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AGRICULTURE AND OTHER SOCIAL AND ECONOMIC SYSTEMS AND GOVERNMENT STRUCTURES DEVELOPMENT IN RESPONSE TO ENVIRONMENTAL POLLUTION AND CLIMATE CHANGE

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INTRODUCTION

The existence and effect of global challenges are common to all states, but the level of influence on individual countries can vary significantly depending on the size of the state, its socio-economic development level, geographical location, climatic conditions, availability of fertile land, natural resources, cultural values, traditions, mentality, stereotypes, stan dards of conduct, corruption level, measures taken by public authorities to minimize negative influences, etc. According to the World Economic Forum, global risks are divided into 5 groups: economic, environmental, geopolitical, societal, and technological. If in 2007 the strongest global risk was the collapse of asset prices, i.e. economic risk, in recent years the strongest risks are extreme weather, climate action failure, and human environmental damage, i.e. environmental risks[1].

Climate change is affecting all nations, and given the long-term perspective, neither military conflict nor the socio-behavioral constraints caused by the COVID-19 pandemic can be compared to the impact of environmental risks, including climate change. At the same time countries with low adaptive potential, i.e. limited economic resources, low technology, poor information network, weak infrastructure, unstable or underdeveloped institutions, and unfair access to resources, are characterized by increased vulnerability to climate change. On the contrary, developed countries have high adaptive potential and therefore have a better ability to adapt to climate impacts than developing countries or emerging markets. Climate change is a major global development challenge with potentially serious threats to the global economy and international security due to increased direct and indirect risks related to energy security, food and drinking water providing, stable ecosystems existence, health, and people’s life standards ensuring. Climate change directly affects health and migration, land resources, agriculture, forestry, biodiversity, water resources, energy, industry, and infrastructure.

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[1] The Global Risks Report (2022). URL: https://www.weforum.org/reports/global-risks-report-2022

The most important is climate change for the agricultural sector, which in turn affects food security, quality of life, and demographics.

Both international organizations, authorities, and individual researchers are engaged in the study of climate change and its impact on various social and economic systems. World Health Organization conducted a study aimed at enhancing the capacity of health care facilities to protect and improve the health of their target communities in an unstable and changing climate; and empowering healthcare facilities to be environmentally sustainable, by optimizing the use of resources and minimizing the release of waste into the environment. Climate-resilient and environmentally sustainable healthcare facilities contribute to a high quality of care and accessibility of services, and by helping reduce facility costs also ensure better affordability[2].

Sulser T. and others in their study "Climate change and hunger: estimating costs of adaptation in the agrifood system" assess the cost of adaptation to climate change across a range of future climate scenarios and investment options. They focus on offsetting climate change impacts on hunger through investment in agricultural research, water management, and rural infrastructure in developing countries. They link climate, crop, water, and economic models to analyze scenarios of future change in the agriculture sector to 2050 and assess trade-offs for these investments across key Sustainable Development Goals (SDGs) for poverty, hunger, and water. Their research shows that climate change slows progress toward eliminating hunger, with an additional 78 million people facing chronic hunger in 2050 relative to a no-climate-change future, over half of them in Africa south of the Sahara. Increased investments can offset these impacts[3].

Carter C., Xiaomeng C., Ghanem D., Mérel P. identify the economic impacts of climate change on agriculture. Cross-sectional and panel regression analysis are the most commonly used methods to infer climate impacts on agriculture while accounting for the behavioral response of humans. The former seeks to correlate cross-sectional differences in climate to agricultural outcomes and thus implicitly accounts for long-run adaptation to climate change, however, it falls short on causal identification due to the likely presence of omitted variables. The latter features a cleaner identification strategy but may only partially capture long-run adaptive behavior. In their

[2] WHO guidance for climate-resilient and environmentally sustainable health care facilities (2020). URL: https://www.who.int/publications/i/item/9789240012226

[3] Sulser T., Wiebe K., Dunston S., Cenacchi N., Nin-Pratt A., Mason-D'Croz D., Robertson R., Willenbockel D., Rosegrant M. (2021). Change and hunger: estimating costs of adaptation in the agrifood system, IFPRI, 62. DOI: https://doi.org/10.2499/9780896294165

article, the authors focus on important methodological issues that arise in the context of estimating climate change impacts from panel data[4].

Dellink R., Lanzi, E., Chateau, J. describe two main types of models which are used for assessing the economic consequences of climate change such as Computable General Equilibrium (CGE) models and Integrated Assessment models (IAM). CGE models focus on the relations between different economic actors and contain a full description of the economic system using multiple economic sectors: households supply production factors (labour, capital, land) and consume goods and services, while firms transform the production factors, with intermediate deliveries from other sectors, into the output of goods and services. IAMs focus more on describing the interactions between the economic and biophysical system, i.e. how economic activity leads to environmental pressure, and how environmental affect the economy[5].

Rising J., Taylor C., Ives M., Ward R. made a summary of key dimensions in the economic evaluation of climate risks (Table 1). They say that economic assessments of climate change risks are intended to be comprehensive, covering the full range of physical impacts and their associated market and non-market costs, considering the greater vulnerability of poor people and the challenges of adaptation. Traditional approaches (column 2) are still reflected in many estimates of economic risk (e.g., the SCC), but there is established research that offers an expanded perspective (column 3). The research frontier in each dimension offers many new opportunities (column 4), while there remain significant undeveloped areas of enquiry (column 5). The items listed under Specific climate impacts are a subset of relevant impact types which are under-represented in IAMs, and these rows describe the progress in underlying biophysical impact, however economic valuation of these (e.g., morbidity, SLR adaptation costs, ecosystem service loss) are notably incomplete[6].

Despite the fact that many organizations and individual researchers are engaged in the problem of climate change, the problem remains extremely relevant. Requires a detailed analysis of the impact of climate on various areas, in particular on public health, agriculture and food security, the energy sector, industry, and so on, which will make it possible to understand better

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[4] Carter C., Xiaomeng C., Ghanem D., Mérel P. (2018). Identifying the Economic Impacts of Climate Change on Agriculture, Annual Review of Resource Economics, 25. URL: https://www.webofscience.com/wos/woscc/full-record/WOS:000447824600018

[5] Dellink R., Lanzi E., Chateau J. (2019). The Sectoral and Regional Economic Consequences of Climate Change to 2060. *Environmental and Resource Economics*, 72, 309–363. DOI: https://doi.org/10.1007/s10640-017-0197-5

[6] Rising J., Taylor C., Ives M., Ward R. (2022). Challenges and innovations in the economic evaluation of the risks of climate change. *Ecological Economics*, 197. DOI: https://doi.org/10.1016/j.ecolecon.2022.107437

which areas, and which sectors of the economy will be affected primarily by the climate, which the scale and the consequences of such influence, which in turn will determine the necessary measures and the cost of adaptation to climate change and accordingly adjust the interaction and cooperation at different levels.

