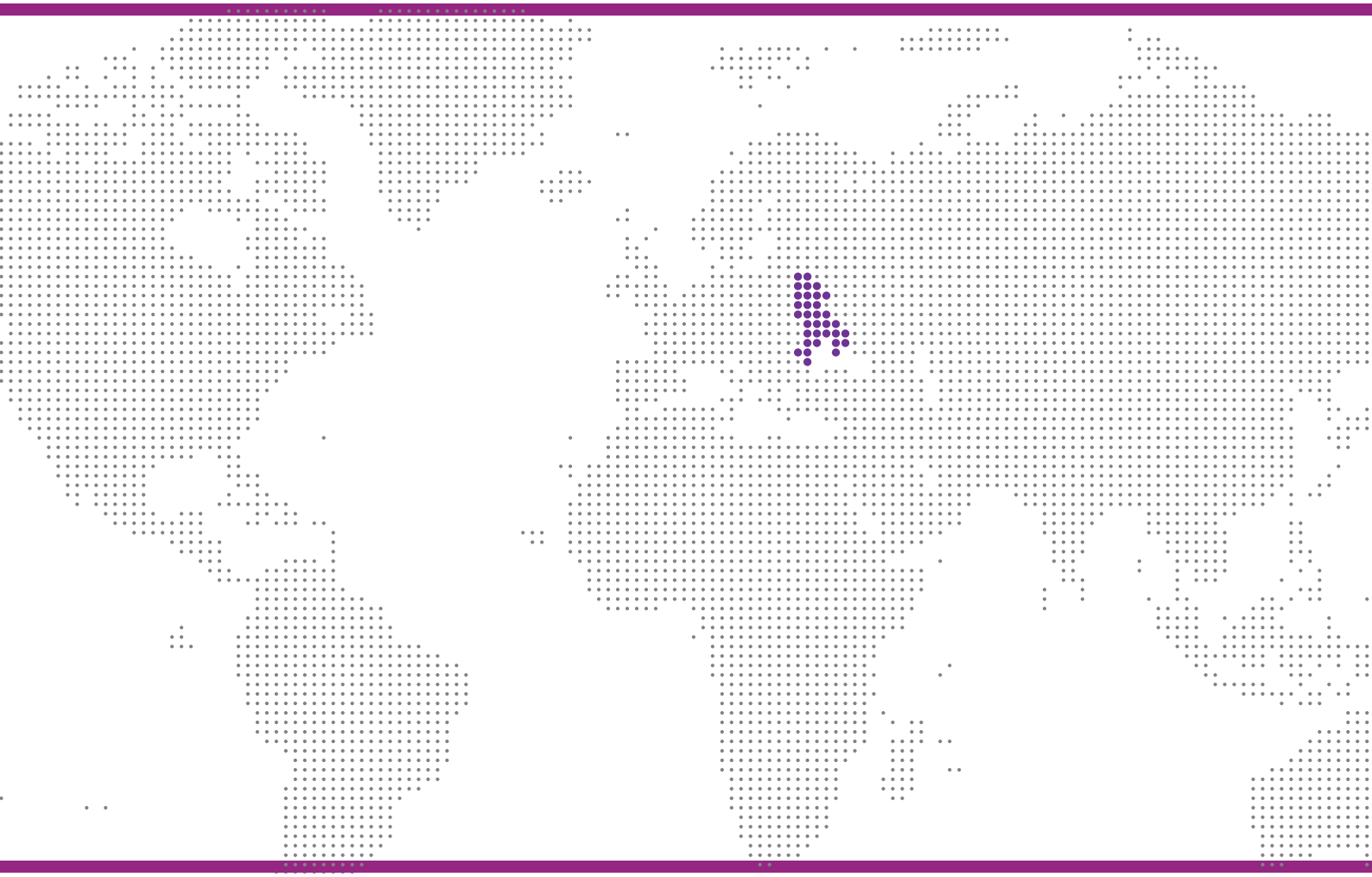
CLIMATE CHANGE AND SECURITY
IN EASTERN EUROPE



REPUBLIC OF BELARUS, REPUBLIC OF MOLDOVA, UKRAINE

Regional Assessment

ENVSEC
Environment & Security

ACKNOWLEDGEMENTS

PROJECT CO-ORDINATION

Christine Kitzler, Dana Bogdan (OSCE)

ASSESSMENT CO-ORDINATION

Harald Egerer, Pier Carlo Sandei, Filippo Montalbetti (UN Environment), Valentin Yemelin (GRID-Arendal)

LEAD AUTHOR

Lesya Nikolayeva (Zoï Environment Network)

CONTRIBUTORS AND REVIEWERS

Nickolai Denisov, Viktor Novikov, Iryna Vanda, Elena Arkhipova, (Zoï Environment Network)

Valentin Yemelin (GRID-Arendal)

Marika Palosaari, Mahir Aliyev, Harald Egerer (UN Environment)

Leonid Kalashnyk, Hanna Plotnykova, Alla Yushchuk, Tamara Kutonova (OSCE)

Mariia Khovanskaia, Vera Demus, Matthias Puhringer (REC)

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FORMATTING AND PRINT PREPARATION:

Livia Mata

EDITING BY

Geoff Hughes (Zoï Environment Network)

VISUALS BY

Carolyne Daniel, Matthias Beilstein, Maria Libert (Zoï Environment Network)

The European Union (EU) through its Instrument for Stability has provided support to the Environment and Security (ENVSEC) Initiative for contributing to regional stability through transboundary co-operation on adaptation to the consequences of climate change.

Within the framework of the project **Climate Change and Security in Eastern Europe, Central Asia and the Southern Caucasus under the Environment and Security Initiative (ENVSEC)**, one of the four main activities aimed at identifying and mapping climate change and security risks in Eastern Europe, Central Asia and the South Caucasus in a participatory way, the conclusions of which are presented in the current report for Eastern Europe.

The Austrian Development Agency (ADA) has co-funded the project by providing financial resources for the project activities in the pilot region in the Dniester River Basin. Moreover, the ENVSEC initiative partners the Organization for Security and Co-operation in Europe (OSCE), the United Nations Development Programme (UNDP), UN Environment, the United Nations Economic Commission for Europe (UNECE) and the Regional Environmental Centre for Central and Eastern Europe (REC) contributed their own resources to the implementation of this project.

The Ministry of Foreign Affairs of Ukraine sent an official note on the position of Ukraine concerning political developments in 2014-2015 in the Crimean Peninsula and Eastern Ukraine. Only the positions related to climate change and security issues were taken into consideration while preparing the final version of the regional assessment.

The Environment and Security Initiative (ENVSEC)

The Environment and Security Initiative (ENVSEC) is a partnership of five international organizations – the Organization for Security and Co-operation in Europe (OSCE), UN Environment (UNEP), United Nations Development Programme (UNDP), United Nations Economic Commission for Europe (UNECE) and the Regional Environmental Centre for Central and Eastern Europe (REC) – with specialized, but complementary mandates and expertise, that provides an integrated response to environment and security challenges. The mission of ENVSEC is to contribute to the reduction of environment and security risks through strengthened co-operation among and within countries in four regions: Central Asia, Eastern Europe, Southern Caucasus, and South-Eastern Europe.

The Environment and Security Initiative (ENVSEC) as a platform for co-operation provides multi-stakeholder environment and security assessments and facilitates joint action to reduce tensions and increase co-operation between groups and countries. Detailed information on ENVSEC is available at www.envsec.org

The assessments herein rely on the most recent statistical data available, while the recommendations take into account the latest developments and trends.

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

ADA	Austrian Development Agency
AR-5	IPCC Fifth Assessment Report
CARPIVIA	Carpathian integrated assessment of vulnerability to climate change and ecosystem-based adaptation measures
CBD	Convention on Biological Diversity
CIS	Commonwealth of Independent States
DG CLIMA	Directorate-General for Climate Action
ENVSEC	Environment and Security Initiative
EU	European Union
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH; (German International Co-operation Agency)
GNI	Gross National Income
ICPDR	International Commission for the Protection of the Danube River
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
Ktoe	Kilotonne of oil equivalent
Mtoe	Million tonnes of oil equivalent
OSCE	Organization for Security and Co-operation in Europe
PPP	Purchasing Power Parity
REC	Regional Environmental Centre for Central and Eastern Europe
SIDA	Swedish International Development Agency
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	UN Environment
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WGI	Worldwide Governance Indicators
WWF	World Wide Fund for Nature

GLOSSARY OF TERMS

Source: Except where noted, definitions come from IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130.

Adaptation	The process of adjustment to actual or expected climate and its effects.
Adaptive capacity	The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.
Afforestation	Planting of new forests on lands that historically have not contained forests.
Biodiversity	The variability among living organisms from terrestrial, marine and other ecosystems.
Chernozem	Fertile black soil rich in humus, typical of temperate grassland. [Oxford English Dictionary]
Deforestation	Conversion of forest to non-forest.
Drought	A period of abnormally dry weather long enough to cause a serious hydrological imbalance.
Ecosystem	An ecosystem is a functional unit consisting of living organisms, their non-living environment and the inter-actions within and between them.
Ecosystem approach	The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. [CBD]
Energy intensity	The ratio of energy use to economic or physical output.
Energy security	The goal of a given country, or the global community as a whole, to maintain an adequate, stable and predictable energy supply.
Extreme weather event	An extreme weather event is an event that is rare at a particular place and time of year.
Food security	A state that prevails when people have secure access to sufficient amounts of safe and nutritious food for normal growth, development and an active and healthy life.
Hazard	The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.
Heatwave	A period of abnormally and uncomfortably hot weather.
Permafrost	Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years.
Reforestation	Planting of forests on lands that have previously contained forests but that have been converted to some other use.
Resilience	The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation.
Risk	The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values.
Sensitivity	In IPCC reports, equilibrium climate sensitivity (units: °C) refers to the equilibrium (steady state) change in the annual global mean surface temperature following a doubling of the atmospheric equivalent carbon dioxide (CO_2) concentration.
Vulnerability	The propensity or predisposition to be adversely affected.
Water security	The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socioeconomic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability. [UN-Water]

SUMMARY

Climate change may exacerbate environmental, economic, political and social challenges, and additional climate stress on water resources and on the agriculture and energy sectors is likely to have consequences for individual countries and for the region as a whole. In many cases, such as, for example, when regional climate risks such as low-water years and droughts disproportionately affect densely populated areas that are already marginalized, security concerns may ensue.

The economies of all three countries are in transition, but while the Republic of Moldova and Ukraine are moving towards a market approach, Belarus has chosen to maintain centralized control over its economy. The lack of diversity in agricultural and industrial production in Eastern Europe exposes the region's economies to fluctuations in international markets, and the region has too few small and medium sized enterprises to make up the difference in either sales or employment.

The countries of Eastern Europe are rich in natural resources, and are heavily agricultural: about 60 per cent of the total area in the Republic of Moldova, 43 per cent of Belarus and 70 per cent of Ukraine is agricultural land. Forestry is equally important in the region: forests cover about 40 per cent of the total area in Belarus, 13 per cent of the Republic of Moldova and 16 per cent of Ukraine.

The energy intensity of the economies of all three countries is high and presents a serious challenge in economic, environmental and geopolitical terms. Currently the region's energy resources and production capacities fall far below their energy consumption and the countries reliance on imports compromises their energy security, putting the internal and external security of the countries at risk. The countries' economic growth remains a hostage to the continuing availability of reliable external energy sources. Reducing energy intensity is a policy focus for all three countries.

The three countries took an active part in preparation of the new global climate agreement and contributed to it by submitting Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC). In particular, INDCs describe their ambitions and commitments on greenhouse gas emission reductions. With the entry into Force of the new global climate agreement the INDCs will transform into Nationally Determined Contributions (NDCs). Belarus and Ukraine ratified the new global climate agreement (Paris Agreement) in September 2016.

Eastern Europe experienced its longest period of warming in the instrumental record at the end of the twentieth and the beginning of the twenty-first century. Overall precipitation levels have remained close to the norm or slightly higher, but seasonal variations are pronounced, and snowfall has diminished. Heatwaves have become more common and the number and severity of extreme weather events has increased dramatically, with numerous floods and droughts in the Republic of Moldova and Ukraine as a consequence.

The Intergovernmental Panel on Climate Change (IPCC) notes in its Fifth Assessment Report that warming is likely to continue in all seasons, with the number of warm days and nights likely to increase, and the number of cold days and nights likely to decrease. Precipitation trends and scenarios are less clear in Eastern Europe: precipitation is expected to be more variable across subregions and seasons, with increases in mean precipitation in winter and small changes in summer, and with more rain than snow in mountainous regions.

The countries of Eastern Europe will not face the severe climate changes that high mountain countries or islands will face, but the changes are nevertheless likely to carry implications for all areas of daily life. Ultimately, climate change may weaken security in such sectors as agriculture, energy and water, and may pose challenges to personal and national security. The climate change implications for human security are likely to become more prevalent over time. Climate change and security hotspots are areas where several security issues intersect.

The regional/transboundary hotspots identified within the study include:

- Urban areas
- The Carpathian Mountains
- Polesie and Chornobyl
- The Tisza River
- The Pripyat River
- The Danube Delta
- The Dniester River
- The Neman River

The national hotspots identified in the study are all in Ukraine:

- Eastern Ukraine
- The Steppe zone of Ukraine
- The Crimean Peninsula

This study recommends that the Governments of the Eastern European countries take swift actions from the local to the regional level to tackle the impacts of climate change and the implications for security. Some of the proposed areas of intervention, including those matching the priorities of the Environment and Security Initiative, will need strengthened regional co-operation as well as more consistent and targeted international support.

1. METHODOLOGY

The overall goals of the climate change and security assessment are to identify and explain how climate change may exacerbate threats to security, and to propose effective measures in response. Achieving these goals requires a clear understanding of the current political, socioeconomic, and environmental conditions, trends and driving forces. These are likely to vary across the countries in a region, and may vary significantly within countries or transboundary ecosystems. The comprehensive survey of these underlying factors is therefore an important element of the climate change and security assessment, and is based on an examination of the publications and routine reporting of national, regional and international organizations, and on academic studies and journal articles.

An understanding of how climate change may affect political, socioeconomic, and environmental conditions depends in part on an understanding of current and projected climate change, and entails the identification and analysis of the effects of rising and extreme temperatures, changing precipitation patterns and extreme weather on resources and livelihoods, and on security. The most recent Intergovernmental Panel on Climate Change (IPCC) reports, the countries' national communications to the United Nations Framework Convention on Climate Change (UNFCCC), other country or river basin studies and inputs from multi-stakeholder consultations all inform this analysis.

The assessment of the effects of climate change on vulnerability focuses on security implications, and identifies how the hazards related to climate change, in combination with other cumulative pressures, may affect the environmental, socioeconomic and political conditions, and how these changed conditions may affect security and stability within and across borders. This assessment necessarily includes a consideration of the climate change adaptation capacity and resilience of governments, institutions and key sectors. It also examines how climate change and the other pressures play out in socioeconomic and environmental terms at the local, national and regional levels.

