive or sectoral adaptation measures at EU or EU country level. The strategy addresses crucial global problems of changes in natur, such as disruptions to supply chains and limited access to supplies of materials, energy and food, as well as their implications for the EU (Agency for Sustainable Development of the Carpathian Region "Forza", 2015).

But the implementation of the Strategy's provisions requires effective implementation "locally". Therefore, building on the success of the pilot project "Adaptation Strategies for European Cities", the European Commission decided to continue the policy of supporting urban adaptation strategies (Climate adapt, 2013).

In particular, the document states that on October 14, 2020, the European Commission adopted the Chemical Sustainability Strategy and its Action Plan, which are part of the EU's ambition for zero environmental pollution. The Strategy aims to improve the protection of citizens' health and the environment, stimulate innovation in safe and environmentally friendly chemicals, and propose a new subordination structure for chemicals management (Resource and Analytical Center "Society and Environment", 2020).

The Strategy outlined a r oadmap of measures needed to reform the EU's chemicals policy. In particular, it proposes to establish a severe restrictions on the most damaging and dangerous chemicals the the consumers' market, a p hase-out of the use of per- and polyfluoroalkyl substances (PFAS), and the need to take into account the "cocktail effect" when assessing the risks associated with chemicals (European Commission, 2024).

It also envisaged simplifying the risk assessment process for chemicals, updating the sustainability of supplies of critical chemicals in the EU, and increasing investment and innovation opportunities to produce safer compounds with sustainable structure (European Commission, 2020).

One of the measures to achieve the EU's zero pollution objective is the adoption of a corresponding action plan, which outlined the following important steps:

– measures to strengthen implementation and enforcement. The issue of how public authorities, businesses and citizens can use EU pollution legislation more effectively will be examined;

– the need to improve existing legislation on human health and the environment (will be the subject of a separate initiative);

– improving the monitoring and governance of pollution prevention and reduction policies, which will consider the possibilities of strengthening monitoring and governance both at EU and international level;

– promoting social change, in particular through the use of digital solutions, promoting the transition to sustainable consumption and making more sustainable decisions in society (European Commission, 2021).

On 16 September 2020, the European Parliament adopted a Resolution on the part of the European Union in protecting and restoring the world's forests, calling for a review of national policies to protect European forests and to step up the fight against deforestation worldwide. Among other things, the document calls for the establishment of binding targets for the protection and restoration of forest ecosystems, especially old-growth forests, in line with the EU Biodiversity Strategy to 2030 (European Parliament, 2020).

On 17 October 2020, the European Commission published a report containing the latest assessment of the state of nature in the European Union, carried out using a more detailed technical report from the European Environment Agency. The reports indicate some positive developments in nature conservation, mainly at n ational and regional level, but also highlight the need for further efforts to improve monitoring in Member States, obtain more data on marine species and habitats, and fully assess the role of the Natura 2000 network (European environment agency, 2020).

We would also like to mention such an important event as the annual UN Climate Change Conference. The event was initiated to accamulate the progress in combating the CC and, starting from the end of 20s, to establish solid legal obligations for developed countries to reduce the GGE under the Kyoto Protocol (UN Climate Change Conference Baku, 2024).

The 29th conference (hereinafter COP29) was held from 11 t o 22 November, this time hosted by Baku, Azerbaijan (UN COP29, 2024). Although the organization and holding of the conference were heavily criticized by activists and participants, the main goal of the event was the implementation ot further measures to slow global warming, highlighting the issues of the investments in the CC adaptation actions. Emphasis was placed on the

importance of operationalizing the Loss and Damage Fund to support vulnerable communities, especially in Small Island Developing States (SIDS) and Least Developed Countries (LDCs), calling for enhanced Nationally Determined Contributions (NDCs) in line with the 1.5 °C objective and insisting on the submission of national NDCs by 2025, with a focus on phasing out fossil fuels, increasing the use of renewable energy sources and addressing non-carbon emissions such as methane.