Table 1

A summary of key dimensions on the research frontier in the economic evaluation of climate risks

Indicator	Traditional	Established	Frontier	Undeveloped
Data inputs for estimating impacts				
Climate-related data	Global resolution	High resolution downscaled	Extreme events, tipping points	Deep uncertainty associated with a changing physical system
Data for evaluating impacts	Marketable goods, infrastructure	Physical inputs (e.g., water, crop yields, labour)	Spatially disaggregated GDP impacts, developing country data	Non-market valuation, ecosystem services and biodiversity loss indicator
Methodologies for producing damage functions				
Econometric methods	Econometric methods	Econometric models	Econometrics w/ heterogeneity	Empirically calibrated adaptation
Process-based methods	Point-calibrated models (e.g., individual, field)	Coupled models (e.g., water-energy-food)	Gridded and global models, adaptation	Improved representations of uncertainty
Top-down economic impacts	Expert elicitation	Econometric relationships	Non-linearity and persistence	Drivers of long-term adaptation
Features of cost-benefit IAMs				
Regional heterogeneity	Global	Continental	National/ subnational	Local/ municipality
Tipping points	ECS feedbacks; economic catastrophe risk	Analytical decision-making	Multiple tipping points, endogenous technological change	Socioeconomic tipping points; sociallycontingent outcomes
Equity	Social-welfare function using observed savings and interest rates	Social-welfare function using ethics-based pure time preferences	Separation of intra- and intergenerational equity	Heterogeneous agents with risk preferences vulnerability

Features of non-IAM economic assessments				
Response-times studied	Static changes	Immediate responses	Short-term resilience	Long-run adaptation
Agent-level decision-making	Ignored	Technology adoption studies	Sector-specific adaptation	Agent-based modelling
Specific climate impacts				
Health and disease	Climatic temperature responses	Weather shock responses	Accounting for adaptation; Vector-borne diseases	Multi-disease vulnerability
Sea-level rise	High-tide inundation	Storm surge damage	Cost reduction under optimal protection	Political economy of protection decisions
Ecosystems and biodiversity	Species environmental suitability	Managed ecosystems (e.g., fisheries, forests)	Multispecies interaction	Changing and mosaic environments
Cascading impacts	Qualitative assessment	Summed independent impacts	CGE-mediated equilibria across static risks	Empirically grounded microfoundation models, simultaneous and cascading impacts

ECS-equilibrium climate sensitivity – is the long-term global temperature rise that is expected to result from an increase in atmospheric CO_2 concentration. The use of a constant ECS does not produce any tipping point dynamics, but it captures the average outcomes of any tipping points that are included in its calibration.

CGE-Computational general equilibrium models used in traditional economic representations of market dynamics[7].

The purpose of the research is identification social and economic areas that are most susceptible to climate change and determination the scale of impacts on these areas and activities.

In this research the following methods were used in the research process: methods of analysis and synthesis, induction and deduction, comparative analysis (for identification causal relationships between climate change and the social and economic systems development); forecasting models (for prediction temperature changes); methods of correlation and regression analysis, methods of factor analysis (for determination the influence of temperature and precipitation on production volumes). To forecast climate

[7] Rising J., Taylor C., Ives M., Ward R. (2022). Challenges and innovations in the economic evaluation of the risks of climate change. *Ecological Economics*, 197. DOI: https://doi.org/10.1016/j.ecolecon.2022.107437

change, it is proposed to use formalized forecasting methods based on dynamic series (adaptive forecasting models), such as the exponential smoothing method, Holt's method, Holt-Winters and Tail-Wage models. The essence of the exponential smoothing method is the alignment of fluctuating dynamic series for further forecasting. The current value of the time series is weighted with a smoothing constant. The calculation is carried out according to the formula:

$$S_t = \alpha y_t + (1-\alpha) S_{t-1,} \quad (1)$$

where S_t is the value of the exponential average at time t; y_t is the current value of the dynamics series; S_{t-1} is the value of the exponential average at the moment (t – 1); α is smoothing constant.

The value α is always between 0 and 1, and in each case the most appropriate value must be selected. The advantages of this method are accuracy, which increases with the increase in the number of levels of the dynamic series. The disadvantage of the method is that there is no exact method for choosing the optimal value of the smoothing parameter α. The accuracy of the forecast by this method decreases with the increase of the forecast interval. It is effective for short-term forecasts, in long-term forecasting it can be used to obtain approximate estimates.

In the Holt's model, the parameters a_0(t) and a_1(t) are estimated using two moving averages that have different independent smoothing parameters. The coefficient a_1(t) is estimated as the exponential average of increments of the parameter a_0(t). Notation for the increment of the parameter a_0(t) at time t:

$$p(t) = a_0(t) - a_0(t-1). \quad (2)$$

Then according to the Holt model:

$$a_1(t) = \alpha_1 p(t) + (1-\alpha_1) a_1(t-1), \quad (3)$$

where $0 \le \alpha_1 \le 1$ is the first smoothing parameter.

The coefficient a_0(t) is the exponential average of the levels of the series, which is calculated taking into account the correction for the previous increase a_1(t-1):

$$a_0(t) = \alpha_0 y_t + (1-\alpha_0) a_0(t-1) + (1-\alpha_0) a_1(t-1), \quad (4)$$

where $0 \le \alpha_0 \le 1$ is the second smoothing parameter, not dependent on α_1.

Holt-Winters and Tail-Wage models are used to take seasonality and cyclical components into account. The Tail-Wage model takes into account seasonality and an additive trend, unlike the Holt-Winters model, which multiplicatively includes a linear trend.

1. Analysis of the temperature change and temperature forecast

Worldwide, winters and summers alike are becoming increasingly hotter than the 1951–1980 average (Figure 1). With 1,7 °C more than the reference average for the world, 2020 was the warmest year at the global level; 2016 had the second highest global mean annual temperature change.

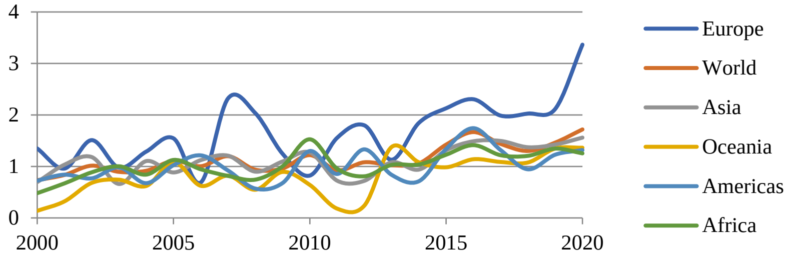

Figure 1. Temperature change by region[8]

Europe is the region where the temperature change has been the highest in 2020 (and also for most of the 2000–2020 period), with 3,4 °C, followed by Asia (1,6 °C), Oceania (1,4 °C), the Americas and Africa (1,3 °C). The average temperature change in the 2010s was 1,26 °C, compared to 0,96 °C in the 2000s. More than 150 countries had a mean annual temperature change at least 1,0 °C higher than the 1951–1980 average in 2020. The value of the average absolute percentage error made it possible to choose the most adequate models for forecasting climate change (Figure 2 and Figure 3).

Forecast results show an increase in average temperatures in all regions of the world, especially in Europe.

Global challenges are closely interconnected, forming a closed circle of socio-economic, socio-political, biological, demographic, and technical disasters.

Climate change can be caused by climatic changes over time, caused not only by human activity, but also by natural processes, and directly or indirectly caused by human activity, its eco-destructive impact on the environment (in particular, due to the burning of fossil fuels (oil, gas, coal), the growth of emissions from the transport, industry, and intensive agriculture, etc.), which generates changes in the global atmosphere and is superimposed on the natural climate fluctuation observed during comparative periods of time.