The definition of "security" in the context of climate change keeps evolving over time much like the Intergovernmental Panel on Climate Change definition of "vulnerability". These modifications of the meanings of the terms do not indicate loose usage but rather the refinements of understanding of the complex relationships among the many contributing factors, and the respective points of view of the agencies and institutions conducting assessments. A sampling of definitions demonstrates how different organizations have grappled with the security terms relevant in the context of climate change and security assessment.

The Food and Agriculture Organization of the United Nations (FAO) noted in a 2002 report that "food security" is a flexible concept, and that some 200 definitions have appeared in the literature. In 1996, the World Food Summit determined that food security existed, "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". The IPCC defines the term as, "A state that prevails when people have secure access to sufficient amounts of safe and nutritious food for normal growth, development and an active and healthy life."

In a 2009 statement, the World Economic Forum defined "water security" as, "the gossamer that links together the web of food, energy, climate, economic growth and human security challenges that the world economy faces over the next two decades". UN-Water provides a comprehensive definition of water security: "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socioeconomic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."

A 2011 Brookings Institution paper notes that, "Although there is a vast literature and much discussion about what constitutes energy security', there is no consensus on a definition," but asserts that, "At the most basic level, energy security means having access to the requisite volumes of energy at affordable prices." The International Energy Agency expands on this definition to include the concept of uninterrupted availability of energy sources, and distinguishes between long-term and short-term security. The former "mainly deals with timely investments to supply energy in line with economic developments and environmental needs", while the latter "focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance." In the IPCC definition, energy security is, "The goal of a given country, or the global community as a whole, to maintain an adequate, stable and predictable energy supply."

Other categories of security include personal, physical, human, national and others, each with their own range of definitions and applications. In the consideration of potential climate threats to security, the assessments strive to be as explicit as possible about the nature of the security at risk.

The approach used during the climate change and security assessments follows the Environment and Security Initiative general approach for developing integrated climate vulnerability assessments and consists of three phases:

1. **Desk studies**: Conducting desk studies and developing a preliminary assessment of the main climate-security implications and sites in the project countries of a region

2. **National and regional consultations:** Holding national and regional multi-stakeholder consultations based on the desk studies and preliminary assessment reports

3. **Joint analysis:** Preparing regional a joint analysis, a final assessment report and a visual synthesis of climate change-security issues and hotspots, and communicating climate change and security implications and areas of concern, priorities and recommendations to policymakers, state institutions and the public

The vulnerability assessment also considers the adaptive capacity of the countries and the region as a whole, and may include an evaluation of financial and institutional capacities and of regional co-operation processes.

The IPCC applies five criteria for assessing vulnerability which are listed below:

1. Exposure of a society, community, or social-ecological system to climatic stressors. If a system is not at present nor in the future exposed to hazardous climatic trends or events, its vulnerability to such hazards is not relevant in the current context.

2. Importance of the vulnerable system(s). Views on the importance of different aspects of societies or ecosystems can vary across regions and cultures. However, the identification of key vulnerabilities is less subjective when it involves characteristics that are crucial for the survival of societies or communities or social-ecological systems exposed to climatic hazards. Defining key vulnerabilities in the context of particular societal groups or ecosystem services also takes into account the conditions that make these population groups or ecosystems highly vulnerable, such as processes of social marginalization or the degradation of ecosystems.

3. Limited ability of societies, communities or social-ecological systems to cope with and to build adaptive capacities to reduce or limit the adverse consequences of climate-related hazards. Coping and adaptive capacities are part of the formula that determines vulnerability. While coping describes actions taken within existing constraints to protect the current system and institutional settings, adaptation is a continuous process which encompasses learning and change of the system exposed – including changes of rule systems or modes of governance. Severe limits of coping and adaptation provide criteria for defining a vulnerability as key, since they are core factors that increase vulnerability.

4. Persistence of vulnerable conditions and degree of irreversibility of consequences. Vulnerabilities are considered key when they are persistent and difficult to alter. This is particularly the case when the susceptibility is high and coping and adaptive capacities are very low due to conditions that are hard to change. Irreversible degradation of ecosystems, chronic poverty and marginalization, and insecure land tenure arrangements are drivers of vulnerability that in combination with climatic hazards determine risks which often persist over decades. In this way, communities or social-ecological systems (e.g. coastal communities dependent on fishing or mountain communities dependent on specific soil conditions) may reach a tipping point that would cause a partial or full collapse of the system. Inability to replace such a system or compensate for potential and actual losses and damages is a critical criterion for determining what is "key".

5. Presence of conditions that make societies highly susceptible to cumulative stressors in complex and multiple-interacting systems. Conditions that make communities or social-ecological systems highly susceptible to the imposition of additional climatic hazards or that impinge upon their ability to cope and adapt, such as violent conflicts are considered under this criteria. Also, the critical dependence of societies on highly interdependent infrastructures (e.g. power supply [or] transport) leads to key vulnerabilities [in] systems where capacity to adapt is low.

These IPCC criteria provide guidance on how to evaluate the relative importance of various areas of vulnerability. The ENVSEC climate change and security assessment considers these criteria in defining the corresponding vulnerable areas (climate change hotspots) and the context-specific implications for security.

1.1. Phase 1: Desk studies

The desk studies consider the underlying political, socioeconomic and environmental conditions; the current and projected climate change; the climate hazards and stressors; and the impact of climate change in the context of the vulnerability of specific places in the region. The desk studies culminate in the identification of climate and security hotspots.

1.1.1. Survey of underlying political, socioeconomic and environmental conditions

A comprehensive survey of the underlying socioeconomic, political and environmental conditions in the countries and the region as a whole entails the examination and description of the range of factors that may influence the interplay of climate and security. These factors include the following:

- The geopolitical situation and broad security influences
- Climate change politics and mainstreaming
- Governance
- Social dynamics
- The economic situation
- The availability and condition of natural resources
- Agriculture and food security
- Energy production and security
- The water-agriculture-energy nexus
- Critical infrastructure

1.1.2. Current and projected climate change

The relationships between rising global temperatures and a host of secondary effects are increasingly well understood. Climate trends and projections are available at the global, regional, national and sometimes local levels. Such trends and projections usually consider the following:

- Average annual and seasonal temperature
- Number of hot days and nights
- Frequency of heatwaves
- Average annual and seasonal precipitation
- Number of days above and below precipitation thresholds
- Number of extreme weather events

Among the reliable sources of climate information are the following:

- Intergovernmental Panel on Climate Change publications, including special reports and the parts of the Fifth Assessment Report published in 2013-2014, and international online resources with climate data and climate change models
- National communications to the United Nations Framework Convention on Climate Change
- Country statements, positions and presentations
- National policies, programmes and plans related to environmental issues, natural resources and adaptation to climate change
- Official data from international organizations
- Peer-reviewed international research

An understanding of the climate trends and projections for a country and a region provided the basis for the analysis of climate change hazards and risks in this study, and for the analysis of likely regional consequences on security.

1.1.3. Climate hazards and stressors

The identification and analysis of hazards resulting from climate change is an essential step in the climate change and security assessment. Some of these hazards come in the form of sudden events, and some arise slowly over time. The long-term effects of rising temperatures and disrupted precipitation patterns may diminish pastures, interfere with irrigated and rain-fed agriculture and energy production, change sea levels and compromise human health. For either sudden or slow onset effects, the hazard analysis considers the potential environmental, socioeconomic and political consequences of these hazards. The array of hazards under consideration included the following:

- Melting glaciers and the formation of potentially dangerous glacial lakes
- Floods, flash floods and other climate-related disasters
- Sea-level rise and enhanced coastal flooding
- Desertification and loss of usable land
- Hailstorms, cold waves, dust storms
- Droughts and heatwaves
- Wildfires
- Changes in the hydrologic cycle; too much and too little water; major seasonal shifts
- More frequent and severe extreme weather events

1.1.4. Impact and vulnerability assessment

The analysis of the role of climate change as an additional stressor examines how natural hazards caused or intensified by climate change may affect the existing environmental, socioeconomic and political conditions. It considers the likelihood of the climate risk and the potential exposure to hazards, and explores the implications for security. Some of the relationships are fairly straightforward, and some are highly complex. Floods or extreme cold waves, for example, may cause immediate human and economic losses, may trigger an energy or food crisis and may threaten livelihoods. Changes in the hydrologic cycle, in contrast, may cause environmental degradation over time with repercussions for the economy and food and power production for a growing population in the coming years. The security implications may be far-reaching and complicated by other factors.

The levels of identified risks are likely to rise over time, especially in the absence of adaptation, and therefore the timeframe for the analysis is an important factor in the vulnerability assessment. The IPCC Fifth Assessment Report uses three distinct time frames – the present, near term (2030-2040) and long term (2080-2100) – in its evaluation of climate risks. By taking a similar approach, this assessment aims to help alert policymakers to the prospect that a low-level present risk has the potential of becoming a high-level long-term risk, even when long-term projections of the underlying security conditions may not be feasible.

The IPCC describes risk as "The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values." In its enumeration of key climate-related risks, the IPCC offers descriptions, including the following:

- Systemic risks due to extreme weather events leading to breakdown of infrastructure networks and critical services such as electricity, water supply, and health and emergency services
- Risk of mortality and morbidity during periods of extreme heat, particularly for vulnerable populations and those working outdoors in urban or rural areas
- Risk of food insecurity and the breakdown of food systems linked to warming, drought, flooding, and precipitation variability and extremes, particularly for poorer populations.
- Risk of loss of rural livelihoods and income due to insufficient access to drinking and irrigation water and reduced agricultural productivity.

This assessment considers the structural, socioeconomic and environmental consequences of climate change, and covers a broad range of perceived risks and context-specific security concerns:

- Livelihood insecurity (urban and rural)
- Human and economic losses
- Additional pressure and competition over scarce natural resources
- Seasonal or persistent water shortages and possible energy and water insecurity
- Damage to infrastructure; industrial safety concerns, including stability of tailings
- Diminished ecosystem services
- Biodiversity disruptions and possible loss of fish stocks, pastures and genetic resources
- Increased social tension and conflict
- Changes in trade patterns and economic impacts
- Increased rates and wider geographic spread of diseases, and declines in human health
- Loss of sources of income and increased poverty or diminished well-being
- Decreased physical security and possible growth in crime
- Displacement and increased migration
- Loss of land and cultural and natural heritage

According to the IPCC definitions, a hazard is "the potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources" and vulnerability is "the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected." In ranking risks, the IPCC considers the hazard and the vulnerability of the exposed society or systems, and applies the following criteria:

- Magnitude
- Probability that significant risks will materialize and their timing
- Irreversibility and persistence of conditions that determine risks
- Limited ability to reduce the magnitude and frequency or other characteristics of hazardous climatic events and trends and the vulnerability of societies and social-ecological systems exposed

The examination of climate change as an additional stressor also considers the adaptation capacity of the countries and the region as a whole, and includes evaluations of financial and institutional capacities, regional co-operation processes, resilience and national climate change policies and plans.

1.1.5. Climate change and security hotspots

In this report, climate change and security hotspots are areas with ongoing tensions or environmental concerns where climate change is expected to undermine social or economic stability, threaten infrastructure or livelihoods, or compromise security by exacerbating political or social tensions, conflicts or instability.

The identification of hotspots started with a review and analysis of existing information on environmentally sensitive areas. The sources included the Environment and Security Initiative assessments in the region, national communications, international studies on climate change and security and interviews with national and regional experts. Stakeholders at national and regional consultations reviewed the initial designations, and refined the assessments.

Defining climate change and security hotspots

This project identifies and assesses climate change and security hotspots across Eastern Europe, Central Asia and the Southern Caucasus. These hotspots are identifiable in geographic terms, and are characterized by ongoing tensions, environmental concerns or both. In each of these hotspots, climate change through one or more pathways is expected to undermine social or economic patterns, threaten infrastructure or livelihoods, or compromise security by exacerbating political or social tensions, conflicts or instability. Areas with weak institutions or lacking the effective mechanisms for transboundary environmental and security co-operation are especially vulnerable.

The analysis of hotspots, which has been discussed with stakeholders in the countries during several consultations, recognizes the value of natural resources both economically and in terms of security, and considers the tensions associated with the value of resources. Such tensions may arise from criminal activity conflicting with legitimate uses or from questions of who can use a resource, and how. How climate change may affect these situations is of particular interest.

The hotspots included here reflect the judgement of the project analysts and the stakeholders, informed by the following considerations:

- Existing or prospective vulnerability to climate change
- Existing instability or security risks
- Analytical conclusions regarding the connections between climate change and security
- Other existing political, socioeconomic and environmental factors

1.2. Phase 2: National and regional consultations

A series of multi-stakeholder national meetings in each of the three Eastern European countries to discuss and complement the preliminary findings of the assessment followed a participatory approach that ensured that the voices of key-stakeholders and CSO representatives were heard. The participants in the meeting comprised experts from various ministries or other national institutions, academia, non-governmental, regional or international organizations.

Work sessions in the meetings focused on country-specific issues raised by background papers and expert presentations. Discussions concentrated on the relationship between climate change and security, and on how that relationship is playing out in the country.

Participatory mapping exercises supported the identification of vulnerable areas. The perception of risk from the country perspective is an integral part of this determination, as are national political sensitivities. The participatory mapping process accounts for these national views in a way that a vulnerability assessment based on a desk study alone cannot.

The regional consultations brought together experts, policymakers and representatives of the ENVSEC organizations. These consultations attempted to reconcile national perceptions of climate change across the region, and to identify regional commonalities and differences. The goals were to try to reach agreement on what the problems are, to combine the national assessments into a regional synthesis assessment and to identify the issues that require a regional approach.

From 8 to 9 September 2014, representatives of governments of Belarus, the Republic of Moldova, Ukraine, as the countries of the ENVSEC Eastern European region; academic and non-governmental institutions; and ENVSEC's international partners convened in Minsk, Belarus, to take part in the ENVSEC Eastern Europe Regional Consultation meeting, generously hosted by the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus.

The meeting saw two days of plenary and group discussions, where the scope of problems calling for immediate attention and action on the part of the Eastern European countries and their ENVSEC partners was outlined and analyzed in great depth and detail.

The meeting reviewed prospects for future co-operation and interaction with the donor community, with main challenges and priorities in the area of environment and security for the parties outlined, as well as the steps to be taken to tackle them jointly. The outcomes of this meeting are partly reflected in this assessment as well.

1.3. Phase 3: Joint analysis

In developing the regional synthesis report based on the preliminary assessment and the multi-stakeholder consultations, ENVSEC takes account of international knowledge, practitioner expertise and available technologies; incorporates the national concerns expressed by the countries; and seeks a regional consensus on hotspots.

1.4. A note on the limitations of the methodology

The assessments here rely heavily on the available data and on the findings of assessments or studies conducted by other organizations and institutions. Where possible, national stakeholders verified the data during the consultation process. Climate change and security risks are based in part on perceptions and on climate change scenarios, both of which tend to be uncertain. The analyses may be limited by weaknesses in the data and uncertainty in the projections.