Fig. 4. Members of the COP29 in Baku (Esgdive, 2024)

Regarding adaptation, key figures appealed to all countries to organise the preparation and further submission of their National Adaptation Plans (NAPs) by 2025. Participants also highlighted the need to increase financing for this matter. More over, the Conference encouraged global financial institutions and the private investors to scale up financing for climate initiatives and promote investments in green technologies (UN Climate Change Conference Baku, Aliyev, 2024).

At COP29, climate finance was seen as a central theme, with a focus on increasing support for developing countries (hereinafter "the DCs") to address climate challenges and transition to green, low-carbon economies. One of the main events was the discussion of a New Collective Quantitative Goal (NCQG) on climate finance, which would set a new financial goal to support the DCs beyond 2025, building on the previous commitment of $100 billion annually. Discussed propositions included blended finance, which combined public and private investments to increase financing for climate initiatives, and debt-for-nature swaps, which would allow countries to redirect debt repayments to environmental and climate projects (Chathamhouse, 2024).

Developed countries have agreed to help channel "at least" $300 billion per year to the DCs by 2035 to support their efforts to fight back climate change (Chandrasekhar et al., 2024).

Here is a quick look at other key points of COP29:

Article 6 of the Paris Agreement. A major achievement over the past two weeks has been progress on carbon markets. After almost ten years of tough negotiations and hard work, countries have agreed on the final framework that defines how carbon markets will operate under the Paris Agreement, making trading between countries and the carbon crediting mechanism fully operational.

On the first day of COP29, countries agreed on standards for a centralized carbon market under the auspices of the UN (Article 6.4 mechanism). This is good news for developing countries, which will benefit from new financial flows. And it is especially good news for the LDCs, which will receive support in developing the capacity needed to take a place in the market (United Nations Climate Change Conference Baku, 2024);

Transparency. Transparent climate reporting took a big leap that will assist to build a stronger evidence base for the climate policy and identify financial needs and opportunities.

In addition, all transparency negotiation items were successfully concluded at CO P29, with Parties expressing their appreciation for the timely completion of the Enhanced Transparency Framework (ETF) reporting tools, technical training programs, support provided to the DCs for ETF reporting in 2024, and the successful launch of the verification process;

Adaptation. COP29 was a pivotal moment for adaptation, with several key outcomes being delivered. The COP decision on issues relating to the LDCs includes assistance in establishment of the programme for the implementation of the NAPs. Discussions on such adaptation plans brought together ministers from LDCs and SIDS, financial experts and international donors to underscore the growing necessity of climate adaptation. Their discussions focused on innovative financing, technical support and accelerated action to meet the 2025 deadline for submitting NAPs. The event concluded with a strong call for action to accelerate NAPs and translate plans into concrete results.

Gender and Climate Change. The Participants agreed on extending the prolonging Lima Work Programme on Gender and Climate Change for another 10 years, reaffirming the importance of gender equality and promoting gender mainstreaming within the Convention (UNFCCC. Secretariat, 2015).

Participation of civil society, children and youth. World leaders at COP29 were joined by representatives of civil society, subnational authorities, business, indigenous peoples, youth, philanthropy and international organizations.

COP29 was a substantial milestone as dedicated spaces were created to ensure meaningful participation of children in the Youth Climate Forum for the first time. Four children played the roles of moderators and speakers, engaging directly with Parties and observer organisations.

Their participation emphasized the importance of inclusiveness and intergenerational collaboration in advancing climate action.

No less important is the holding of conferences similar in content with the result of adopting regional Climate Change Adaptation Strategies, such as the APENA 3 Pilot Project "Adaptation to Climate Change in Ukraine". On September 18, 2024, the APENA 3 pilot project "Adaptation to Climate Change in Ukraine" was presented with the participation of representatives of: the Directorate-General for Climate of the European Commission, the Intergovernmental Panel on Climate Change (IPCC); representatives of local governments and OBAs; the Covenant of Mayors – East represented by the national expert of the project Oksana Kysil (Department of Energy, Energy Saving and Introduction of Innovative Technologies of the Mykolaiv City Council, 2024).