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[8] WHO. Checklists to assess vulnerabilities in health care facilities in the context of climate change (2021). URL: https://policycommons.net/artifacts/1455502/checklists-to-assess-vulnerabilities-in-health-care-facilities-in-the-context-of-climate-change/2090343/

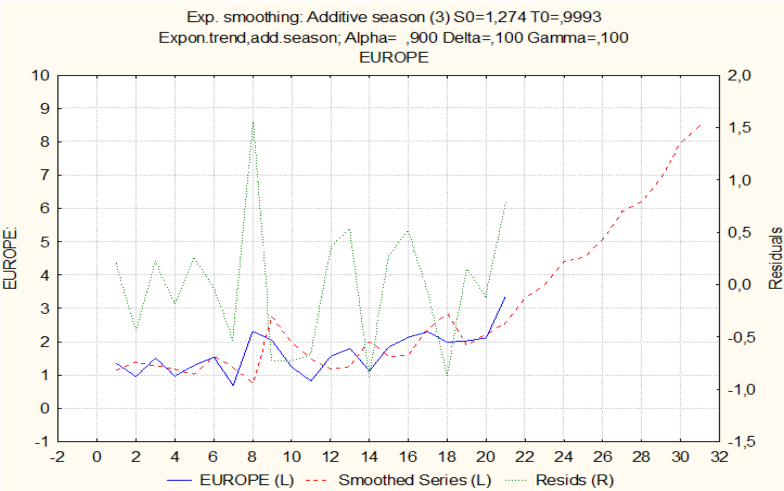

Figure 2. Forecast of temperature in Europe

Source: built by the author

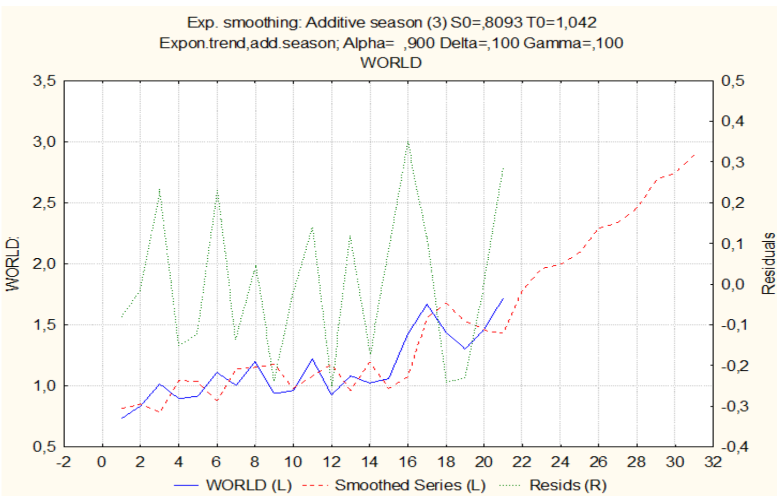

Figure 3. Forecast of temperature in the world

Source: built by the author

According to the report of the Intergovernmental Panel on Climate Change, scientific studies show that climate change as a result of anthropogenic influence since the end of the 19th century is only about one-third due to natural changes, and two-thirds is caused by human activity, in particular, the increasing concentrations of greenhouse gases in the atmosphere. The Intergovernmental Panel on Climate Change (IPCC) has concluded that to avert catastrophic health impacts and prevent millions of climate change-related deaths, the world must limit temperature rise to 1,5°C. Past emissions have already made a certain level of global temperature rise and other changes to the climate inevitable. Global heating of even 1,5°C is not considered safe, however; every additional tenth of a degree of warming will take a serious toll on people's lives and health[9].

2. Impact of climate change on health and healthcare system

Pollution of the natural environment caused by human actions affects both climate changes in the long term and social and demographic indicators, leads to exacerbation of chronic human diseases, rejuvenation of some diseases, increase in the probability of mutation of some diseases, which strengthens the negative consequences of another global challenge like the COVID-19 pandemic when people with chronic diseases were at risk of increased mortality.

Climate change affects health and migration. Climate change affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food, and secure shelter. According to the estimates of the World Health Organization, between 2030 and 2050, climate change is expected to cause approximately 250000 additional deaths per year, from malnutrition, malaria, diarrhea, and heat stress. The direct damage costs to health (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), are estimated to be between 2-4 billion USD per year by 2030[10]. The impacts of climate change on health and healthcare system are presented in Figure 4.

The significance of the impact of climate change on health depends on the level of adaptability of communities to negative changes in the external environment. At the same time, the quantitative and qualitative characteristics of these changes differ significantly depending on the place of living, the initial environment state, the spread of "green technologies" and the environmental awareness of citizens. The level of sensitivity of people to the negative consequences of climate change largely depends on the individual characteristics of the functioning of the body, and the presence of acute and chronic diseases. However, people of the oldest age groups and children are most prone to exacerbation of negative conditions.

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[9] The Intergovernmental Panel on Climate Change (2022). URL: https://www.ipcc.ch/

[10] World Health Organization. Climate change (2023). URL: https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

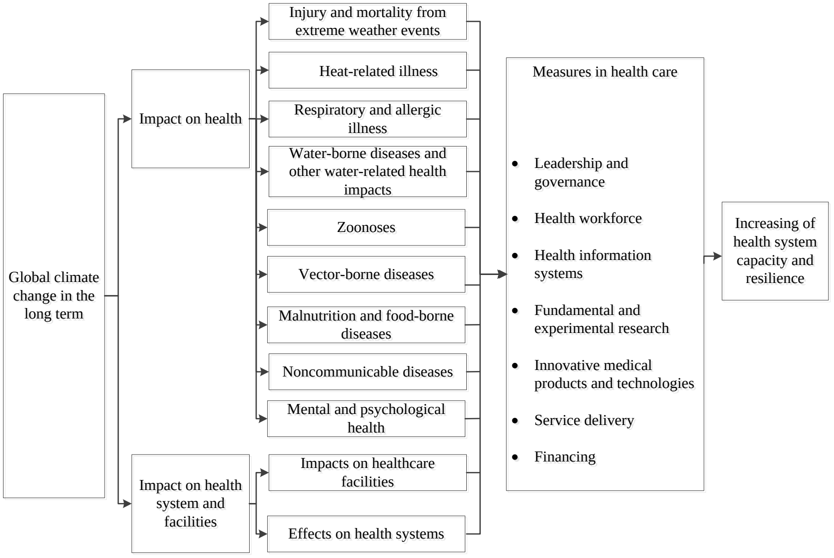

Figure 4. The impacts of climate change on health and healthcare system

Source: built by the author

Social and economic factors of life support (nature and scope of employment, leading a healthy lifestyle, availability of access to quality food and clean drinking water) largely determine the level of resistance of both individuals and social groups to the negative factors of climate change. Climate change leads to an increase in the number of days when extremely high temperatures are observed in the moderate continental climate prevailing in Europe. This has negative consequences for public health in the context of increased cardiovascular risks and even sudden death caused by overheating. This is especially true for children, the elderly, people with chronic illnesses, and workers who work outdoors. For children under one year of age, overheating can cause death due to sudden body dehydration. Western scientists have proven that during periods when abnormally high temperatures persist for several days in a row or longer, there is a significant increase in the number of deaths related to this phenomenon in cities, especially due to the exacerbation of chronic cardiovascular diseases. Due to a number of factors, diseases of the cardiovascular system are not only the main cause of death in general but also the most frequent cause of premature mortality of middle-aged people (especially men). In this context, the manifestations of climate change will deepen the negative trends in the formation of the age profile of mortality.