In addition, identifying geographic hotspots in some areas and presenting the security implications in a neutral manner can sometimes be a challenge for the international community. In this regard the climate change and security assessment may not report fully on the details of those regions that are experiencing protracted conflicts or that are very sensitive about certain areas, issues or resources.

2. EXISTING POLITICAL, SOCIOECONOMIC AND ENVIRONMENTAL CONDITIONS

This chapter surveys the underlying socioeconomic, political and environmental conditions in the countries and the region as a whole, and examines the range of factors that may influence the interplay of climate change and security.

2.1. The geopolitical situation and broad security influences

Climate change is a global issue that does not respect borders or a country's welfare. Therefore global or regional responses are required to meet such changes and the countries of the Eastern Europe region should take a co-operative approach in determining priorities for short- and long-term actions. Geopolitical aspects, the level of co-operation and mutual trust will determine how far the countries can develop and strengthen their interactions, including in the area of climate change insecurity.

The countries of Belarus, the Republic of Moldova and Ukraine are often grouped into the Eastern Europe region, which lies between the European Union (EU) and the Russian Federation (Russia) and stretches from the northern coast of the Black Sea in the south (Ukraine) to the Baltic Sea basin in the north (Belarus) as shown in Figure 1. Its territory is 840 000 km^2 and it has a population of nearly 60 million. The countries of the region have several joint borders and are located within the same water catchment basins. They are united by the similarity of their geography, a common history and culture, and economies with a similar infrastructure.

Geopolitical aspects of the region are significantly determined by Eastern Europe's unique geographical position. Two of the countries in the region have experienced conflicts – the Transdniestrian conflict in the Republic of Moldova and the crisis in and around Ukraine – that have implications for the entire region and beyond.

Through a series of agreements including the formation of the Union State of Russia and Belarus (1999), Belarus maintains close ties with Russia.

Relations between the countries of the region are well established. The existing problems are solved on the basis of international law and mutual benefit such as in the exchange of land between the Republic of Moldova and Ukraine giving the landlocked Republic of Moldova access to the Black Sea via the Danube. Although not all borders areas are demarcated, there are no border conflicts among the countries of the region.

According to the Fragile States Index of the Fund for Peace, Ukraine, Belarus and the Republic of Moldova belong in the "Warning" category of countries, with rankings of 84, 87 and 96 respectively, out of 178 countries.

The protection of human rights was more or less stable in the region in the 2006–2014[1] period, though still a lot of issues have to be addressed – the protection and promotion of a free press and civil activism; the reduction of discrimination against sexual groups; the reduction of violence; and the strengthening of the level of human rights protection in civil disputes, among others.

After the break-up of the Soviet Union, the three countries inherited natural resources depleted by unsustainable use, including depleted chernozems (once fertile "black soils") and polluted waters, as well as a huge volume of toxic waste from mining and heavy industry and radioactive waste storage, the consequences of the Chornobyl catastrophe. In addition to complicated economic conditions over recent years, the people and economies of the countries have suffered from numerous natural disasters caused partly by climate change. The signs of climate change are apparent in the region: extremes of temperature, an increase in the number of hot days, an overall reduction in atmospheric precipitation (although with a drastic rise in some areas), together with an increase in gales and rainstorms, catastrophic floods and droughts, forest fires and desertification. The consequences of these trends are having a negative impact on agriculture, forests, water and other sectors, as well as on people's health and safety.

1 http://fsi.fundforpeace.org/rankings-2015, http://fsi.fundforpeace.org/rankings-2007

Geopolitical map of Eastern Europe

Figure 1: Geopolitical map of Eastern Europe

Although there are rarely direct connections between political conflicts, climate change and security, political developments show the importance and role of environmental protection for the countries. Moreover, where conflicts or tensions already exist, any changes in the natural environment, including the adverse changes caused by climate or other human-induced factors, are accelerated due to lack of capacities, will and funds to address them.

2.2. Climate change politics and mainstreaming

In Eastern Europe, climate change may exacerbate environmental, economic, political and social challenges, and additional climate stress on water resources and on the agriculture and energy sectors is likely to have consequences for individual countries and for the region as a whole. When regional climate risks such as low-water years and droughts – but also increased frequency of unusual and severe events such as floods – disproportionately affect densely populated areas that are already marginalized, security concerns may ensue.

Belarus, the Republic of Moldova and Ukraine are parties to the United Nations Framework Convention on Climate Change and its Kyoto Protocol, which obligate the countries to develop national policies on climate change and greenhouse gas emissions in accordance with the Convention's conditions and with international standards. Indeed, the countries have adopted appropriate laws and legislative acts on climate change issues.

The Republic of Belarus developed national policy that includes:

- An action plan for implementing the Kyoto Protocol
- A national programme of measures to mitigate climate change for 2008-2012
- A state programme of measures to mitigate climate change for 2013-2020

The Republic of Moldova developed and adopted:

- A Parliament Decision of the Republic of Moldova about ratification of the UNFCCC
- A law on the Republic of Moldova's accession to the Kyoto Protocol
- A National Climate Change Adaptation Strategy
- An Environmental Strategy for 2014-2023
- A new Climate Action Plan
- A Draft Law on Emission Development Strategy until 2030

Main Ukrainian legislation on climate change consists of:

- Laws on ratification of UNFCCC and Kyoto Protocol
- A National Plan on realization of the Kyoto Protocol
- "Ukraine-2020" Sustainable Development Strategy
- A Plan of Urgent Adaptation Actions (pending approval)

All three countries actively participated in the process of preparation of a new global climate agreement that was adopted at the end of 2015 in Paris, France. The countries prepared and submitted Intended Nationally Determined Obligations (INDCs) – intended obligations to reduce or stabilize greenhouse gas (GHG) emissions by 2030 taking into account the countries' economies, population growth and potential for emissions reduction. According to national INDCs, Belarus aims to reduce its GHG emissions by 29 per cent of the 1990 base year level by 2030, the Republic of Moldova by 64-67 per cent by 2030 and Ukraine by 60 per cent by 2030. The countries have adopted regulations on GHG emissions, and report to the UNFCCC every two years.

Additionally, in 2014 the Republic of Moldova and Ukraine signed and ratified Association Agreements with the EU, which among other things include such co-operation on climate change as the elaboration and implementation of adaptation and mitigation strategies and plans, vulnerability and adaptation assessments, a strategy for low-carbon development, the reduction of greenhouse gas emissions, carbon trading and the transfer of green technologies. In 2015 Belarus became a Party to the Eurasian Economic Union – together with Armenia, Russia, Kazakhstan and Kyrgyzstan – that will likely bring new changes in economic and trade developments, as well as have possible implications on climate change policy and GHG emissions due to broadening economic horizons and increases in production.

In order to implement climate change policy targets, the countries initiate and implement a number of strategies, programmes and specific projects. In Belarus these include the integration of climate change issues into sectoral programmes, adaptation in the agriculture sector and renovation of irrigation systems, maintaining forestry and protected areas, developing energy efficiency projects (including low-carbon production) and renewable energy. The Republic of Moldova's initiatives include flood prevention and protection on major rivers, rational water management, maintenance of hydrometeorological observations, renovation of irrigation systems, combat of desertification, disaster and climate risk reduction (in all sectors) and management, inclusive rural economic development and climate resilience. Ukraine's projects include research on wetlands and forestry in Polesie, protection and management of transboundary water bodies, development of low-emission production, GHG emissions trading, combatting desertification, maintaining protected areas and environmental monitoring.

2.3 Governance

The government of a country elaborates the strategies for a country's development, and identifies priorities for preliminary actions. Strong governments that identified climate change and the associated insecurities as a priority and enforce the implementation of respective commitments in climate change mitigation and adaptation support the efforts of internal and international processes for combating climate challenges. Thus they have stronger capacities for the management and prevention of climate change and insecurity risks or timely adaptation to those risks.

A country's planning and governance is a critical factor in its capacity to respond effectively to climate change. The Worldwide Governance Indicators (WGI) project compares the countries of the world against each other, and reports the rankings. The World Bank applies these indicators, among other factors, in the development of its adaptive capacity index – an attempt to quantify and summarize a country's potential to respond to climate change. The IPCC (2007) reports that, "The specific determinants of adaptive capacity at the national level represent an area of contested knowledge," but says that, "Some studies relate adaptive capacity to levels of national development, including political stability, economic well-being, human and social capital and institutions."

According to the Worldwide Governance Indicators project, the countries of Eastern Europe generally rank in the 50th percentile or lower (percentile rank is measured from 0 to 100). Political stability may be the most important indicator in terms of responding to climate change and security threats. The countries of Eastern Europe rank from the 42nd to the 46th percentile on the political stability factor in 2012. The latest changes in Ukraine in 2014 moved the country to the 21th percentile[2].

The Republic of Moldova generally ranks higher than Belarus and Ukraine, with rankings in the 40s for voice and accountability, regulatory quality and rule of law, and in the 30s on government effectiveness and control of corruption. Ukraine ranks in the 40th percentile on voice and accountability, but drops into the 30s and 20s on the other factors except for control of corruption where it ranks in the 16th percentile, but the latest political developments in the country would likely change the rankings. Belarus ranks in the 37th percentile for control of corruption, but falls below the 20th percentile in all other categories.

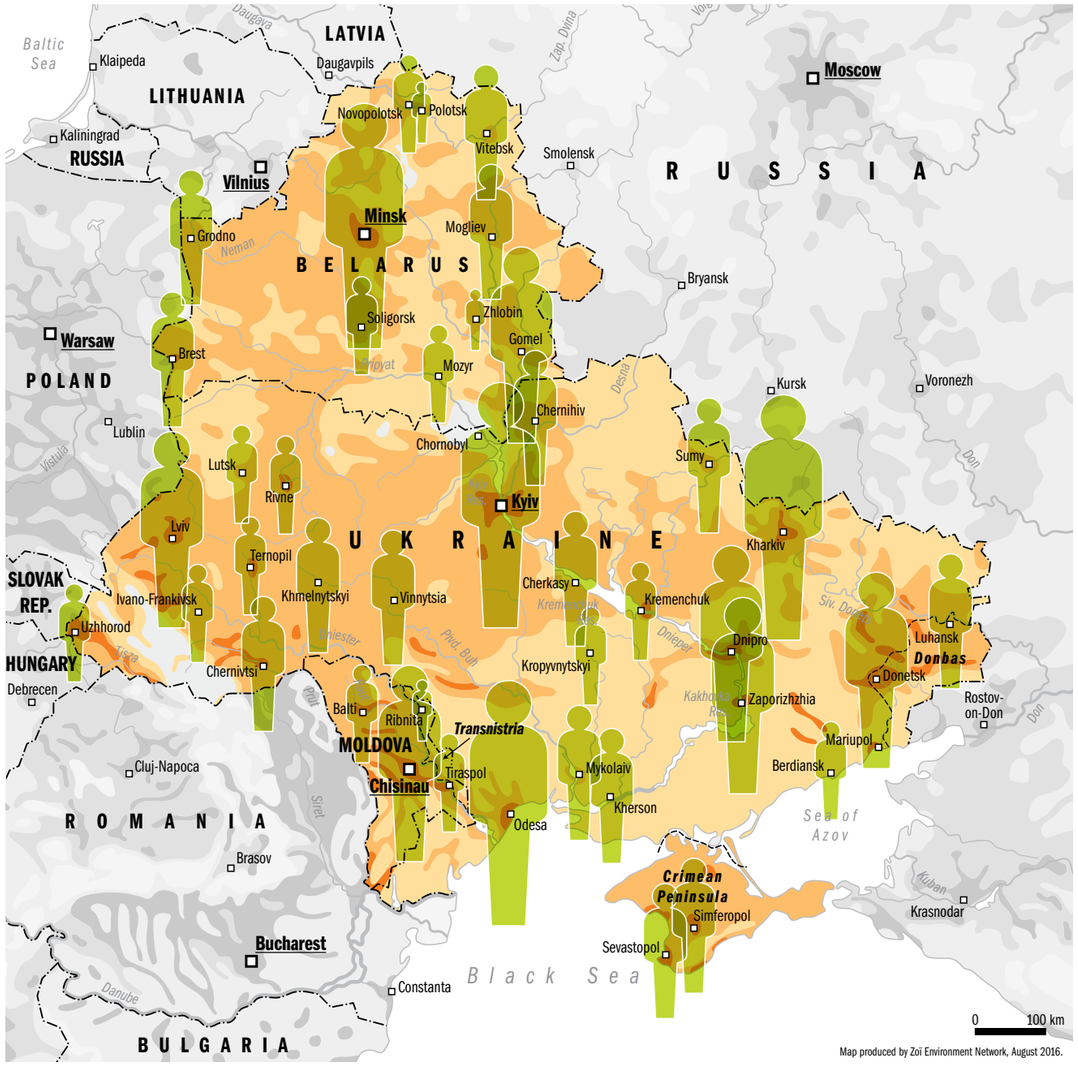
The countries are developing a vast array of new laws, but the legislative framework requires more harmonization (all the three countries aim to apply the EU acquis communautaire, more fully in the EU-associating Republic of Moldova and Ukraine and on a case-by-case basis in Belarus). Private businesses perceive certain impediments, although the situation varies across the region. Despite attempts to prevent it, corruption is still perceived to be the main impediment to effective governance, including for the effectiveness of local authorities in the region.

2.4. Social dynamics

The examination of social dynamics in the region facilitates an understanding of the human capacity for dealing with climate change impacts, and for the insecurities and challenges these impacts may cause. Knowledge of education levels, the percentage of employed and unemployed, the distribution of wealth and income, and vulnerable groups based on age or gender can guide policy makers in identifying the scope of adaptation measures that may be necessary and that are feasible. Future projections compared to the current situation also help estimate what contribution could be expected for adaptation.

Between 2000 and 2014, the population of Eastern Europe declined by 4.6 million people. The countries of the region are densely populated with 92 inhabitants per km^2 overall, and 42 in Belarus, 121 in the Republic of Moldova and 75 in Ukraine (see Figure 2).

2 http://info.worldbank.org/governance/wgi/index.aspx#countryReports



Map produced by Zoï Environment Network, August 2016.