As part of the strategic analysis. on the strategies, researchers examined the current climate conditions in each region which helped to receive the climate forecasts until the end of the century, identify the vulnerabilities and evaluate the risks across various economic sectors, and ultimately develop a list of recommendations on necessary adaptation measures tailored to specific industries.

More over, the scientists calculated the following needed adaptation measures and funds required for three pilot regions − early warning systems, protective engineering structures, irrigation and drainage systems, information and educational campaigns, smart power grids, and many others (Press and information team of the Delegation to Ukraine, 2024).

2.2.2. National legislation in the field of climate change adaptation

For the most effective implementation of framework international agreements, it is crucial to adopt national profile legislation that would allow implementing the provisions of ratified treaties, which, according to Article 9 of the Constitution of Ukraine, are part of our national legislation (Konstytutsiia Ukrainy, 1996).

In our opinion, for real adaptation to climate change within the entire state, we need a comprehensive strategic document that would contain:

– a description of the problems that led to its adoption;

– a list of regulatory legal acts in force in the relevant field;

– an analysis of the current state of affairs, trends and justification for the need to solve the identified problems;

– strategic goals and objectives aimed at achieving the set goals, stages of their implementation, expected results;

– the procedure for monitoring, evaluating results;

– implementation of the Strategy and reporting.

On October 20, 2021, the Cabinet of Ministers of Ukraine approved by decree the Strategy for En-

vironmental Security and Adaptation to Climate Change for the period until 2030 (hereinafter referred to as the Strategy) and the operational plan for the implementation of the Strategy for Environmental Security and Adaptation to Climate Change for the period until 2030 in 2022–2024 (Stratehiia ekolohichnoi bezpeky ta adaptatsii do zminy klimatu na period do 2030 roku, 2021).

According to the Strategy, Ukraine ranks 60th in the Environmental Performance Index. The worst indicators in Ukraine's assessment are the following categories: air quality, conditions for biodiversity conservation, the state of ecosystem services, sanitation and waste management.

The key issues in the field of environmental protection and natural resources that negatively impact people's health and the ecosystems` sustainability include:

– environmental pollution by emissions into the atmosphere and discharges into water bodies from industrial enterprises;

– irrational use of basic natural resources and their depletion;

– insufficient implementation of a robust state supervision system for environmental protection;

– intensification of global climate change and negative consequences for a number of sectors of the economy and spheres of human activity;

– insufficient educational and scientific and technical support to address challenges in the field of environmental protection in terms of reducing the impact, mitigating the consequences and adapting to climate change (Stratehiia ekolohichnoi bezpeky ta adaptatsii do zminy klimatu na period do 2030 roku, 2021).

The document also contains a list of regulatory legal acts, both legislative and subordinate, to ensure which it was adopted. The first among them is the Law of Ukraine "On National Security of Ukraine". This is due, among other things, to the fact that according to Part 4 of Article 3, state policy in the spheres of national security and defense is aimed at ensuring, among other things, environmental security (Stratehiia ekolohichnoi bezpeky ta adaptatsii do zminy klimatu na period do 2030 roku, 2021). This is a very important point, because threats to the environmental security of Ukraine are formed due to a significant level of pollution of atmospheric air, water resources, land resources, an imperfect system of state supervision (control) and insufficient efficiency of environmental monitoring.

These threats are also direct threats to national security, in particular, insufficient attention to the challenges posed by t he consequences of climate change will contribute to social inequality, undermine democracy, cause dislocation and instability, which will ultimately threaten the prospects for achieving the Sustainable Development Goals (Pro natsionalnu bezpeku Ukrainy, 2018).

In our opinion, the document is quite well-written and contains very important provisions within the framework of the national policy in the field of adaptation to climate change. The document does not contain a lar ge number of declarative provisions, unlike another, but similar in content document – the Information Security Strategy of December 28, 2021 (Stratehiia informatsiinoi bezpeky, 2021).