An important factor in morbidity and mortality due to temperature rise is the formation and preservation of favorable conditions for the spread of infectious agents, in particular those that cause acute intestinal infections in humans. In the risk group: children who are in organized children’s collectives, persons from low-income households in which the minimum sanitary and hygienic standards of life are not maintained, as well as population groups prone to consumption of low-quality food products.

Less critical, but significant in the long term, is the increase in fatigue and stress caused by high temperatures, and as a result, the number of mental illnesses in the population, and weakening of resistance to infectious diseases.

An increase in the average air temperature leads to a lengthening of the flowering period when there is a significant amount of allergen plant pollen in the air, which negatively affects the life quality of people with allergies and asthma. Over the past 30 years, allergic diseases have become one of the most common ailments in the world. As a result, social and economic indicators are deteriorating, in particular, the periods of incapacity for work for people suffering from allergies increase and labor productivity and economic indicators of enterprises are declining. Also, the quality of education decreases because children are prone to allergies more than adults.

In addition, for people with chronic asthma and allergies, the risk of developing or complicating acute respiratory conditions increases, which are a significant factor in premature mortality, especially in low-income countries.

Thus, extending the period of exposure to allergens on the health of the population can significantly affect the general level of working capacity and economic indicators as a result. Climate change leads to an increase in the concentration of ground-level ozone, a component of urban smog, which can quickly be carried by air currents to a distance of up to 1000 km. This substance provokes the emergence of asthma, manifestations of allergies, causes lung emphysema, and a general decrease in immunity. Due to the noticeable generally toxic, irritating, carcinogenic, mutagenic, and genotoxic effect of surface ozone on the human body, the WHO classifies it as an environmental parameter subject to constant monitoring. Climate change is one of the key factors in increasing drought which is the main cause of natural fires. An increase in the number of natural fires also negatively affects air quality and, accordingly, the health of the population. An abnormally warm winter can lead to a shortage of water resources and an increase in the number of natural fires. Fires lead to significant air pollution in the regions. Consequences of warming for population health are presented in Table 2.

Table 2

Consequences of warming for population health

Nature of influence and risk factor	**Health impact**	**Risk assessm ent**
Abnormally high temperature in cities (direct influence)	Excess heat-related mortality; increased incidence of heat exhaustion and heat stroke; exacerbated circulatory, cardiovascular, respiratory and kidney diseases; increased premature mortality related to ozone and air pollution produced by fires, particularly during heat waves. An increase in the number of deaths from coronary heart disease and other cardiovascular diseases, diabetes, suicides, murders, traffic accidents, mental disorders	Very high
Higher temperatures and humidity; changing and increasingly variable precipitation; higher sea surface and freshwater temperatures	Accelerated microbial growth, survival, persistence, transmission; shifting geographic and seasonal distribution of diseases (such as cholera, schistosomiasis); ecological changes, droughts and warmer temperatures leading to cyanobacterial blooms, pathogen multiplication; extreme events leading to disruption of water supply system and contamination; insufficient or intermittent water access for health care practices; insufficient quality and quantity of water leading to poor hygiene; flood damage to water and sanitation infrastructures; contamination of water sources through overflow	Very high
An increase in the concentration of pollutants in the air (indirect effect)	An increase in the number of cases of cardiovascular and respiratory diseases. Spread of bronchial asthma, bronchitis, other diseases of the respiratory and ENT organs, allergies	Average
Higher temperatures and humidity; changing and increasingly variable precipitation. Expansion of wetlands, fodder base and breeding	Accelerated parasite replication and increased biting rates; prolonged transmission seasons; re-emergence of formerly prevalent diseases; changing distribution and abundance of disease vectors; reduced effectiveness of vector control interventions. An increase in the number of diseases such as malaria, West Nile fever, Crimean-Congo fever, tick-borne encephalitis and borreliosis,	Average

places for mosquitoes, tick habitat, changes in areas of natural foci of infections	rickettsiosis, leptospirosis, tularemia and other infectious and parasitic diseases	
Storms, floods, hurricanes, typhoons and other natural disasters (direct effect, remote effect)	Fatalities, injuries; post-traumatic shock, stress, mental disorders	High, Average
The influence of high temperature on the state of the causative agents of intestinal infectious diseases and parasitosis, disruption of water supply and sewage facilities	An increase in the number of intestinal infections such as dysentery, typhoid, hepatitis A, salmonellosis, lambiosis, cryptosporidiosis, etc.	High
Higher temperatures and humidity	Outdoor and unprotected health workers obliged to work either in physiologically unsafe conditions or to lose income and livelihood opportunities	High
Higher temperatures and changes in precipitation. A decrease in the productivity of agricultural production and food calorie content	Lower food production in the tropics; lower access to food due to reduced supply and higher prices; combined effects of undernutrition and infectious diseases; chronic effects of stunting and wasting in children.	High

Source: built by the author based on[11, 12]

In the Slovak Republic at the first place are diseases of the circulatory system, in particular ischemic heart diseases, cerebrovascular diseases (46%), in the second place are neoplasms (23,74%), in the third place are diseases of the respiratory system (6,41%)[13].

[11] WHO guidance for climate-resilient and environmentally sustainable health care facilities (2020). URL: https://www.who.int/publications/i/item/9789240012226

[12] EPA. United States Environmental Protection Agency. Climate Impacts on Agriculture and Food Supply (2021). URL: https://climatechange.chicago.gov/climate-impacts/climate-impacts-agriculture-and-food-supply#crops

[13] Statistical yearbook of the Slovak Republic (2022). URL: https://slovak.statistics.sk/wps/portal/

Because abnormally high temperatures can lead to an increase in the number of deaths from coronary heart disease and other cardiovascular diseases, diabetes, suicides, murders, traffic accidents, and mental disorders, then the situation will worsen in the future.

3. Impact of climate change on the fuel and energy complex

Environmental pollution and climate change, in addition to health, also affect energy, industry, and infrastructure.

The fuel and energy complex is traditionally considered the industry 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 related to natural and climatic conditions and the need for a significant transformation to ensure the adaptation of the fuel and energy complex (Figure 5).

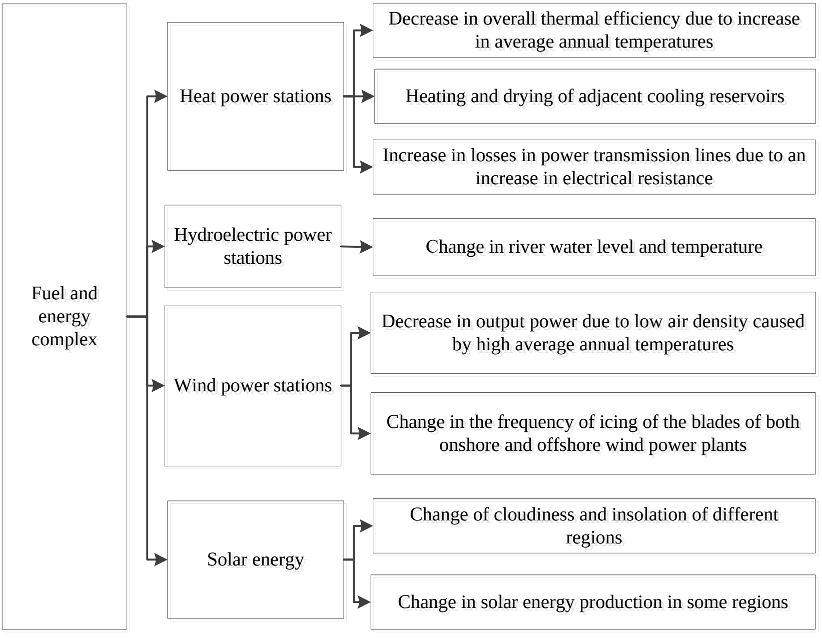

Figure 5. Impact of climate change on the fuel and energy complex

Source: developed by the author

The impact of climate change on thermal power plants is expressed in a decrease in their overall thermal efficiency due to an increase in average annual temperatures, as well as in the heating and drying of nearby cooling reservoirs. Renewable energy is critically important from the point of view of decarbonizing the electricity system and mitigating the effects of anthropogenic climate change.