Population in Eastern Europe

Population of major cities and municipalities

- > 1 million inhabitants
- 500 000 - 1 million inhabitant
- 250 000 - 500 000 inhabitant
- 100 000 - 250 000 inhabitant
- < 100 000 inhabitants

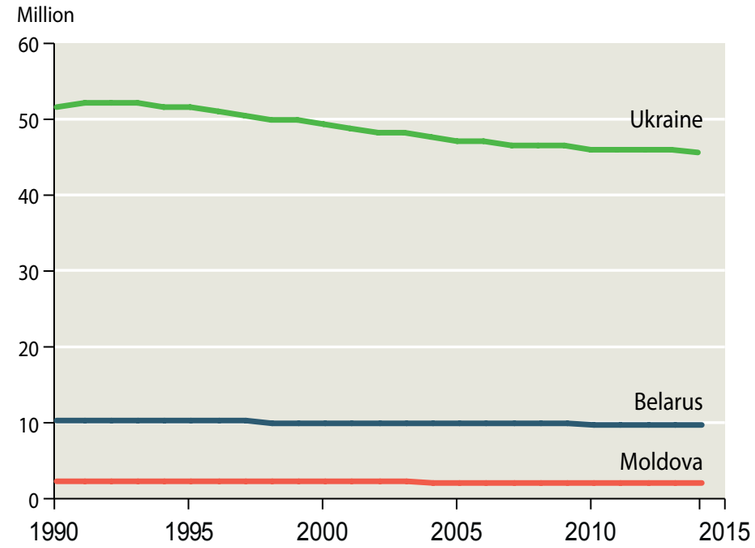
Population density (inhabitants per km²)

1 5 50

Source: Thomas Brinkhoff: City Population (www.citypopulation.de).

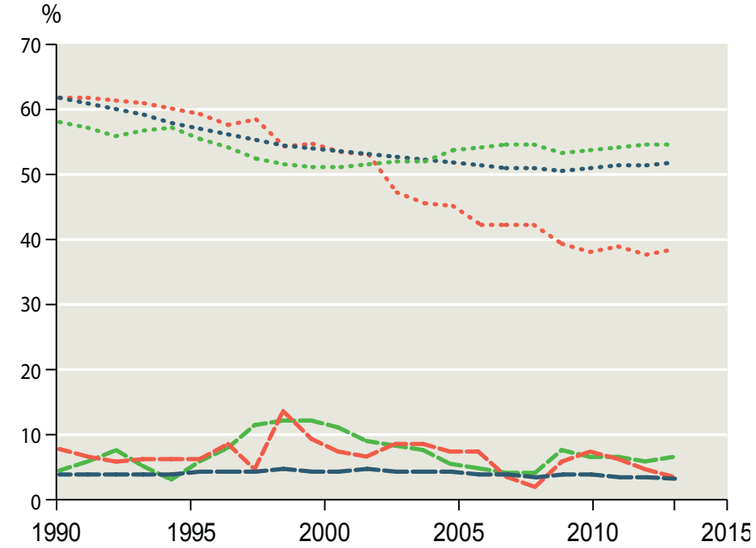
Figure 2: Population in Eastern Europe

The population density is decreasing due to depopulation. In 1990, birth rates in the region exceeded death rates, but between 1990 and 2000 birth rates decreased while death rates rose, and since 2000, death rates have exceeded birth rates while both rates have remained fairly steady. (See Figure 3) The fertility rates for all three countries have remained stable at 1.5 births per woman, a rate insufficient for natural replacement of generations (World Bank, 2013).



Population

Source: World Bank Open Data, Indicators.
http://data.worldbank.org/indicator/SP.POP.TOTL



Employment and unemployment

Source: World Bank Open Data, Indicators.
http://data.worldbank.org/indicator/SL.EMP.TOTL.SP.ZS

Produced by Zoï Environment Network, 2015.

Figure 3: Population and employment dynamics

Ageing of the population is a characteristic feature of Eastern Europe, the result of modern rates of natality and mortality. From 1990 through 2014, the share of children in Belarus declined from 23 per cent to 16 per cent, in the Republic of Moldova from 23 per cent to 17 per cent and in Ukraine from 22 per cent to 15 per cent of the total population. In the same period, the share of the elderly population increased from 11 per cent to 14 per cent in Belarus, from 8 per cent to 12 per cent in the Republic of Moldova and from 12 per cent to 15 per cent in Ukraine. In Ukraine, the number of inhabitants age 65+ exceeds the number of children 0-14, indicating a regressive age structure of the population (World, 2015).

In the Republic of Moldova, ethnic Moldovans are 76 per cent of the population, Ukrainians 8 per cent, Russians 6 per cent and Gagauz 4 per cent. In Ukraine, Ukrainians are 78 per cent of the population, Russians 17 per cent and other ethnic groups less than 1 per cent. In Belarus, ethnic Belarusians are 84 per cent of the population, Russians 8 per cent, Poles 3 per cent and Ukrainians 2 per cent.

The aggregate indicator of group grievances is in the upper-medium range for countries of the region. In the Republic of Moldova and Belarus intergroup tension is decreasing, while Ukraine has a stable high level of group grievance.[3]

2.4.1. Socioeconomic migration

All three countries have lost population to net migration. Between 2000 and 2012, Belarus lost 96 000 persons. The Republic of Moldova lost 27 000 persons between 2005 and 2012, and Ukraine lost 76 000 persons between 2002 and 2012. Altogether these losses to net migration represent less than 5 per cent of the total population decline. The number of emigrants from the region has been slowly declining in recent years. The proportion of the population living in urban areas increased by 2-5 per cent between 2000 and 2012 in all three of the Eastern Europe countries.

Migration flows are different in the Eastern European countries: Belarus has a positive migration balance, the Republic of Moldova's is negative, and Ukraine's is varying. According to the World Bank (WB), the average annual net migration for the period 2000-2014 is 39 300 persons in the Republic of Moldova, 2 000 in Ukraine and 1 600 in Belarus (WB, 2014). Official national statistics of the countries provide different data: the average annual net migration for the 2001-2014 is 6 600 in the Republic of Moldova, 10 300 in Ukraine and 8 200 in Belarus. A significant part of the population in both the Republic of Moldova and Ukraine are labour migrants.

Personal remittances generally grew between 1992 and 2013. Ukraine as the country with biggest human (and labour) potential also has the most receipts – US $9.6 billion in 2013 compared to US $1.2 billion for Belarus and US $2.0 billion for the Republic of Moldova. But in terms of Gross Domestic Product (GDP) the most significant contribution from personal remittances is in the Republic of Moldova with 26.6 per cent of total GDP in 2013 compared to 5.2 per cent in Ukraine and 1.7 per cent in Belarus. Personal remittances are important mostly for providing for the well-being of families in the Republic of Moldova, Ukraine and Belarus. At the same time personal remittances exceeded flows of foreign direct investments: US $3.8 billion in Ukraine, US $2.2 billion in Belarus and US $0.2 billion in the Republic of Moldova in 2013 (UNCTAD, 2015).

The numbers of refugees and asylum seekers in Eastern Europe grew from the first days of independence until 2005-2007 when the numbers stabilized or declined. The Transdniestrian conflict caused the number of refugees from the Republic of Moldova (World Bank, 2015). With the advent of the crisis in and around Ukraine, more than 237 000 people left the country, while 823 000 people were internally displaced within Ukraine (UN Refugee Agency, 2015). According to the United Nations Refugee Agency, in June 2015 Ukraine had 318 786 refugees, 20 754 asylum seekers and 1 382 000 internally displaced persons.

2.4.2. Urbanization

Employment and place of residence are significant factors in determining lifestyle. Eastern Europe has, on average, 68 per cent of the population living in urban areas. For the period 2000-2014 the urban population in Belarus grew from 70 per cent to 76 per cent of total population, and from 67 per cent to 69 per cent in Ukraine while remaining stable near 45 per cent in the Republic of Moldova where 44 per cent of the urban population is concentrated in the capital – the largest city. In contrast, Ukraine has a wide network of cities and towns. The population density of cities suggests the need for special consideration of security issues related to climate change in urban areas. Rural lifestyles are more dependent on the environment, as reflected by employment in agriculture, forestry, hunting and fishing. Agriculture accounts for 26 per cent of employment in the Republic of Moldova, 17 per cent in Ukraine and 10 per cent in Belarus, and supports 4.3 million individual households in Ukraine, 1.0 million in Belarus[4] and 0.9 million in the Republic of Moldova.[5]

2.4.3. Environmental migration

Climate change is likely to affect different populations and areas in specific ways. The effects will vary by location according to the specific sensitivities of the affected communities. Similarly, the ability of communities to respond to climate change and to cope with the consequences will vary by each community's specific political, economic, environmental and social circumstances, and where the ability of communities to respond is low, may cause environmental migration. The migration policies in the future may significantly influence security, but the range of possibilities is wide: restricted migration would likely increase domestic economic and environmental pressures and instability, and more open migration would likely have the opposite effects. To date, Eastern Europe has not experienced any noticeable environmental migration.

2.4.4. Religion

Historically and culturally the church plays a major role in the social and political lives of the countries, including taking an active part in social education, manners, policymaking and the promotion of socially important ideas and orientations. Thus the church and religion generally could be considered as one of the means of communication and public education.

2.4.5. Education

Nine years of obligatory education and high enrolment ratios account for the region's literacy rate of nearly 100 per cent. In addition, nearly 25 per cent of the labour force in Belarus and the Republic of Moldova has tertiary education. Total enrolment in tertiary education is 93 per cent in Belarus, 41 per cent in the Republic of Moldova and 79 per cent in Ukraine.

Eastern European cou ntries inherited a state-financed public sector from Soviet times. Continuous reform between 1990 and the present has established private entrepreneurs in the education, health and insurance sectors. Health expenditures in Belarus are 5.3 per cent of GDP, compared to 7.2 per cent in the Republic of Moldova and 11.4 per cent in Ukraine. Out of pocket expenditures are 26.7 per cent of total health expenditures in Belarus, 45.2 per cent in the Republic of Moldova and 44.9 per cent in Ukraine.[6]

Despite its low GDP per capita, the region's high literacy rate, the number of years spent in school and life expectancy at birth all contribute to the rather high Human Development Index of the countries: Belarus ranks 53rd among 187 countries of the world, while Ukraine is 83rd and the Republic of Moldova is 114th.[7]

2.4.6. Poverty and welfare

Economic transformation has led to major social changes: the level of employment decreased (from 62 per cent to 53 per cent in Belarus, from 62 per cent to 39 per cent in the Republic of Moldova and from 58 per cent to 55 per cent in Ukraine). The unemployment rate is stable (about 6 per cent) in Belarus, a result of the planned economy. The Republic of Moldova and Ukraine had their highest unemployment in the periods of economic crisis (World Bank, 2015).

The youth labour market, which covers people aged 15-24, reflects the conditions in the economies of Eastern European countries. From 1990 through 2013, the Belarus youth employment rate decreased from 45 per cent to 35 per cent, while the unemployment rate remained stable (from 12 per cent to 13 per cent). The Republic of Moldova's youth employment rate declined from 45 per cent to 18 per cent, while the unemployment rate varied significantly – 25 per cent in 1999, 11 per cent in 2008 and 14 per cent in 2013. Ukraine has a high stable level of youth employment (34 per cent in 2013) and significant fluctuations in the unemployment rate (25 per cent in 1999, 14 per cent in 2008) and 18 per cent in 2013.

Early warnings of social and personal insecurity in Eastern Europe include high levels of HIV prevalence (0.4 per cent of the adult population in Belarus, 0.9 per cent in Ukraine and 0.7 per cent in the Republic of Moldova); the death rate from alcohol and drug use (5.4 per 100 000 population in Belarus, 3.0 in the Republic of Moldova and 5.9 in Ukraine); the high homicide rate, especially in the Republic of Moldova with 8.6 per 100 000 of population, while Belarus and Ukraine are near 5.0; and the high levels of incarceration, especially in Belarus and Ukraine with over 300 per 100 000 population, while the Republic of Moldova has 188 (World Bank, 2015).

The social fabric varies among the countries of the region, but the general picture is one of rather low social stability and security, with a worsening situation in Ukraine and some improvement in Belarus.

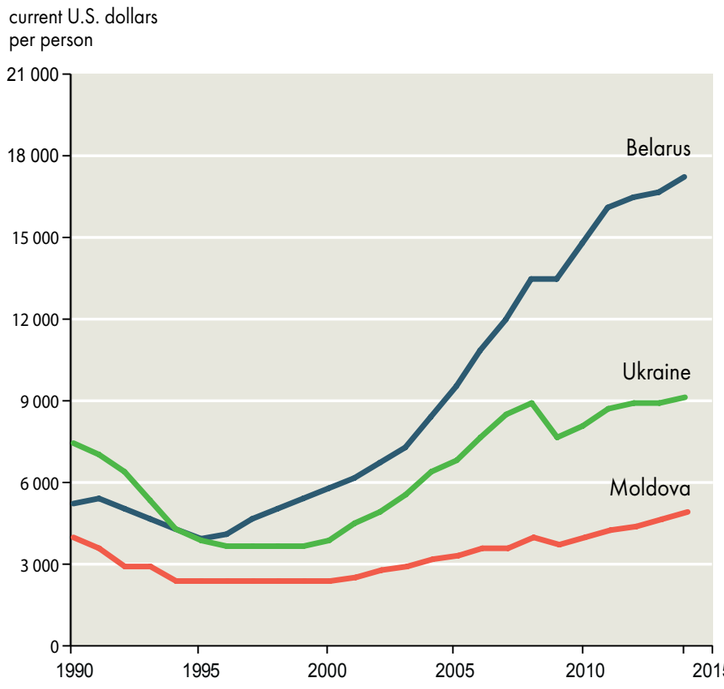
2.5. The economic situation

The countries' economic conditions are among the most important determinants of their financial capacities to address climate challenges, to adapt their affected sectors to new circumstances, and to maintain a path to a green economy via economic modernization, and thus to reduce their contributions to global climate disruption.

With the collapse of the Soviet Union, Belarus, the Republic of Moldova and Ukraine faced daunting challenges to modernize their economies. Lacking the necessary capital, and without the previous Soviet financial support, the countries' economies plunged into recession. Belarus fared better than the other two countries with relatively

3 http://fsi.fundforpeace.org/rankings-2015
4 World Bank Indicator, 2015
5 National statistics offices
6 http://hdr.undp.org/en/content/human-development-report-2014
7 http://hdr.undp.org/en/content/human-development-report-2014

modest declines in GDP until the mid-1990s while maintaining steady growth in gross national income per capita. From 2006, the Gross National Income (GNI) per capita in Belarus is higher than those in the other countries in the region (Figure 4). The Republic of Moldova and Ukraine, in contrast, saw their economies contract in terms of GDP, and lost ground in terms of gross national income per capita until the early 2000s.



Source: World Bank Open Data, Indicators.
http://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD/countries?display=default

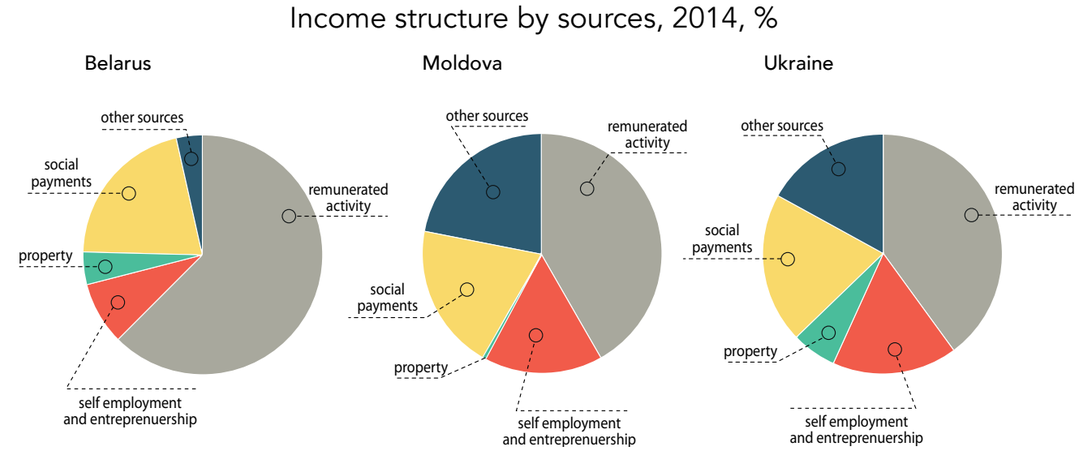
Produced by Zoï Environment Network, 2015.