Achieving the goals set out in the strategy is a necessary step towards building a stable and effective green economy in Ukraine. The state policy of developing a "green" economy is an integral part of the sustainable development strategy of Ukraine and represents a promising path to achieving it, contributing to a balanced combination of economic growth, social progress and environmental responsibility. However, the success of its implementation requires effective state policy, business support and civic activism (Kruhlov V., 2023).

The Green economy's development is a part of Ukraine's commitments that we made when signing the Association Agreement with the European Union (Association Agreement, 2014).

Since the Constitution of Ukraine sets the course for European integration, it is also worth mentioning such a strategic document as the "EU Green Deal", the goals of which are:

– to build a climate-neutral continent;

– to protect human life, flora and fauna by reducing greenhouse gas emissions;

– to help companies achieve global leadership in the production of clean products and technologies;

– to facilitate a smooth and just "transition" (European Commission, 2019).

Another important document dedicated to the implementation of international standards and obligations of Ukraine in the field of environmental protection is the *"Strategy for the Formation and Implementation of State Policy in the Field of Climate Change for the Period Until 2035"* (Stratehiia formuvannia ta realizatsii derzhavnoi polityky u sferi zminy klimatu na period do 2035 roku, 2024).

The purpose of this Strategy is to create organizational and legal foundations for implementation of state policy in the field of the CC to achieve su-

stainable development and ensure an effective transition to low-carbon development of the state under the conditions of economic, energy, food and environmental security, increasing the level of well-being of citizens, reducing the consequences of the CC, and taking into account the goals of state climate policy during the post-war reconstruction of Ukraine.

The Strategy is implemented in four stages, each of which involves the development and implementation of an operational plan of measures for the implementation of the Strategy for the relevant period, based on the defined strategic goals and objectives and defining, in particular, an indicator of the implementation of measures. Among the measures, we would like to highlight the implementation of the provisions of European Union law in the field of climate change and the development of relevant program documents (planning documents) for adaptation to climate change.

Having examined the general global trends in the field of adaptation to climate change, as well as the legislative basis of the main decisions aimed at gradually minimizing the harmful anthropogenic impact on the climate, we propose to consider an example of the implementation of the above-mentioned approaches in the Lviv region.

Recently, the international technical assistance project "Strengthening the capacity of regional and local authorities to implement and enforce EU legislation in the fields of environmental protection, the CC mitigation and development of infrastructure projects" (APENA 3 Project), implemented by the Delegation of the European Union to Ukraine and implemented by a consortium of companies "ENVIROPLAN S. A.", "EgisInternational", "Egis Structures and Environment" and "Centre for Renewable Energy Sources & Saving" (CRES) and the Department of Ecology and Natural Resources of the Regional State Administration, has developed a "Climate Change Adaptation Strategy for Lviv Region" for the successful implementation of the goals and objectives of the APENA 3 Project (Krakovska S. et al., Non-Technical Summary, 2024).

The aim of the Strategy is to identify and prioritize the necessary measures and actions to support the adaptation of economic sectors and individual territories of the Lviv region to climate change. The development of the CC adaptation strategies is a national and regional obligation arising from the United Nations Framework Convention on Climate Change (UNFCCC, 1992), the Paris Agreement and commitments to the EU. The Climate Change Adaptation Strategy of the Lviv region identifies immediate priorities for climate change adaptation at the regional and district levels, taking into account that the intensity of climate change and the corresponding consequences will not be the same in all geographical regions of Ukraine (Krakovska S. et al., Non-Technical Summary, 2024).

The content of the Strategy largely reflects international and national trends in the CC adaptation, in particular, the current document of the Climate Change Adaptation Strategy of Lviv Region was prepared based on t he original methodology of the APENA3 Project, which we mentioned above, for developing the CC adaptation strategies and implementation plans, as well as in accordance with the best practices of strategic planning for climate change adaptation at the international and European levels (Krakovska S. et al., 2024).