The vulnerability of hydropower is the change in river water level and temperature due to global warming.

The resource base of wind power plants is also strongly influenced by temperature changes, as low air density due to high average annual temperatures leads to a decrease in their output power. An effective solution to the problem is the improvement of wind resource assessment methods.

Accounting for random changes in energy planning and establishing sufficient reserve capacities are the main options for adaptation. A gradual weather change, in particular the relative humidity, will affect the frequency of icing of the blades of both onshore and offshore wind power plants. A partial solution to the problem can be a change in the design of the blades or an internal heating[14,15].

A similar situation is with the solar energy. Climate change affects the cloudiness and insolation of different regions, as well as the production of solar energy. An increase in average annual temperature also increases the productivity of solar heating systems, especially in cold regions, but at the same time reduces the efficiency of photovoltaic conversion.

Also, the increase in average annual temperatures leads to an increase in electrical resistance, and therefore to an increase in losses in power transmission lines.

Global climate change has direct and indirect impacts on the industrial sector. Direct impacts are associated with a direct change in natural and climatic conditions due to a change in the pattern of energy consumption and the availability of natural resources due to the difficulty of access to minerals, as a result of an increase in the risk of man-made emergency situations, an insufficient amount of water resources of appropriate quality, etc. Indirect impacts are caused by changes occurring in related industries and consist in a change in the economic conditions of operation due to the dependence of processing enterprises on management schemes in agriculture and forestry. The vulnerability of industrial enterprises and infrastructure facilities to soil erosion, floods, sea level rise and associated changes in the wave regime will increase significantly.

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[14] Jafari M., Botterud A., & Sakti A. (2022). Decarbonizing power systems: A critical review of the role of energy storage. *Renewable and Sustainable Energy Reviews*, 158, 112077.

[15] Miller L. M., & Keith D. W. (2018). Climatic impacts of wind power. *Joule*, 2(12), 2618–2632.

Floods and inundation are a threat of a significant negative impact on infrastructure objects due to their damage and destruction, which in turn will cause the destruction of logistics and resource-energy schemes. An increase in the number and frequency of dangerous meteorological phenomena will cause an increase in the vulnerability of industrial facilities, an increase in accidents and the frequency of their repairs, which will lead to a corresponding increase in material and financial costs. An increase in temperature will be a factor in increasing product storage costs, especially for the food industry, and will cause an increase in the threat of fires and deformation risks, especially for spatially distributed objects.

The climate changes impact on agriculture and as a result on food security because the country's food security directly depends on the agriculture development. At the same time, it should be noted that in 2020 nearly 690 million people – or 8.9 percent of the global population – are hungry, up by nearly 60 million in five years. The food security challenge will only become more difficult, as the world will need to produce about 70 percent more food by 2050 to feed an estimated 9 billion people. Research shows that without adaptation measures, climate change could reduce global agricultural growth by up to 30% by 2050. The 500 million small farms around the world will be most affected[16].

The challenge is intensified by agriculture's extreme vulnerability to climate change. Climate change's negative impacts are already being felt, in the form of increasing temperatures, weather variability, shifting agroecosystem boundaries, invasive crops and pests, and more frequent extreme weather events. On farms, climate change is reducing crop yields, the nutritional quality of cereals, and lowering livestock productivity. Substantial investments in adaptation will be required to maintain current yields and to achieve production and food quality increases to meet demand. Climate change is very likely to affect food security at the global, regional, and local level. Climate change can disrupt food availability, reduce access to food, and affect food quality. For example, projected increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability may all result in reduced agricultural productivity. Increases in the frequency and severity extreme weather events can also interrupt food delivery, and resulting spikes in food prices after extreme events are expected to be more frequent in the future. Increasing temperatures can contribute to spoilage and contamination.

[16] WHO. Checklists to assess vulnerabilities in health care facilities in the context of climate change (2021). URL: https://policycommons.net/artifacts/1455502/checklists-to-assess-vulnerabilities-in-health-care-facilities-in-the-context-of-climate-change/2090343/

4. Impact of climate change on the agricultural sector

Climate change leads to changes in arable, livestock and hydrology sectors. At first, let's consider impacts on arable sector. Changes in temperature, atmospheric carbon dioxide (CO_2), and the frequency and intensity of extreme weather could have significant impacts on crop yields.

For any particular crop, the effect of increased temperature will depend on the crop's optimal temperature for growth and reproduction. In some areas, warming may benefit the types of crops that are typically planted there, or allow farmers to shift to crops that are currently grown in warmer areas. Conversely, if the higher temperature exceeds a crop's optimum temperature, yields will decline.

Higher CO_2 levels can affect crop yields. Some laboratory experiments suggest that elevated CO_2 levels can increase plant growth. However, other factors, such as changing temperatures, ozone, and water and nutrient constraints, may counteract these potential increases in yield. For example, if temperature exceeds a crop's optimal level, if sufficient water and nutrients are not available, yield increases may be reduced or reversed[17].

Elevated CO_2 has been associated with reduced protein and nitrogen content in alfalfa and soybean plants, resulting in a loss of quality. Reduced grain and forage quality can reduce the ability of pasture and rangeland to support grazing livestock[18]. More extreme temperature and precipitation can prevent crops from growing. Extreme events, especially floods and droughts, can harm crops and reduce yields.

Dealing with drought could become a challenge in areas where rising summer temperatures cause soils to become drier. Although increased irrigation might be possible in some places, in other places water supplies may also be reduced, leaving less water available for irrigation when more is needed.

Many weeds, pests, and fungi thrive under warmer temperatures, wetter climates, and increased CO_2 levels[19].

Though rising CO_2 can stimulate plant growth, it also reduces the nutritional value of most food crops. Rising levels of atmospheric carbon dioxide reduce the concentrations of protein and essential minerals in most

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[17] EPA. United States Environmental Protection Agency. Climate Impacts on Agriculture and Food Supply (2021). URL: https://climatechange.chicago.gov/climate-impacts/climate-impacts-agriculture-and-food-supply#crops

[18] USGCRP (2014). Ch. 6: Agriculture. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 150–174.

[19] Nelson G. C., Valin H., Sands R. D., Havlík P., Ahammad H., Deryng D., ... & Willenbockel D. (2014). Climate change effects on agriculture: Economic responses to biophysical shocks. *Proceedings of the National Academy of Sciences*, 111(9), 3274–3279.

plant species, including wheat, soybeans, and rice. This direct effect of rising CO_2 on the nutritional value of crops represents a potential threat to human health. Human health is also threatened by increased pesticide use due to increased pest pressures and reductions in the efficacy of pesticides. Thus, examples of the impact of climate change on biodiversity can be:

– phenological changes – when the average temperature increases by 20 C, plants begin to bloom 5-30 days earlier when there is a threat of frost and there are still no pollinating insects, which causes a negative effect;

– changes in the distribution of species, i.e. change in the range due to a change in conditions leads to the rapid appearance and distribution of invasive species, including many dangerous weeds, allergens, poisonous, etc. Invasive species are usually more durable and gradually completely replace local ones, for example, ragweed and borscht, which pose a significant threat to public health[20].