Figure 4: Gross National Income per capita

The economies of all three countries are in transition, but while the Republic of Moldova and Ukraine are moving towards a market approach, Belarus has chosen to maintain centralized control over its economy. As a consequence, Belarus has more equal income distribution than Ukraine and the Republic of Moldova: the respective Gini coefficients are 26.5, 28.3 and 33.0. The population below the poverty line at the national level in 2013 was only 5.5 per cent in Belarus, but 8.4 per cent in Ukraine and 12.7 per cent in the Republic of Moldova. Rural poverty is twice as high as urban poverty.[8]

The main source of household income is remunerated activity, mostly salary (Figure 5). Belarus has the highest share of remunerated activity and social payments, and the lowest share of income from entrepreneurship and other sources. The Republic of Moldova and Ukraine have similar income structures with high shares of other income, including remittances from abroad – 17.6 per cent of the Republic of Moldova's household income.[9]

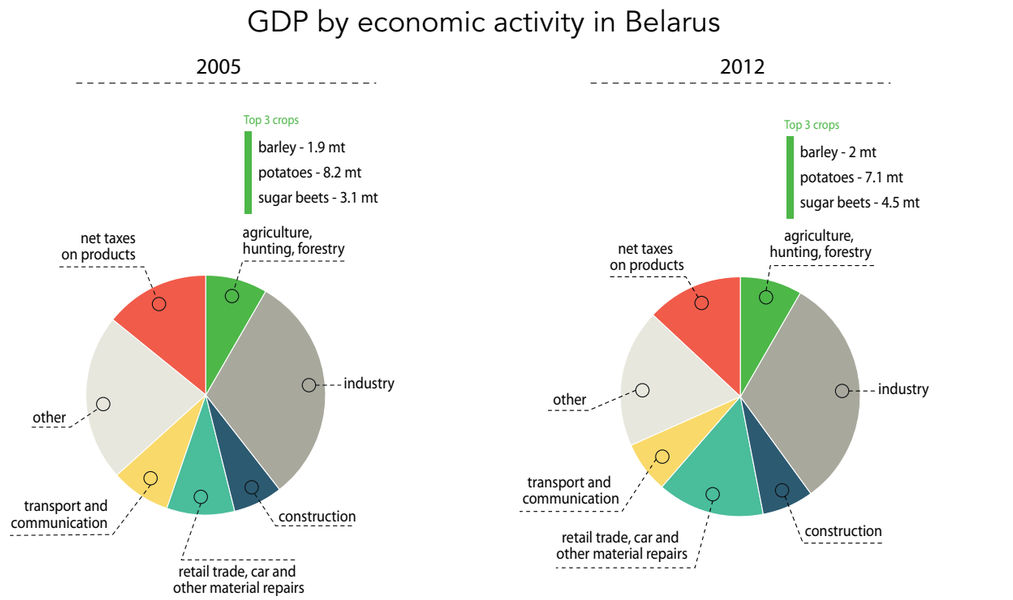
8 World Bank Indicator, 2015
9 National statistics offices



Source: National Statistic Offices. Produced by Zoï Environment Network, 2016.

Figure 5: Income structure by sources, 2014

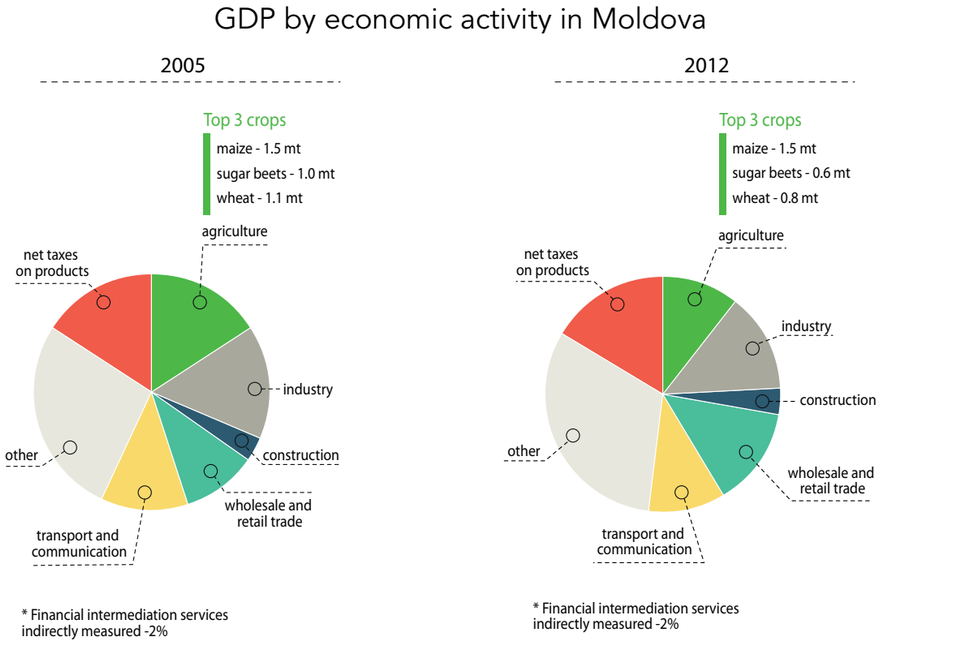
In the Republic of Moldova and Ukraine, the service sector contributes more than 50 per cent of gross value added to the economy, and nearly 50 per cent in Belarus where industrialization leads the development of the economy. (See Figures 6, 7 and 8.) In the Republic of Moldova, the agricultural and service sectors have increased their roles, and in Ukraine the service sector has increased its share of the economy.[10] In all three countries the energy intensity of the economy is high: as much energy as 334 tonnes of oil equivalent are used for the generation of $1 000 of GDP (expressed in purchasing power parity) in Ukraine, 234 in the Republic of Moldova, and 188 in Belarus. On a positive note, between 2000 and 2011 energy consumption per unit of GDP fell by 55 per cent in Belarus, 59 per cent in Ukraine and 68 per cent in the Republic of Moldova.[11]



Source: Statistical offices in Belarus, Moldova and Ukraine; FAOstat. Produced by Zoï Environment Network, 2015.

Figure 6: GDP by economic activity in the Republic of Belarus

10 World Bank Indicator, 2015
11 World Bank Indicator, 2015



Source: Statistical offices in Belarus, Moldova and Ukraine; FAOstat. Produced by Zoï Environment Network, 2015.

Figure 7: GDP by economic activity in the Republic of Moldova

Source: Statistical offices in Belarus, Moldova and Ukraine; FAOstat. Produced by Zoï Environment Network, 2015.

Figure 8: GDP by economic activity in Ukraine

Eastern Europe has accumulated significant external debt to support socioeconomic reforms during the years of independence. In 2014 external debt was US $40.3 billion (53.5 per cent of GDP) in Belarus, US $6.8 billion (88.3 per cent of GDP) in the Republic of Moldova and US $153.6 billion (113.9% of GDP) in Ukraine. Belarus had the lowest total debt service in 2013 at 6.7 per cent of GNI, while Ukraine had the highest at 20.9 per cent of GNI and the Republic of Moldova had 7.6 per cent.[12]

Agriculture is an important economic sector in Eastern Europe in terms of both employment and contribution to the GDP. Agriculture accounts for 8.9 per cent of Belarus's national economy, for 11.8 per cent of Ukraine's national economy, and 15.2 per cent in the Republic of Moldova.[13] Around 35 per cent of manufacturing production cost in the Republic of Moldova, 27 per cent in Belarus, and 20 per cent in Ukraine is supplied by food and consumer goods industries, heavily dependent on domestic agricultural raw material.[14] Between 2000 and 2012, the agricultural sectors in the countries experienced a 2-5 per cent decline in agricultural land and in arable land, but crop production improved across the region due to intensification of agricultural technologies.

The agro-industrial complex produces 59 per cent of exports in the Republic of Moldova, 34 per cent in Ukraine and 20 per cent in Belarus. The share of wood products (including furniture) is 3.0 per cent in Belarus, 4.9 per cent in the Republic of Moldova, and 3.5 per cent in Ukraine, and 9.6 per cent of Ukraine's exports are ores and metals.[15] This shows the great reliance of the economies of Eastern Europe on agriculture, and of Ukraine also on mining.

Eastern Europe has negative net international trade. One of the main trade partners is Russia, especially for Belarus with 41.5 per cent of its exports in 2014 and 53.8 per cent of imports. The corresponding figures for the Republic of Moldova are 15.5 per cent and 19.5 per cent, and for Ukraine 18.2 per cent and 23.3 per cent. Other important partners include the developed countries of Europe, especially for the Republic of Moldova with 56.1 per cent of its exports and 49.9 per cent of its imports. The corresponding figures for Ukraine are 31.9 per cent and 40.9 per cent, and for Belarus 30.1 per cent and 25.1 per cent. Intraregional trade turnover is only 13.4 per cent for the Republic of Moldova, 8.1 per cent for Belarus, and 5.9 per cent for Ukraine, so the economic co-operation between the countries could be more developed.[16]

The lack of diversity in agricultural and industrial production in Eastern Europe exposes the region's economies to fluctuations in international markets, and the region has too few small and medium sized enterprises to make up the difference in either sales or employment.

2.6. The availability and condition of natural resources

Natural resources such as land, water and biodiversity are essential for livelihoods. Their equitable and sustainable use is a precondition for the peaceful coexistence of communities and for national security. Scarcity, degradation or over-exploitation of natural resources can, however, lead to tension or impede important economic activities such as agriculture. Climate-induced degradation of natural resources in combination with unsustainable management may increase the overall risks to security and stability.

The countries of Eastern Europe are rich in natural resources, and are heavily agricultural: about 60 per cent of the total area in the Republic of Moldova, 43 per cent of Belarus and 70 per cent of Ukraine is agricultural land. The central authorities in Belarus exercise strict control over land ownership, with most land owned by the state and not much in private hands. A 1993 law allows for the privatization of up to 1.5 million hectares of the country's total of 9.0 million hectares of agricultural land. Both short-term and long-term rentals of land in collective farms are also options. The privatization of land ownership is increasing in Ukraine – from 5.9 million hectares in 1994 to 20.2 million hectares in 2009. About one-third of the total land area in the country is now privately held. In 2008, however, a new law limited the privatization of land in what had been collective farms so that farmers can rent this land for private farming, but cannot own it privately. The Republic of Moldova is following a similar pattern. The worst cases reportedly entail the selling of land in national parks and other protected areas for commercial purposes. Individual land capture in the Crimean Peninsula has been a particularly egregious case in a notably sensitive area.

Forestry is as important in the region as agriculture: forests cover about 40 per cent of the total area in Belarus, 13 per cent of the Republic of Moldova and 18 per cent of Ukraine. Some forests are in national parks and are protected by forest authorities, while others are used for forestry. While the forests are owned by the state, private individuals can receive short-term licenses for forestry activities, in particular for the harvesting of building materials and fuel. In spite of

12 World Bank Indicator, 2015
13 World Bank Indicator,2015
14 National Statistics Offices
15 UNCTAD stat
16 UNCTAD stat

these opportunities, illegal logging remains one of the priority environmental issues in the countries, especially in Ukraine.

Water bodies, most under state ownership, cover between roughly 2 per cent and 4 per cent of each country. Most of the large rivers in the region are transboundary and protected by international conventions and national programmes, and regulated jointly by riparian countries. Major rivers provide water for drinking, industry, irrigation, fishing, navigation and a small amount of hydropower production. Private farms rent small lakes for fishing, and state authorities license fishing activities in the Azov and Black Seas. Water resources seem to be the most vulnerable resources to climate change, and the countries of Eastern Europe can no longer take for granted that their surface and groundwater supplies will be sufficient for domestic and industrial needs. The south-eastern parts of Ukraine and most of the Republic of Moldova are already regularly experiencing a deficit of drinking and irrigation water. In large industrial centres water quantity and quality are both problems.

Deposits of potassium salts in Belarus provide the raw material for the domestic manufacturing of fertilizers. The country's other mineral and energy resources otherwise include salt, peat and brown coal.

Ukraine's abundant natural resources include the large iron ore deposits that support the country's steel industry, and more than 40 per cent of the known deposits of manganese in the world. The Donbas region has large coal and brown coal and coking coal reserves. Before the crisis in and around Ukraine unfolded, Ukraine ranked among the top ten coal producers. Ukraine imports about one third of the energy it consumes.

2.7. Agriculture and food security

At one time, all three countries provided all the food for their own consumption, and exported their surplus to neighbours and worldwide. Now the countries feel serious concerns about food security – both the quality and quantity of products vary depending on the country and the type of product. There are also a number of issues with the quality of some imported food products.

Belarusian agriculture structure possesses almost equal shares of crop production and livestock farming, with the latter increasing (over 50 per cent in 2012-2014).[17] Major commodities in terms of value are milk at $1.776 billion; indigenous cattle meat at $804.5 million; indigenous pig meat at $681.4 million; and indigenous chicken meat at $428.5 million. The top three crops in terms of production value in Belarus are potatoes, sugar beets and barley, with production of 7, 4, and 2 million tonnes in 2011, respectively. The country's production of grains and legumes dropped slightly between 1995 and 2000, but then rose by 2012. Potato production dropped from 9.5 million tonnes in 1995 to 6.9 million tonnes in 2012 (FAOSTAT, 2015). Belarus still maintains a high level of food quality production, especially for milk products.