Based on the data of the Strategy and the standards that were highlighted in the conclusions of the Climate Summit in Baku, we can highlight the following most important principles of adaptation to climate change and interpolate them to the Lviv region, in particular:

– *Strengthening monitoring of the implementation of international standards* in the field of climate change adaptation, control of international carbon traffic and reduction of carbon emissions into the atmosphere. In the Climate Change Adaptation Strategy for Lviv region, this is reflected in the objectives, in particular, through strengthening the resilience of the region in all sectors and priority areas, with the implementation of adaptation measures that meet the requirements of sustainable development – monitoring the implementation and effectiveness of measures, strengthening the administrative institutions of the region that will be called upon to solve the problem, or creating new institutions, communication and dissemination of information;

– *Transparent reporting and the creation of a special authorized body to carry out constant monitoring of the implementation of state policy in the field of ecology and climate.* In Lviv region, this is the Department of Ecology and Natural Resources of the Lviv Regional State Administration (hereinafter referred to as the Department), which is a structural unit of the regional state administration responsible for the implementation of the Lviv Strategy for Adaptation to Climate Change, which in turn is subordinate to the head of the regional state administration, and is also accountable to the Ministry of Environmental Protection and Natural Resources of Ukraine, which is responsible for monitoring the implementation of this Strategy.

– *Adaptation:* work at the highest level on the international community's adaptation roadmap to climate change. In particular, this has been implemented through the Climate Change Adaptation Strategy for Lviv Oblast, namely Section 5, which contains proposed thematic components or areas of action for climate change adaptation (resilience measures) and presents adaptation costs, which will be assessed, analyzed and further prioritized during the next stage of preparation of the Climate Change Adaptation Implementation Plan for Lviv Oblast. The proposed thematic components of adaptation include actions and measures that aim to:

– help avoid future impacts,

– reduce the intensity and extent of impacts, and

– support recovery in the event of current impacts, and

– focus on sectors and geographical areas of the region with the highest vulnerability / risk, as identified in section 4, and also cover other sectors / geographic areas that are not directly affected (Krakovska et al., Strategy goals, 2024).

– *Participation of civil society, children and youth.* This is reflected in the plan "Development of regional climate change adaptation strategies and implementation plans", an important point of which is public discussions on pilot strategies and plans, raising awareness of civil servants and the public about fisheries and aquaculture and their adaptation to climate change and their impact on water resources, and communication and educational activities to inform and raise awareness among the public in order to attract volunteers to carry out reforestation in areas burned by fires (Krakovska et al., Resilience measures and adaptation costs, 2024).