Three types of reactions of biota to climate change are identified: migration, adaptation, and extinction (disappearance) (Table 3).

Table 3

Characteristics of types of biota reactions to climate change[21]

Reaction	Characteristics
Migration	Under normal conditions, it is an ecologically balanced process, but due to the increase in the rate of changes in the environment and the presence of anthropogenic obstacles (ecological holes), the balance is disturbed. Invasive species displace natives and occupy their econiches, breaking coevolutionary ties. Accordingly, the species that we would like to see in nature migrate most often.
Adaptation	Evolution is a long process, and today’s climate is changing faster than evolutionary possibilities. This leads to the vulnerability of species with a long development cycle (perennials) and their replacement, in particular, by annual weeds. On a global scale, this leads to the reduction of energy reserves in the biomass of ecosystems and, in the final case, to the disruption of the energy pyramid. For the conditions of Europe, the risk of settling unproductive annuals is very high.
Extinction	The most negative process. It is predicted that within a century, 17–35% of species will disappear from certain territories, and in Europe, in particular, by 2080, about 50% of plant species will reduce their range.

[20] EPA. United States Environmental Protection Agency. Climate Impacts on Agriculture and Food Supply (2021). URL: https://climatechange.chicago.gov/climate-impacts/climate-impacts-agriculture-and-food-supply#crops

[21] WHO guidance for climate-resilient and environmentally sustainable health care facilities (2020). URL: https://www.who.int/publications/i/item/9789240012226

The correlative dependence of production volumes on temperature and precipitation volumes in the Bratislava region is shown in Table 4.

Table 4

The correlative dependence of production volumes on temperature and precipitation volumes in the Bratislava region

Correlations (Spreadsheet4) Marked correlations are significant at p < ,05000 N=5 (Casewise deletion of missing data)			
	Temperature	Precipitation	Production
Temperature (T)	1,00	0,31	-0,91
Precipitation (P)	0,31	1,00	-0,70
Production (Pr)	-0,91	-0,70	1,00

Source: built by the author

The correlative dependence of production volumes on temperature and precipitation volumes in the Preshov region is shown in Table 5.

Table 5

The correlative dependence of production volumes on temperature and precipitation volumes in the Preshov region

Correlations (Spreadsheet10) Marked correlations are significant at p < ,05000 N=5 (Casewise deletion of missing data)			
	Temperature	Precipitation	Production
Temperature (T)	1,00	-0,37	-0,93
Precipitation (P)	-0,37	1,00	0,75
Production (Pr)	-0,93	0,75	1,00

Source: built by the author

The regression model of the dependence of production per ha of agricultural land on temperature and precipitation is:

$$Pr = 4{,}37 - 0{,}177 \times T - 0{,}000198 \times P.$$

Taking into account the need to ensure the adequacy of the model, the volume of observations must be greater than the volume of independent variables by at least 5 times, the reproduction of the input data is carried out. The built regression model is adequate according to the Fisher, Student, Durbin-Watson criteria[22]. The model was tested for heteroscedasticity and multicollinearity.

The results of both correlation and regression analysis show the dependence of production volumes on temperature than on precipitation

[22] Lukyanenko I. G., Gorodnichenko Yu. O. (2002). Modern econometric methods in finance. Kyiv: Litera LTD, 352.

volumes. But at the same time, the results show that with a decrease in the volume of precipitation, the volume of production of agricultural products will also decrease. The scatterplot of temperature, precipitation and production of agricultural land is presented in Figure 6.

Further, let's consider the impacts on the livestock sector. Heat waves, which are projected to increase under climate change, could directly threaten livestock. Heat stress affects animals both directly and indirectly. Over time, heat stress can increase vulnerability to disease, reduce fertility, and reduce milk production.

Drought may threaten pasture and feed supplies. Drought reduces the amount of quality forage available to grazing livestock. Some areas could experience longer, more intense droughts, resulting from higher summer temperatures and reduced precipitation. For animals that rely on grain, changes in crop production due to drought could also become a problem.

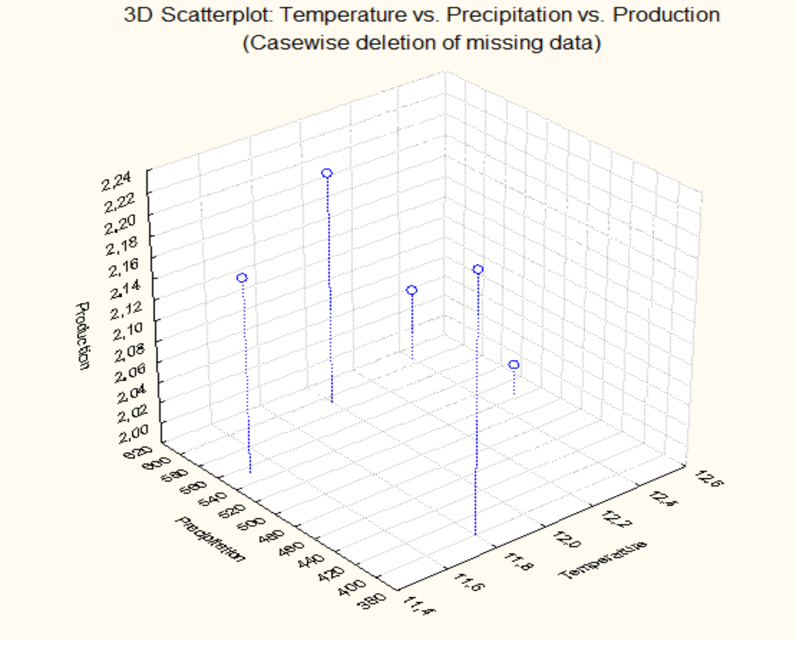

Figure 6. Scatterplot of temperature, precipitation and production per ha of agricultural land

Source: built by the author

Climate change may increase the prevalence of parasites and diseases that affect the livestock. The earlier onset of spring and warmer winters could allow some parasites and pathogens to survive more easily. In areas with increased rainfall, moisture-reliant pathogens could thrive. Potential changes in veterinary practices, including an increase in the use of parasiticides and other animal health treatments, are likely to be adopted to maintain livestock health in response to climate-induced changes in pests, parasites, and microbes. This could increase the risk of pesticides entering the food chain or lead to the evolution of pesticide resistance, with subsequent implications for the safety, distribution, and consumption of livestock and aquaculture products. Increases in carbon dioxide (CO_2) increase the productivity of pastures, but may also decrease their quality. Increases in atmospheric CO_2 can increase the productivity of plants on which livestock feed. However, the quality of some of the forage found in pasturelands decreases with higher CO_2. As a result, cattle would need to eat more to get the same nutritional benefits.

Climatic factors and agriculture mutually influence each other. On the one hand, agriculture has an impact on the surrounding natural environment, and affects climate change in the long term (Table 6). It is necessary an assessment of the ecologically destructive impact of agriculture on the natural environment (soil, water, air, and biodiversity).