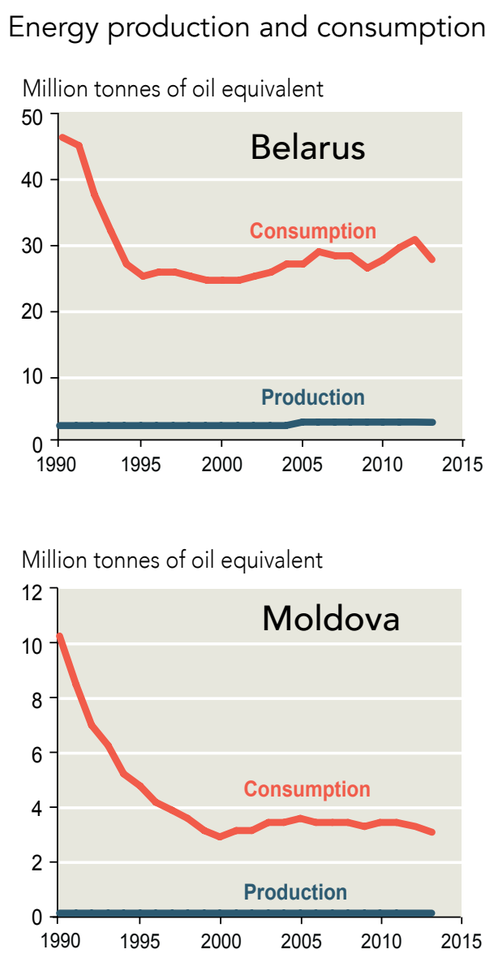
In monetary terms overall agricultural production in the Republic of Moldova increased by 57 per cent from 2005 to 2012. Plant production declined as a percentage of total production (from 67 per cent to 60 per cent), and animal production increased as a percentage of total production (from 30 per cent to 38 per cent). Over the 2005-2012 period, production (by weight) of green maize, leguminous crops, sunflowers and sugar beets rose. Production of potatoes, vegetables, and melons and gourds was somewhat more stable over the same timeframe. The main crops are maize, wheat and sugar beets, with production of almost 2.0, 0.8, and 0.6 million tonnes in 2011, respectively (World Bank, 2013). In the 1980s and 1990s, the Republic of Moldova converted large wine-grape vineyards to other crop production, and lost the important contribution of wine production to the national economy.

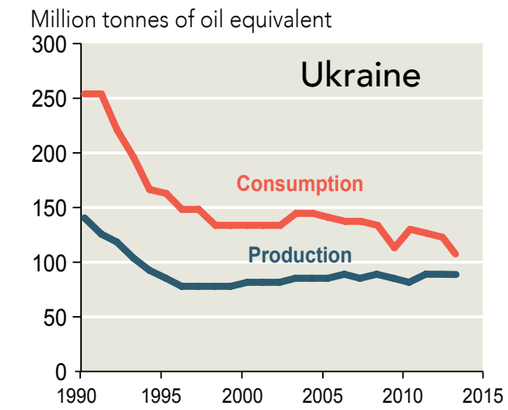
Ukraine has the largest area of highly valuable, mineral-rich black soils in Europe. Over the period of 1990-2014 the agriculture sector witnessed a growth in crop specialization (from 52 to 71 per cent in terms of actual production cost).[18] At the same time, with regard to production output by 2012, grain and legume production had recovered to 91 per cent of the 1990 level, and sugar beet production to 42 per cent and fruits and berries to 69 per cent of the 1990 level. Vegetable production dropped slightly between 1990 and 2000, but the 2012 production level was 50 per cent higher than the 1990 level. Potato production increased by 19 per cent between 1990 and 2000, and by 39 per cent between 1990 and 2012. Sunflower production rose by 34 per cent between 1990 and 2000, and by a whopping 226 per cent between 1990 and 2012. Ukraine's top crops are potatoes, wheat and sugar beets, with production of 24, 22, and 19 million tonnes in 2012, respectively. Major commodities in terms of value are milk at $3.015 billion; sunflower seeds at $2.253 billion; and potatoes at $1.598 billion.[19]

17 State Statistics Service of Ukraine
18 State Statistics Service of Ukraine
19 State Statistics Service of Ukraine

2.8. Energy production and security

The capacity of the countries in the region to develop their own secure and affordable energy supply will determine their potential to sustain economic development and to meet the social needs for transportation and heating. Currently the region's energy resources and production capacities fall far below their energy consumption (Figure 9), and the countries reliance on imports compromises their energy security, putting the internal and external security of the countries at risk. The countries' economic growth remains hostage to the continuing availability of reliable external energy sources.





Note: The values on the y axis vary from country to country

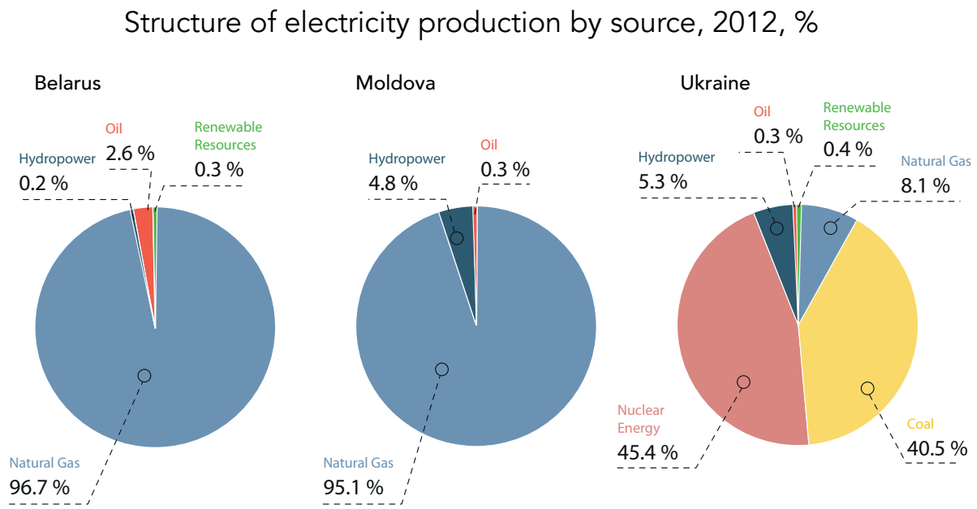
Source: International Energy Agency, Statistics
http://www.iea.org/statistics/statisticssearch/report

Produced by Zoï Environment Network, 2015.

Figure 9: Energy production and consumption

The energy intensity of the economies of Eastern Europe is extremely high, and reducing energy intensity is a policy focus for all three countries. The potential benefits of reducing energy intensity include an increase in energy security and a decrease in emissions. Belarus, for example, plans to reduce its energy intensity by 50 per cent by 2015 and by 60 per cent by 2020 (from a 2005 baseline), and is working to replace imported energy with domestic peat, brown coal, biofuels and small hydropower stations. Ukraine's energy strategy calls for a 26 per cent reduction in energy intensity by 2020 from a 2007 baseline.

In Belarus and the Republic of Moldova natural gas accounts for more than 90 per cent of electricity production while Ukraine relies mainly on coal and nuclear power (Figure 10), however, as a result of the conflict in Eastern Ukraine in 2014-2015, the share of electricity production at thermal power plants decreased due to reduction in power-generating coal production.



Source: World Bank Open Data, Indicators.
http://data.worldbank.org/indicator/EG.ELC.NGAS.ZS; http://data.worldbank.org/indicator/EG.ELC.COAL.ZS; http://data.worldbank.org/indicator/EG.ELC.HYRO.ZS

Produced by Zoï Environment Network, 2015.

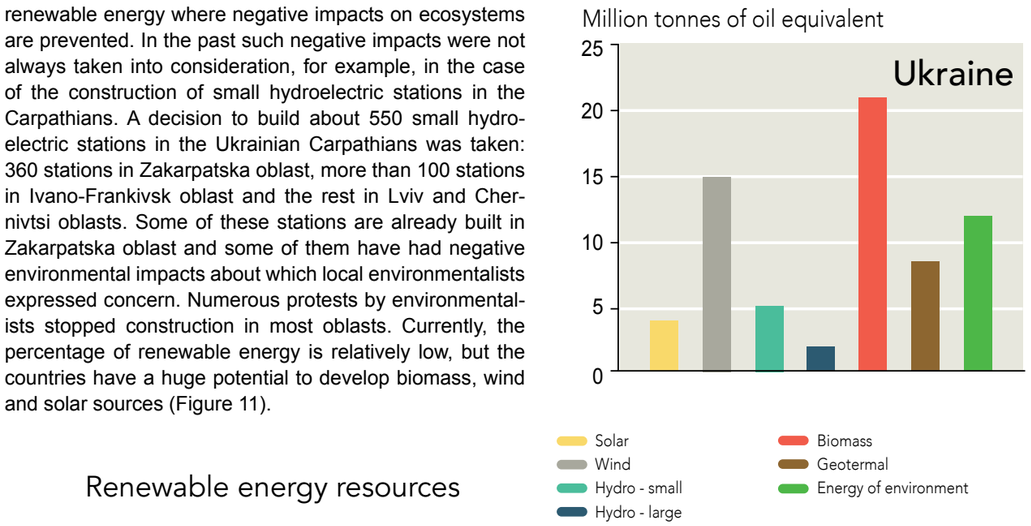
Figure 10: Structure of electricity production by source, 2012, %

Belarus has few energy resources of its own, and the country's energy system depends heavily on oil and natural gas imported from Russia and on electricity from Ukraine and Russia. The production of energy in electricity power stations has increased due to high levels of urbanization. According to the new Concept of Energy Security in the Republic of Belarus, renewable and alternative energy resources will be under development, and expected to contribute 9 per cent of total energy by 2035. The country is also planning hydroelectric plants, wind farms and solar power plants, as well as the use of peat and brown coal as domestic alternatives. The questions of energy efficiency, energy security and energy independence are on the daily agenda of the government.

Due to the lack of energy resources, the Republic of Moldova remains dependent on post-Soviet republics that are energy producers, and imports 98 per cent of its energy, mostly from Russia, but intends to reduce its energy dependence by diversifying its sources of supply, constructing power plants and integrating into the European energy system. The country's energy strategy calls for renewable sources to provide 20 per cent of the country's energy needs by 2020. The country has developed a number of country policies and legislative acts on energy security, including the National Development Strategy "Moldova 2020", the Energy Strategy of the Republic of Moldova until 2030, and the Law on Energy Efficiency. The "Environmental sustainability and combating climate change" objective envisions improved energy efficiency and increased use of renewable energy through the establishment of a modern regulatory framework. In domestic energy resources hydropower dominates. Currently the main power generation facilities in the Republic of Moldova are the Moldovan Thermal Power Plant in Dnestrovsk; Combined Heat Power Plants No1 and No2 in Chisinau; Combined Heat Power Plant North in Balti, Dubasari and Costesti Hydro-Power Plants.

Energy is one of the priority security issues for Ukraine. The country uses domestic energy for residential consumption, but relies on supplies from Russia and Azerbaijan for industrial production. The latest political developments suggest that the national strategy on energy security should focus on the diversification of energy resources. Currently the country is negotiating with Norway, Slovakia, Poland and Hungary for gas supplies. In 2015 Ukraine was supplied by gas from Slovakia (9.7 billion m), Hungary (0.5 billion m^3) and Poland (0.1 billion m^3). In 2016 Ukraine is negotiating gas supply with Poland and Lithuania.[20] Ukraine's strategy for improving its energy security was focused on agreements with the EU, and now calls for a 26 per cent reduction in energy intensity by 2020 from a 2007 baseline (UNFCCC, 2013). Special research and risk analyses are needed to understand the impacts of climate change and to identify the most vulnerable areas related to energy (especially in light of potential losses for the economy if no adaptation measures are taken). The country should carefully develop and implement environmentally friendly projects on renewable energy where negative impacts on ecosystems are prevented. In the past such negative impacts were not always taken into consideration, for example, in the case of the construction of small hydroelectric stations in the Carpathians. A decision to build about 550 small hydroelectric stations in the Ukrainian Carpathians was taken: 360 stations in Zakarpatska oblast, more than 100 stations in Ivano-Frankivsk oblast and the rest in Lviv and Chernivtsi oblasts. Some of these stations are already built in Zakarpatska oblast and some of them have had negative environmental impacts about which local environmentalists expressed concern. Numerous protests by environmentalists stopped construction in most oblasts. Currently, the percentage of renewable energy is relatively low, but the countries have a huge potential to develop biomass, wind and solar sources (Figure 11).

20 http://mpe.kmu.gov.ua/minugol/control/uk/publish/officialcategory?cat_id=35016



Note: The values on the y axis vary from country to country.

Sources:
for Moldova (2010) – http://www.unece.org/fileadmin/DAM/energy/se/pp/ee21_sc/20scJune09/4_june_morn/8_ceban_r.pdf
for Ukraine (2014) – http://www.irena.org/remap/IRENA_REmap_Ukraine_paper_2015.pdf
for Belarus (2011) – http://energobelarus.by/articles/alternativnaya_energetika/shest_vozobnovlyaemykh_istochnikov_energii_dlya_belarusi_mnenie_ispolnitelnogo_direktora_assotsiatsii_vozobnovlyaemaya_energetika_vladimira_nistyuka/

Produced by Zoï Environment Network, 2015.

Figure 11: Renewable energy resources

2.9. Water-agriculture-energy nexus

Agricultural land is a key resource throughout Eastern Europe. Water is also critical, not just for normal human consumption and the sustenance of the natural environment, but also for agricultural and industrial production. Likewise, energy resources are necessary to fuel both economic development and support a comfortable standard of living. This nexus among water, agriculture and energy makes climatic processes and the secondary effects of significant climate events – such as persistent droughts, fires or floods – even more critical. Impacts include crop losses and food shortages and energy shortages with consequences for entire countries and particular regions.

Water-agriculture-energy nexus

- Water for Food: Irrigation, livestock, food processing
- Water for Energy: Heating, cooling thermal powerplants, hydropower, irrigation of bioenergy crops, extraction and refining
- Energy for Water: Extraction and transportation, water treatment, desalinization, wastewater, drainage, treatment and disposal
- Energy for Food: Crop and livestock production, processing and transport, food consumption, energy for irrigated crops
- Food for Energy: Competition between bioenergy and food and fibre, production for water and land
- Food for Water: Impact on water supply, impact of runoff

Annually in Belarus almost 120 million m^3 of fresh water – 19 per cent of total freshwater withdrawals – are used for irrigation in limited areas in the southern part of the country, representing just 0.3 per cent of total agricultural land, and for agricultural water supply mostly for livestock. Approximately 470-500 million m^3 – about 35 per cent of total freshwater withdrawals – are used for household and drinking water.[21] Improved drinking water is available to the entire population, and improved sanitation facilities serve 94 per cent of households.[22] Forty-four mineral water wells are used for recreation and water supply. In 2012, 0.2 per cent of the country's electricity supply was produced by hydropower.[23]

Belarus has well-developed wastewater treatment systems, and built new facilities in 2012 and 2013 with capacities for purifying 40 000 m^3 per day, and reverse osmosis systems with the capacity of 66 000 m^3 per day.[24] Agriculture and forestry use 1.1 mtoe annually – about 4.9 per cent of total final energy consumption – mostly in oil products.