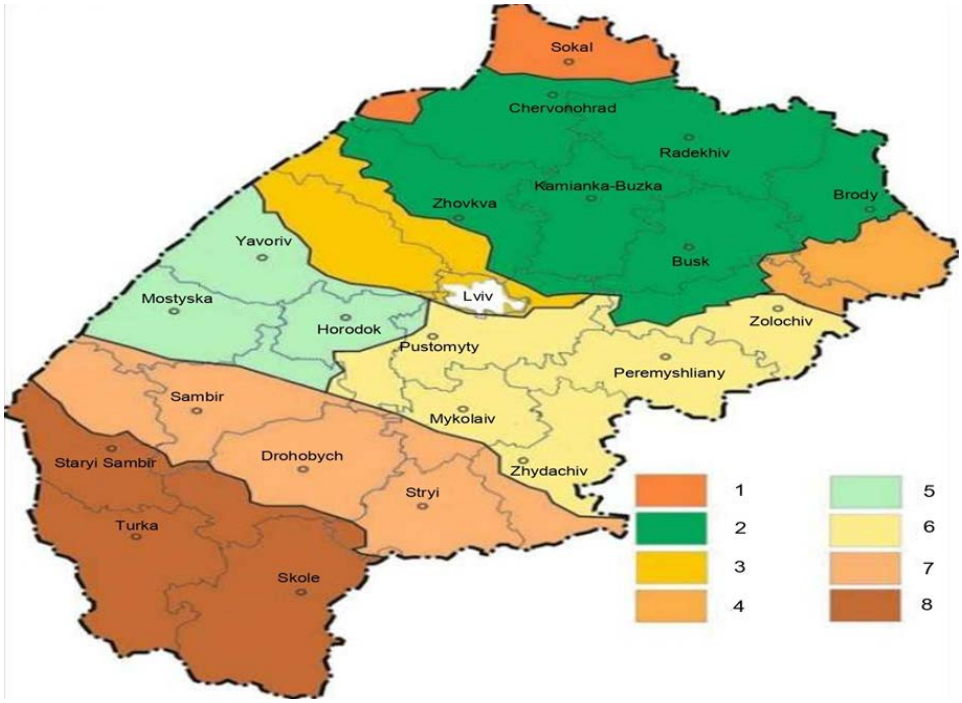

Fig. 5. Physical and geographic zoning of the Lviv region: 1 – Volyn upland; 2 – Male Polissia; 3 – Roztochchya; 4 – spurs of the Podilsk Highlands; 5 – Nadsyan plain; 6 – Opillia; 7 – Precarpathia; 8 – Carpathians (Kravets, 2023)

– *Financing:* a crucial component of countries' adaptation to climate change, which became central to the discussion at the Climate Summit in Baku. According to experts' estimates during the development of the above-mentioned Strategy, which consists of 168 measures for adaptation to climate change in Lviv region, the total cost of adaptation is 273,700,000.00 euros, which are planned to be applied within a seven-year period.

Also, the work "The influence of terrain, climatic conditions and factors on atmospheric air monitoring systems, based on the implementation of EU legislation on the example of the Lviv region" co-authored by Kravets I., Malyovany M., Tymchuk I. and Shkvyrko O. is devoted to the problems of climate change in the Lviv region and the importance of implementing international standards and principles in the field of effective adaptation to climate change.

The data obtained as a result of the research are the first stage of developing information and technical methods for establishing control points of atmospheric air quality caused by chemical pollution of atmospheric air from pollution objects, and will be used in the future to implement the second stage – the development of mathematical models for the distribution of pollutants in the atmosphere from emissions of enterprises – the largest pollutants, pollution along highways and roads (Kravets, 2023).

3. Conclusions

A sustainable climate is a fundamental guarantee of sustainable development of humanity, on a par with the efficient use of resources, the protection of the planet's biodiversity and consolidation for adaptation to regulated and unregulated climate change.

In our opinion, one of the main problems at the moment that prevent humanity from fully addressing the problem of global climate change is the selfish-practical understanding of the use of all possible resources of the planet at minimal cost for its preservation. The planet has only given its materials throughout the existence of humanity. At the same time, we are entering an era of opportunities for the real restoration of the balanced state of nature and the reduction of harmful anthropogenic impact on it. Given all of the above, modern society must take the burden of responsibility for the current situation and make maximum efforts to stabilize it for the sake of future generations.

Modern challenges related to climate change require a systematic approach to their solution through proper forecasting of weather parameters and a deep understanding of the mechanisms of adaptation of society. Only with the comprehensive cooperation of government agencies with the public is it possible to ensure a sustainable future for our planet in the face of rapid environmental changes.

We can also highlight the following general solutions for solving the problem of predicting climate parameters in the light of global climate change: a) implementation of an emissions reduction strategies; b) preservation and restoration of forests (reforestation, leading to carbon absorption, reducing the greenhouse effect, supporting biodiversity and water balance); c) development of technologies for predicting climate change (increasing the accuracy of forecasts, improving modeling of climate processes, monitoring anthropogenic); d) international cooperation and development of regulatory initiatives at the international level (as well as at the regional and local levels) and establishing responsibility for their violations; e) implementation of a "green policy".

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