Table 6

Main indicators of the impact of agriculture on the environment

Land areas	**Water**
– insolvency; – humus content; – soil structure; – degradation; – erosion; – application of fertilizers, plant protection products	– water supply; - water use; – nitrate content; – pesticide content; – discharge of pollutants; – irrigation and drainage of lands
Ecosystem	**Atmospheric air**
– biological diversity; – landscape diversity; – biodiversity of flora; – biodiversity of fauna	– climate changes; – emissions of greenhouse gases; – emissions of pollutants by stationary and mobile sources

Source: built by the author

On the other hand, climate change leads to changes in the agriculture development, both positive and negative (Table 7).

Table 7

Characteristics of the influence of the main natural and climatic factors on the agricultural sector[23, 24]

Natural and climatic factors	Positive influence	Negative influence
Increase in average air temperatures throughout the year	– expansion of the territories of cultivation of traditional crops; – the possibility of collecting several crops during the year; – sufficient heat for growing rice, cotton and other very heat-loving crops; – the growing season for growing agricultural crops has already begun and will begin earlier and last longer, which will contribute to increasing the productivity of crop production; – rising temperatures and lengthening the growing season will allow farmers to grow two crops of some crops under irrigation conditions.	– increase in evaporation of moisture from the soil – salt accumulation in soils
An increase in the concentration of carbon dioxide (CO_2) in the air	– increasing the yield of crops with high sensitivity to increased CO_2 concentration	– decrease in the grain crops quality; – decrease in the yield of crops with low sensitivity to an increase in CO_2 concentration; – spread of diseases and pests of agricultural crops
Increase in extreme temperatures and their periods	–	– increasing the frequency and duration of dry periods; – rapid and excessive accumulation of heat shortens the growing season,

[23] UN Environment Programme. URL: https://www.unep.org/explore-topics/climate-action/what-we-do/climate-action-note/state-of-climate.html

[24] Climate change impact on agriculture and food security (2012). URL: https://unfccc.int/sites/default/files/leg_2012_pacific_workshop_fao_presentation.pdf

		contributes to the premature ripening of various crops and can lead to a decrease in yield; – an increase in air temperature increases the risk of forest fires; – probable migration of pests that are not typical for the territory of the Slovak Republic (EPRS, 2021); – higher temperatures will lead to a decrease in the rate of increase in live weight of animals, a decrease in milk yield and a decrease in the content of fats and proteins in milk
Decrease in frequency and increase in intensity of precipitation	–	– lack of moisture; – water erosion of the soil; – decrease in soil productivity
Lack of stable snow cover	–	– the risk of freezing of winter crops

A significant share of greenhouse gas emissions comes from agriculture, produced as a result of human activity; almost all surface and a significant part of underground water resources, especially in the areas of powerful agricultural complexes, experience anthropogenic influence, manifested in pollution, depletion and degradation of these objects; the problem of decreasing biodiversity is growing rapidly. An indisputable factor in the greening of agriculture is the development of eco-innovations, which are a new or significantly improved product (service), a technological, organizational, or marketing method that brings ecological advantages compared to alternative solutions. Agriculture is both affected by climate change and an important contributor to greenhouse gas (GHG) emissions[25].

Agricultural enterprises in the Slovak Republic are beginning to focus more on non-agricultural activities, such as the production of biofuels[26]. The European Union aims to increase the share of renewable energy sources

[25] Statistical yearbook. World Food and Agriculture (2021). URL: https://www.fao.org/3/cb4477en/cb4477en.pdf

[26] Ministry of Agriculture and Rural Development of the Slovak Republic. Green Report. URL: https://www.mpsr.sk/en/index.php?navID=16

in total energy production in the EU. All these circumstances are incentives to develop energy production from biomass. Several experts fear that EU countries will not be able to generate the biomass needed to meet EU targets without compromising national food security[27].

5. Suggestions for the private and government structures to mitigate the effects of climate change on sectors of the economy

So, agriculture is a major part of the climate problem. It currently generates 19–29% of total GHG emissions. Without action, that percentage could rise substantially as other sectors reduce their emissions. Additionally, 1/3 of food produced globally is either lost or wasted. Addressing food loss and waste is critical to helping meet climate goals and reduce stress on the environment. Serious environmental problems in agriculture include irrational use of nature, a significant degree of plowing and land degradation, loss of biodiversity, environmental pollution, loss of soil fertility, accumulation of waste, etc[28]. That's why it is necessary to indicate priority areas for sustainable management of natural resources and climate change adaptation (Figure 7).

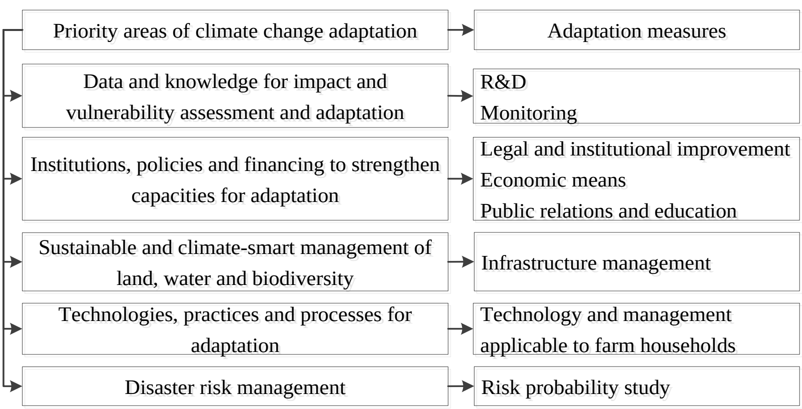

Figure 7. Priority areas for climate change management

On the bases of priority areas identification, the roadmap, which includes seven major adaptation measures such as R&D, monitoring, risk

[27] EPRS. European Parliamentary Research Service. Climate action in Slovakia (2021). URL: https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698767/EPRS_BRI(2021)698767_EN.pdf

[28] FAO. Statistical Yearbook. World Food and Agriculture (2021). URL: https://www.fao.org/ 3/cb4477en/cb4477en.pdf

probability study, infrastructure management, economic means, legal and institutional improvement, public relations and education, and technology and management applicable for individual farm household was developed (Table 8).

Table 8

Roadmap for implementing the adaptation measures in agriculture[29] [30]

Adaptation measures	Characteristics
R&D	– build up the adaptation system to global warming; – convert to the agricultural production system that makes the most of global warming; – build up the crop transformation evaluation system; – build up the early warning system; – popularize the farming simulator; – promote the water resource management system in prevention against natural disasters such as drought and flood
Infrastructure management	– promote the reduction of carbon emission from rice fields and dry fields; – settle the no-tillage farming methods; – build up TMTC system; – expand the energy-saving fusion technology for the protected horticulture
Economic means	– promote the carbon grant for the low-carbon farming methods; – search ways of financing the adaptation measures; – ensure compensation for the consequences of the climate impacts, subsidies and supports; – social and economic interaction of agricultural enterprises, regional communities, government agencies, and international institutions
Legal and institutional improvement	– promote the insurance system for agricultural disasters and regulate of the insurance market; – promote the insurance system for damages by flood and storm; – settle down the programs to help farm households have stable income; – operate the global warming adaptation committee; – settle down the system for calculating the crop damage and the support system

[29] Chang-Gil K. The Impact of Climate Change on the Agricultural Sector: Implications of the Agro-Industry for Low Carbon, Green Growth Strategy and Roadmap for the East Asian Region, 50. URL: https://www.unescap.org/sites/default/files/5.%20The-Impact-of-Climate-Change-on-the-Agricultural-Sector.pdf

[30] Climate-smart agriculture. URL: https://www.worldbank.org/en/topic/climate-smart-agriculture

Public relations and education	– create Disaster Risk Management Centre; – train the agricultural people specialized in risk management; – complement the manual about adaptation to global warming; – build up a systematic education system for each subject related, for their adaptation to global warming
Monitoring	– build up the system for assessing the environmental impact of alternative water use on crop growth; – make mid/long-term forecasts of the world food demand and supply
Technological management applicable to farm households	– change the places of cultivation to proper climate; – fertilize the soil by improving the alkali soil; – prepare the irrigation schedule to enhance the efficiency of water use
Risk probability study	– assessing the probability of climate change and its impact on food security; – disaster risk monitoring; – build of risk management system; – disaster risk reduction.