Wood and peat are important heating sources, but bioenergy accounted for only 7 per cent of the country's heating budget in 2012, and only 0.3 per cent of total electricity. Biogas production is a growing part of the energy sector of Belarus, and biomass has high potential as a renewable energy resource. Brest and Gomel are the poorest oblasts in terms of water resources, but both areas have irrigated lands. In rural areas, intensive groundwater contamination occurs near livestock and poultry farms, chemical fertilizer and pesticide warehouses, irrigated fields of livestock farms and agricultural lands where mineral and organic fertilizers are introduced.[25]

Nearly 10 per cent of agricultural land in the Republic of Moldova is irrigated.[26] Annually, almost 40 million m^3 of fresh water (5 per cent of total freshwater withdrawal) is used for agricultural needs. About 135 million m^3 of fresh water (nearly 17 per cent of total freshwater withdrawal) is used for household water supply and drinking. Summer droughts in 2007 and 2012 caused declines in agricultural production about 77 per cent compared to the previous years.[27] Near the Prut River and in the central part of the country, where nearly 1 million people live and where 300 000 ha of irrigated lands are located, the lack of drinking and irrigation water is becoming a problem. The development of drip irrigation may provide the margin for food and energy security. In 2012, hydropower produced 4.6 per cent of the country's electricity.

In 2013, 3.2 per cent of total electricity consumption in the Republic of Moldova was used for water supply and sewage systems by the country's 834 water supply systems and 1 300 pump stations. Wastewater treatment capacity is near 700 000 m^3 per day. On average about 120 million m^3 of water are purified annually, with about 65 million m^3 occurring after household use.[28] Agriculture and forestry use 48 ktoe annually – about 2.0 per cent of total final energy consumption – mostly in oil products.

21 National Statistical Committee of the Republic of Belarus
22 http://www.wssinfo.org/documents/?tx_displaycontroller%5Btype%5D=country_files
23 http://www.iea.org/statistics/statisticssearch/report/?year=2012&country=BELARUS&product=Balances
24 National Statistical Committee of the Republic of Belarus
25 Water strategy of the Republic of Belarus, www.minpriroda.gov.by/.../000613_306750
26 World Bank Indicator, 2015
27 National Bureau of Statistics of the Republic of Moldova
28 National Bureau of Statistics of the Republic of Moldova

Solid biofuels account for only 1.5 per cent of heat generation, but this represents a large proportion – 76.3 per cent – of domestic energy production in the Republic of Moldova. Agriculture and the food industry generate almost 1 million tonnes of waste annually; of this total, 300 000 to 400 000 tonnes are incinerated or transported to dumps. Food production facilities store 3 500 tonnes of toxic waste, and agricultural operations store an additional 500 tonnes, together about 58 per cent of the toxic waste in the country. This waste can contaminate land and groundwater.

Between 2011 and 2013 in Ukraine, annual average freshwater withdrawals totalled nearly 10 billion m^3, of which 1.7 billion m^3 went to irrigation (mostly in the southern part of the country), 0.2 billion m^3 to agricultural water supply and 0.9 billion m^3 to fish farming. Nearly 17 per cent of freshwater withdrawals goes to drinking and household needs. For 2014 the freshwater consumption for irrigation decreased by 31 per cent (because of the crisis in and around Ukraine). Over 95 per cent of Ukraine's irrigated lands – 427 000 ha – are located in Kherson oblast, which uses 984 million m^3 of fresh water for irrigation mostly for cereals.[29] More than 40 per cent of the water supply and sewage systems in Kherson oblast have deteriorated, and drinking water quality does not meet the provisions of the Law "On drinking water".[30] In 2012, 5.3 per cent of the country's electricity supply was produced by hydropower.

The water treatment capacity of Ukraine is 7.6 billion m^3. In 2014, 1.4 billion m^3 of water were purified. Agriculture and forestry use 2.2 mtoe annually – about 3.0 per cent of total final energy consumption – mostly in oil products.

In spite of energy insecurity and reliance on external fuel resources, the development of bioenergy is not a current priority in Ukraine. Solid biofuels account for less than 0.1 per cent of heat generation, or 1.7 per cent of domestic energy production. The country has a huge potential for biomass energy. Farming activities pollute water bodies, especially when agricultural wastewater and fertilizers and chemicals used in the manufacture enter surface water from fields during spring snow melt. In 2012, Ukrainian agriculture generated 952.9 million m^3, or 12 per cent of total waste in the country. Wastewater without treatment accounted for 71 million m^3. Other issues include groundwater contamination from agricultural run-off, and soil erosion.[31] The food-water nexus is most critical in southern Ukraine, an important agricultural area with inadequate water resources.

2.10. Critical infrastructure

According to the IPCC (2014b), "Critical national infrastructure is defined as assets (physical or electronic) that are vital to the continued delivery and integrity of essential services on which a country relies, the loss or compromise of which would lead to severe economic or social consequences or to loss of life."

These types of infrastructure in Eastern Europe are both critical and sensitive to climate change and extreme weather conditions:

- High-elevation mining facilities located in permafrost with active or historical tailings
- Hydropower stations and power transmission lines
- Small dams and irrigation systems vulnerable to damage
- Oil and gas pipelines and facilities, especially on the Caspian Sea
- High-elevation strategic roads and other major traffic routes
- Municipal sewage and water supply systems and other vital services

Subsequent sections of this report provide the details and rationales on each of these sensitive and critical types of infrastructure and threats associated with climate change impacts and extreme weather conditions.

An analysis of fixed assets shows the critical condition of technical equipment and life support systems that have recently been tested by emergencies. According to the Ministry of Emergency Situations of Ukraine, almost 20 per cent of the country's emergency situations relate to public infrastructure. The majority of these emergencies have arisen in connection with the unsatisfactory technical condition of buildings, equipment and utilities that exceed their useful lives, and are thus unreliable in extreme conditions such as storms.[32] The common Soviet past of the Eastern Europe countries, and the fact that the infrastructure was developed mostly during that period suggests that Belarus and the Republic of Moldova may have similar concerns at least in some areas.

Areas with specific geological, orographic or post-mining conditions may be more vulnerable to infrastructure damage. Rainfall may activate landslides, a potentially critical issue for the Republic of Moldova, where landslides affected 800 km^2 over 16 000 localities, including 2 300 settlements. In neighbouring Ukraine, landslides affected 1 800 km^2 over 12 000 localities and 900 settlements in the Carpathians and Odesa oblast.[33]

Extreme weather events such as floods, heatwaves and wild fires damage critical infrastructure. The floods in July

29 State Statistics Service of Ukraine
30 http://www.menr.gov.ua/docs/activity-dopovidi/regionalni/rehionalni-dopovidi-u-2012-rotsi/khersonska_2012.pdf
31 http://www.menr.gov.ua/index.php/dopovidi
32 http://www.mns.gov.ua/files/prognoz/report/2014/ND_2014.pdf
33 http://ebzr.nung.edu.ua/sites/default/files/journal/3_0.pdf, http://www.mns.gov.ua/files/prognoz/report/2014/ND_2014.pdf

2008 in the upper basin of the Dniester and the Prut were the largest in the last 70 years. Flooding leads to significant damage to power and water infrastructure, as well as to communications and transport infrastructure. Estimated losses in Ukraine ran to US $700-850 million with 39 people killed, more than 45 000 buildings and 62 000 ha of agricultural land damaged, and 711 car and 559 pedestrian bridges, 852 km of roads, 159 km of embankments destroyed.[34] In the Republic of Moldova estimated losses ran to US $120 million with 19 000 ha of land flooded and 21 dams breached.[35]

The catastrophic consequences of the floods on the rivers Dniester, Prut and Siret between 2008 and 2010 (some resulting in dam collapses) offer convincing proof of the urgency of providing flood protection for infrastructure.

Climate change is expected to increase the demand for energy for cooling, with implications for mitigation and adaptation policies. This issue is most vital for the Republic of Moldova: 2014 income from air conditioning was 2.8 per cent of total industry production.[36]

The cold season brings large damages to infrastructure, especially power transmission lines. Icing and rime caused damage in the central part of the Republic of Moldova in 2000, in the central part of Belarus in 2006 and in 2016 and in Ukraine in 2014.

The energy dependence and the unique geographic position of the region is evidenced by the well-developed network of pipelines: 37 000 km of gas pipelines and almost 9 000 km of oil pipelines in the region. Ukraine has 5 000 km of oil pipelines and Belarus has nearly 3 000, while the Republic of Moldova has nearly 2 000 km of gas pipelines. Many of these pipelines cross areas with potential risks associated with erosion, flooding or landslides.

The transportation infrastructure providing for everyday life is rather well developed in Eastern Europe. The rail system extends 1 200 km in the Republic of Moldova, 5 500 km in Belarus and 21 600 km in Ukraine. The road density is lower than in other European countries: 28.1 km per 100 km^2 of land area in Ukraine, 37.7 in the Republic of Moldova, and 46 in Belarus.[37] In Ukraine, nearly 40 per cent of rail lines are located in areas that are potentially affected by erosion, and 20 per cent by flooding. The then Ministry of Emergency Situations of Ukraine reported that the highest risk for infrastructure in emergency situations is in the southern regions of Ukraine, where climate change is most pronounced.[38] The IPCC Fifth Assessment Report says that, “Systematic and detailed knowledge on climate change impacts on transport in Eastern Europe remains limited.”

34 http://www.mns.gov.ua/content/annual_report_2008.html
35 http://uhmi.org.ua/conf/climate_changes/presentation_pdf/oral_3/Koeppel_Lysyuk.pdf
36 National Statistics Bureau of Moldova
37 World Bank Indicator, 2015
38 http://www.mns.gov.ua/files/prognoz/report/2014/ND_2014.pdf

3. CLIMATE CHANGE IN THE REGION

Climate trends and projections are available at the global, regional, national and sometimes local levels and usually consider the following:

- Average annual and seasonal temperature
- Number of hot days and nights and frequency of heatwaves
- Average annual and seasonal precipitation
- Number of days above and below precipitation thresholds
- Number (frequency) of extreme weather events

Among the reliable sources of climate information are the following:

- International Panel on Climate Change publications, including special reports and the Fifth Assessment Report, and international online resources with climate data and climate change models
- WMO and regional climate centre publications
- National communications to the United Nations Framework Convention on Climate Change
- Country statements, positions and presentations at international conferences
- National policies, programmes and plans related to environmental issues, natural resources and adaptation to climate change
- Peer-reviewed international research

An understanding of the climate trends and projections for a country and a region provided the basis for the analysis of climate change risks and hazards in this study, but the analyses may be limited by weaknesses in the data and uncertainty in the projections.

3.1. Trends

The IPCC AR-5 finds that climate models show significant agreement for all emission scenarios in warming (magnitude and rate) all over Europe, including Eastern Europe, with strongest warming projected in Southern Europe in summer and in Northern Europe (including Belarus) in winter.

Each of the last three decades were successively warmer than any previous decade since 1850, and multiple independent datasets show warming in the range of 0.6°C to 1.0°C over the period of 1880-2012. The report notes that globally many extreme weather and climate events have been observed since the middle of the twentieth century. Ice sheet losses were substantial, snow cover and glaciers have diminished, permafrost temperatures have increased, the sea level has risen and concentrations of greenhouse gases have increased.

Eastern Europe experienced its longest period of warming in the instrumental record at the end of the twentieth and the beginning of the twenty-first century: between 1980 and 2011 the average air temperature in Eastern Europe was 0.48°C higher than between 1950 and 1980. The number of days when the overnight low did not drop below 20-25°C also increased, and the rate of warming has increased over the last decade.

In Belarus the average monthly temperature increased for each month during 1990-2015. The temperature increase was greater in winter and early spring months (in January it increased by 2.7°C, in February-March by 2.2°C, in April by 1.7 °C and in December by 1.0°C).

Heatwaves have become more common and the number and severity of extreme weather events has increased dramatically, with numerous floods and droughts in the Republic of Moldova and Ukraine. (The latest severe drought in Ukraine happened in 2015.) The summers of 2010, 2015 and 2016 were exceptionally hot in the region, with an amplitude and spatial extent that exceeded the 2003 heatwave.

Figure 12 (on the next page) demonstrates the change of annual temperature in 1976-2015: an increase in temperature by 0.6-0.7°C was recorded for the north-eastern part of Ukraine, and for almost all its central part; for Belarus, the same trend is observed for most of the country, especially in the east. In the Republic of Moldova, a higher temperature increase was recorded for the east of the country.

Change of annual temperature in 1976-2015

(trend of change in °C/10 years)

Figure 12: Change of annual temperature in 1976-2015

Overall precipitation levels have remained close to the norm or slightly higher, but seasonal variations are pronounced, and snowfall has diminished.

Precipitation has slightly decreased in Belarus over the last two decades, which resulted in less precipitation in April, June and especially August – 91 per cent, 93 per cent and 88 per cent of the norm, respectively. A slight increase of precipitation was recorded for February, March and October. In the Republic of Moldova the trends of annual and seasonal precipitation in the past were positive for all seasons, with the exceptions of spring (1891-1980) and summers (1981-2010). In Ukraine variations in precipitation among seasons and regions was observed.

Figure 13 (below) shows the change of annual precipitation in 1976-2015: about a 5 per cent increase per 10 years had been observed in Belarus as well as in north-western Ukraine and the southern part of the Republic of Moldova compared to the normal amount of precipitation for this region. The remaining part of Ukraine got less precipitation or no changes were recorded.

Change of annual precipitation in 1976-2015

(trend of change in % of norm per 10 years)

Map produced by Zoï Environment Network, August 2016.
Source: Interstate Council on the hydrometeorology of the CIS

Figure 13: Change of annual precipitation in 1976-2015

3.2. Scenarios

The IPCC reports that annual mean temperature trends in Europe for 1979-2010 have exceeded the global trend of 0.27°C per decade, and that warming is likely to continue in all seasons, with the number of warm days and nights likely to increase, and the number of cold days and nights likely to decrease. Precipitation trends and scenarios are less clear in Eastern Europe: precipitation is expected to be more variable across subregions and seasons, with increases in mean precipitation in winter and small changes in summer, with more rain than snow in mountainous regions.