CONCLUSIONS

Thus, the research proves that climate change affects the social and economic systems on a global scale and can lead to significant consequences. Climate change increases the risks for the health of the population, ecosystems, water and forest resources, the sustainable functioning of the energy infrastructure, and the agricultural complex, which can cause and is already causing colossal losses. Climate hazards will affect agriculture through heat stress on plants, changes in soil moisture and temperature, loss of soil fertility through erosion of top soil, less water available for crop production, changes in height of the water table, salinization of the freshwater aquifer, loss of land through sea level rise, etc. The influence on biodiversity can be in phenological changes and changes in the distribution of species. Climate change could lead to injury and mortality from extreme weather events, heat-related illness, respiratory and allergic illness, water-borne diseases and other water-related health impacts, zoonosis, vector-borne diseases, malnutrition and food-borne diseases, no communicable diseases, mental and psychological health which in turn affects the economic indicators associated with the frequent departure of employees on sick leave, the need to pay for the time of disability of employees, a decrease in labor productivity, etc.

Because climate change is one of the greatest threats to humanity, with far-reaching impacts on society, the environment, and the economy, and affects all regions of the world and all segments of the population the urgent measures are needed to adapt to climate change and minimize its consequences.

The process of adaptation in natural or human systems in response to actual or expected climatic impacts will reduce their negative consequences and take advantage of favorable opportunities helping avoid global catastrophic consequences on a global scale. Therefore, further research will be aimed at quantitative interactions of climate change with other challenges, in particular income inequality, and analyzing methods for adapting social and economic systems of different levels to climate change.

SUMMARY

Climate change is affecting all nations, and given the long-term perspective, neither military conflict nor the socio-behavioral constraints caused by the COVID-19 pandemic can be compared to the impact of environmental risks, including climate change. At the same time countries with low adaptive potential, i.e. limited economic resources, low technology, poor information network, weak infrastructure, unstable or underdeveloped institutions, and unfair access to resources, are characterized by increased vulnerability to climate change. The research is aimed at analyzing the impact of climate on various areas, in particular on population health, agriculture, food security, and the energy sector, which will make it possible to determine areas and sectors of the economy, affected primarily by the climate, the scale and the consequences of such influence.

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References

1. Carter C., Xiaomeng C., Ghanem D., Mérel P. (2018). Identifying the Economic Impacts of Climate Change on Agriculture, *Annual Review of Resource Economics*, 25. URL: https://www.webofscience.com/wos/woscc/full-record/WOS:000447824600018.

2. Chang-Gil K. The Impact of Climate Change on the Agricultural Sector: Implications of the Agro-Industry for Low Carbon, Green Growth Strategy and Roadmap for the East Asian Region, 50. URL: https://www.unescap.org/sites/default/files/5.%20The-Impact-of-Climate-Change-on-the-Agricultural-Sector.pdf.

3. Climate change impact on agriculture and food security (2012). URL: https://unfccc.int/sites/default/files/leg_2012_pacific_workshop_fao_presentation.pdf

4. Climate-smart agriculture. URL: https://www.worldbank.org/en/topic/climate-smart-agriculture.

5. Dellink R., Lanzi E., Chateau J. (2019). The Sectoral and Regional Economic Consequences of Climate Change to 2060. *Environmental and Resource Economics*, 72, 309–363. DOI: https://doi.org/10.1007/s10640-017-0197-5.

6. EPA. United States Environmental Protection Agency. Climate Impacts on Agriculture and Food Supply (2021). URL: https://climatechange.chicago.gov/climate-impacts/climate-impacts-agriculture-and-food-supply#crops.

7. EPRS. European Parliamentary Research Service. Climate action in Slovakia (2021). URL: https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698767/EPRS_BRI(2021)698767_EN.pdf.

8. FAO. Statistical Yearbook. World Food and Agriculture (2021). URL: https://www.fao.org/3/cb4477en/cb4477en.pdf

9. Jafari M., Botterud A., & Sakti A. (2022). Decarbonizing power systems: A critical review of the role of energy storage. *Renewable and Sustainable Energy Reviews*, 158, 112077.

10. Lukyanenko I. G., Gorodnichenko Yu. O. (2002). Modern econometric methods in finance. Kyiv: Litera LTD, 352.

11. Miller L. M., & Keith D. W. (2018). Climatic impacts of wind power. *Joule*, *2*(12), 2618–2632.

12. Ministry of Agriculture and Rural Development of the Slovak Republic. Green Report. URL: https://www.mpsr.sk/en/index.php?navID=16

13. Nelson G. C., Valin H., Sands R. D., Havlík P., Ahammad H., Deryng D., ... & Willenbockel D. (2014). Climate change effects on agriculture: Economic responses to biophysical shocks. *Proceedings of the National Academy of Sciences*, *111*(9), 3274–3279.

14. Rising J., Taylor C., Ives M., Ward R. (2022). Challenges and innovations in the economic evaluation of the risks of climate change, *Ecological Economics*, 197(2022). DOI: https://doi.org/10.1016/j.ecolecon.2022.107437

15. Statistical yearbook. World Food and Agriculture (2021). URL: https://www.fao.org/3/cb4477en/cb4477en.pdf

16. Statistical yearbook of the Slovak Republic (2022). URL: https://slovak.statistics.sk/wps/portal/

17. Sulser T., Wiebe K., Dunston S., Cenacchi N., Nin-Pratt A., Mason-D'Croz D., Robertson R., Willenbockel D., Rosegrant M. (2021). Change and

hunger estimating costs of adaptation in the agrifood system, *IFPRI*, 62. DOI: https://doi.org/10.2499/9780896294165

18. The Global Risks Report (2021). URL: https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2021.pdf

19. The Global Risks Report (2022). URL: https://www.weforum.org/reports/global-risks-report-2022/

20. The Intergovernmental Panel on Climate Change (2022). URL: https://www.ipcc.ch/

21. UN Environment Programme. URL: https://www.unep.org/explore-topics/climate-action/what-we-do/climate-action-note/state-of-climate.html

22. USGCRP (2014). Ch. 6: Agriculture. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 150–174.

23. WHO guidance for climate-resilient and environmentally sustainable health care facilities (2020). URL: https://www.who.int/publications/i/item/9789240012226

24. WHO. Checklists to assess vulnerabilities in health care facilities in the context of climate change (2021). URL: https://policycommons.net/artifacts/1455502/checklists-to-assess-vulnerabilities-in-health-care-facilities-in-the-context-of-climate-change/2090343/

25. World Health Organization. Climate change (2023). https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

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