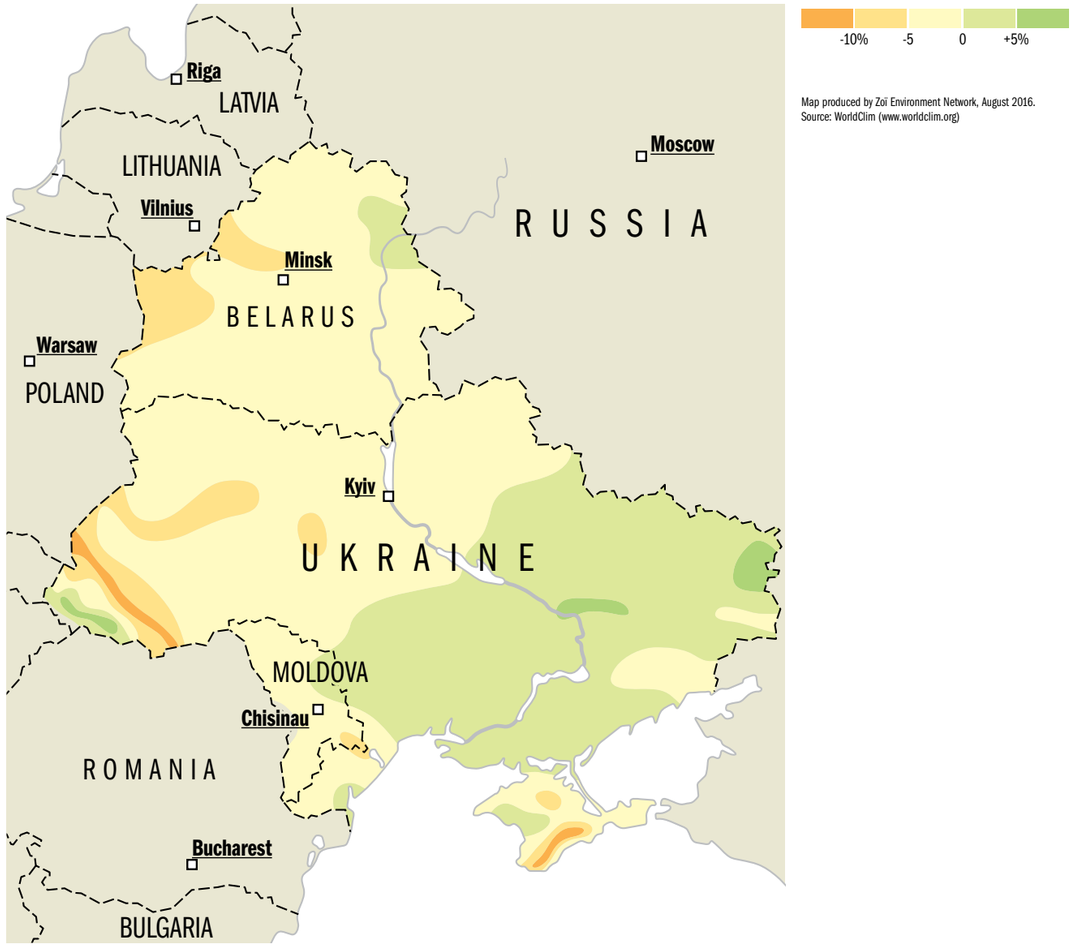
According to IPCC AR-5 projections, the length, frequency and intensity of heatwaves are very likely to increase throughout the whole region with increases in the mean number of heatwaves in May to September projected for 2071-2100 compared to 1971-2000 with large differences depending on the emission scenarios. New evidence suggests that drier soil conditions resulting from the general warming trend may actually amplify the intensity and frequency of heatwaves, thus making dry summer conditions even worse. The implications of this cycle of drying are accelerated desertification and the potential loss of crops and agricultural lands. Figure 14 and 15 show the geographic distribution of projected changes in temperature and precipitation across the region.

Map produced by Zoï Environment Network, August 2016.
Source: WorldClim (www.worldclim.org).

Projected temperature change to 2050

Projected average annual temperature change to 2050, relative to the 1986–2005 period.
Average of scenarios HadGEM2-AO, HadGEM2-CC and HadGEM-ES, greenhouse gas scenario rcp45

Figure 14: Projected temperature change to 2050



Projected precipitation change to 2050

Projected average annual precipitation change to 2050, relative to the 1986-2005 period.
Average of scenarios HadGEM2-AO, HadGEM2-CC and HadGEM-ES, greenhouse gas scenario rcp45

Figure 15: Projected precipitation change to 2050

Climate change modelling and research at the Voyeykov Main Geophysical Observatory in Russia project temperature increases in Belarus of 1°C by 2030 and of 2°C by 2060. Large cities such as Minsk, Vitebsk, Gomel and Brest will suffer from summer heatwaves. Precipitation will change slightly by 2030 with some increase over winter and spring and some decrease in autumn.

In the Republic of Moldova an ensemble of projections from different global models, as well as historical climate data recorded by the State Hydrometeorological Service from 5 meteorological stations (Briceni, Balti, Chisinau, Tiraspol, Cahul) were analysed to produce projections for climate of the twenty-first century for three 30-year time periods (till 2080). The results predict an increase in winter temperature for all three periods, relative to the baseline 1961-1990 period. Temperatures will increase more in the northern and central parts of the country. During the summer the strongest temperature rise will occur over the southern and central areas. By 2080 annual average precipitation is projected to decrease by 14 per cent in the south and by 6 per cent in the north.

Ukrainian universities and institutes analysed global scenarios and climate models with different assumptions about greenhouse gas emissions and population growth to produce regional projections to the end of the century. They noted changes in temperature and precipitation according to the scenario A2, A1B, B1. By 2100 temperature is projected to increase for the whole territory of Ukraine compared to the period of 2001-2010, mainly because of the decreasing number and frequency of cold periods in winter. Precipitation is projected to increase, mainly because winter and spring increases will more than compensate for decreases in summer and autumn. The precipitation projections show a wide range. Dry winters are expected to remain dry, but some scenarios predict wetter winters. Soil moisture in western Ukraine is expected to increase, but an increase in drought events, especially in cold seasons, is probable for most of Ukraine.

3.3. Extreme events: Dynamics and projections

The recent IPCC AR-5 report suggests there will be a marked increase in weather extremes in Europe, in particular, in heatwaves, droughts and heavy precipitation events. Rising temperatures and disruptions in precipitation patterns are likely to accelerate these processes. The changes in the hydrological cycle in Eastern Europe will affect water resources in the region with negative economic and social consequences for agricultural areas. None of this can come as much of a surprise to the people in a region where over the past 20 years severe floods have become more and more common.

Extreme high temperatures and the lengthening of warm periods will cause heat stress that will affect the population more and more, especially in urban areas.

Generally drier conditions and higher temperatures have increased the risk of forest fires, and when a drought occurs in these circumstances, the results can be catastrophic. Indeed, during a severe drought in 2007, the Republic of Moldova had 90 forest fires affecting almost 700 hectares. In every other year between 2000 and 2008, the number of forest fires ranged from 3 to 15. In Ukraine several regions suffer from an increasing number of wildfires (Kherson, Zaporizhzhya, Donetsk, Luhansk oblasts). Concerns about forest fires are particularly high in the Chornobyl Exclusion Zone because of the high risk that fires may spread radioactive contamination.

Small increases in extreme wind speed are projected for the region, mostly in winter and connected to changes in storm tracks. In mountain areas strong winds can bring catastrophic consequences, such as destroyed infrastructure and livelihoods, damaged power lines, and destruction of forest and agricultural areas.

3.4. Slow onset events: Dynamics and projections

The consequences of slow onset climate events are not that visible as, for instance, the consequences of fires and floods, but the subtle long-term effects of rising temperatures and disrupted precipitation patterns will have lasting consequences – some of them positive – for agriculture and forestry in Eastern Europe.

As temperatures increase, climatic zones shift northward and to higher elevations. In the Carpathian Mountains, some changes are already apparent, and native species of flora and fauna – some of which are already threatened – may face long-term competition from invasive species for scarce resources in ever-smaller ecosystems. Storm surges are expected to increase as the global mean sea level rises, and are expected to vary along the coast. A rise in sea level of 2 metres in the Black Sea (the most pessimistic projection) would separate the Crimean Peninsula from the mainland. Of the possible slow onset events, sea level rise poses the most significant risks, in particular for business, tourism and infrastructure on the coastline.

Food security is already a concern, and is expected to remain an issue in some areas of the Republic of Moldova and Ukraine, but rising temperatures may also boost agricultural production in Belarus and in the northern parts of Ukraine. Similarly, higher temperatures have increased the growth in boreal forests, although this gain is offset by the increased risk of fires.

4. CLIMATE HAZARDS AND STRESSORS

The range of climate-related hazards is broad and includes events that are both rapid onset and that have a slow cumulative development over time. Floods, extreme weather, and wildfires are generally rapid onset hazards. Drought, sea level rise and fluctuation, land degradation, changes in pest and disease patterns and crop suitability are hazards that unfold over periods ranging from months to years.

The rate of change for some climate-related hazards may occur slowly enough that normal management systems can adapt and prevent a crisis from developing. Wildfire, which is fairly common in much of Eastern Europe, may be an exception. Changes in average temperature and precipitation may contribute to a rapid increase in the number of wildfire events in some isolated parts of the region.

For either rapid or slow onset effects, the hazard analysis needs to consider the potential environmental, socioeconomic and political consequences. Climate data and trend analysis, climate modelling and hazard assessments can be time-consuming and costly, requiring accessible data and appropriate models, with extensive expert input. Fortunately, the number and diversity of climate change assessments, climate risk and hazard assessments and climate models have increased, providing a wealth of data for many countries and among international sources or organizations.

A summary of some of the more significant climate-related hazards in Eastern Europe is provided below.

4.1. Flooding and related hazards

The latest experts' research and the IPCC AR-5 projections show that climate change is expected to increase the number and magnitude of extreme floods and flash floods for all three countries of the region. In Belarus some transboundary rivers are identified as hotspots due to flooding, and national and international organizations are implementing dedicated projects. The increase in agricultural activities and the development of settlements and related infrastructure in floodplains is likely to increase the losses and damage from floods.

Major floods occurred in Belarus in 1999, as well as in the Republic of Moldova and Ukraine in 1992, 1993, 1995, 1997, 1998 and 2001. Then in 2008, one of the most destructive floods in 200 years caused property damage of more than US $1 billion, displaced more than 150 000 people, washed away crops and soil and took 39 lives in Ukraine and 3 lives in the Republic of Moldova. The 2008 floods occurred on the Dniester, Prut, Reut, Siret and Danube Rivers and their tributaries, and affected the Ivano-Frankivsk, Chernivsti, Lviv and Ternopil oblasts in western Ukraine, much of the Republic of Moldova and the northern part of Romania. The Ukrainian territories affected by the 2008 flood were officially designated as an environmental emergency zone. Two years later flooding of the Prut, Reut and Siret displaced thousands of people and caused extensive damage in the Republic of Moldova and in the Carpathian region of Ukraine, which is particularly vulnerable to flooding and landslides. And in 2013 flooding of the Danube killed two and displaced hundreds in the Artsizsk, Bolgradsk and Tarutyneinsk rayons near Odesa.

4.2. Droughts

Belarus identifies droughts as one of 14 main climate challenges for agriculture, and the implications are already visible: decreasing agricultural land area and harvests in some regions due to desertification (mainly Polesie – the Brest oblast and part of the Gomel oblast). The most severe drought was recorded in Gomel oblast in 2015. An increase in the frequency of droughts in the southern part of the country (Polesie) is projected.

Droughts in Ukraine have become more frequent events affecting wider areas (northern and north-eastern Polesie, steppe and south-east). And the Republic of Moldova had nine droughts between 1990 and 2007, and another in 2012 with almost the entire country affected. According to the statistical authorities in the Republic of Moldova, the 2007 drought caused US $1 billion in damage. The 2007 and 2012 droughts affected more than 70 per cent of the country, and were the most severe droughts in the entire instrumental record (1890-2012).

4.3. Extreme weather events: Heatwaves, cold waves, hailstorms and dust storms

The region is expected to suffer from both extreme hot (heatwaves) and unpredictable cold temperatures, with impacts on human health, energy consumption and human displacement. The number of "tropic nights" (when overnight temperatures do not drop below 20-25°C) will increase during summers, and will pose the biggest climatic challenge to urban areas, where heat islands within cities will experience greater impacts as a consequence of higher densities of population and infrastructure and worse air pollution.

The Republic of Moldova relies heavily on agriculture, and considers hail as harmful to agriculture as floods and droughts. Crop losses to hail can undermine food security by leaving small farmers with no food or income, a situation that might also put the rural population at serious nutritional risk.

The Hydrometeorological Centre of Ukraine projects that the number of hail events in the southern part of the country will increase, and that agriculture yields will decline accordingly.

The reorganization of weather services in the region over the last 20 years has resulted in a lack of historical data and timely forecasts related to hail. Hydrometeorological centres of the three countries make hail observations, but there is a need to extend and maintain regular observations across the entire territories. For the agricultural countries of Eastern Europe, such information is crucial.

Climate change is characterized not only by increasing temperatures but also by weather instability including cold waves and days when extremely cold temperatures were recorded. The latest IPCC report projects that snow-rich winters and cold temperatures for Northern Europe (Belarus) will continue, even though the prospect for milder winters will remain.

While there is not much data on dust storms in the region, the desertification in the steppe zones of Ukraine (mainly in the Kherson and Zaporizhzhya oblasts) could create the necessary conditions. A 2015 drought covered most of Ukraine.

4.4. Changes in the hydrologic cycle

Changes in temperature and the precipitation regime affect the hydrological cycle, and projections for the region show decreasing precipitation in south-eastern Ukraine and the southern part of the Republic of Moldova.

In the Pripyat, Dniester and Southern Bug basins, decreasing overall precipitation in the winter months and less precipitation in the form of snow will reduce the snow melt to the rivers. Winter precipitation will increase in most parts of Belarus, and in the north-western and south-eastern parts of Ukraine. A rapid increase in air temperature in the spring, even with declining snow cover, will continue the threat of flooding. Rising temperatures in summer increase evaporation. Increasing rains in the summer months in Belarus, and the increase in the frequency of intense rainfalls for all of Eastern Europe mean that the threat of floods will continue, and may result in devastating consequences.

National experts project an increase in annual run-off across most of Belarus, and a decrease for the Neman and Zapadnyy Bug.[39] Increasing evaporation and decreasing rainfall in the Republic of Moldova may reduce the run-off of the rivers.

39 Outlook on strategic assessment of climate change impacts for the environment and economic CIS countries in the next 10-20 years

4.5. Region-specific hazards: Sea level rise and enhanced coastal flooding

Global sea level rise (as an important and additional stressor) matters for both the Black and the Azov Seas, as the Bosphorus strait connects the Black Sea with the Mediterranean Sea via the Sea of Marmara and the Aegean Sea. The combination of sea level rise and wave action (even though the wind speed is projected to be lower) will cause coastal flooding and will remain a key challenge for several cities, port facilities and other infrastructure, including tourist infrastructure on the Black Sea coast. (See Figure 16.) Minimal losses due to erosion and flooding are estimated at 6 thousand ha. (Figure 17).

Figure 16: Vulnerability of the Ukrainian coastline

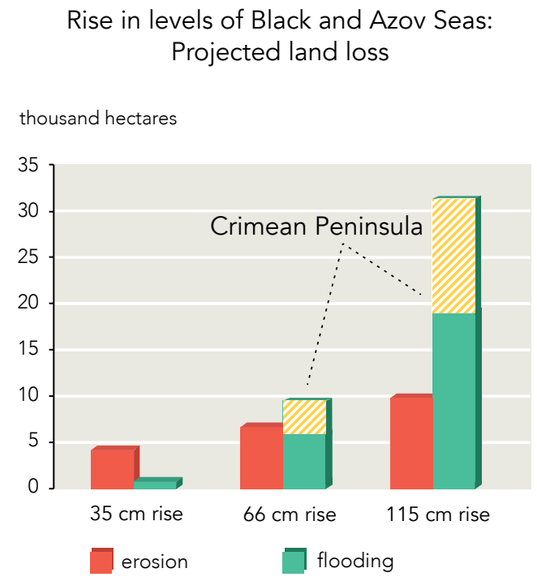


Figure 17: Projected land loss due to sea level rise

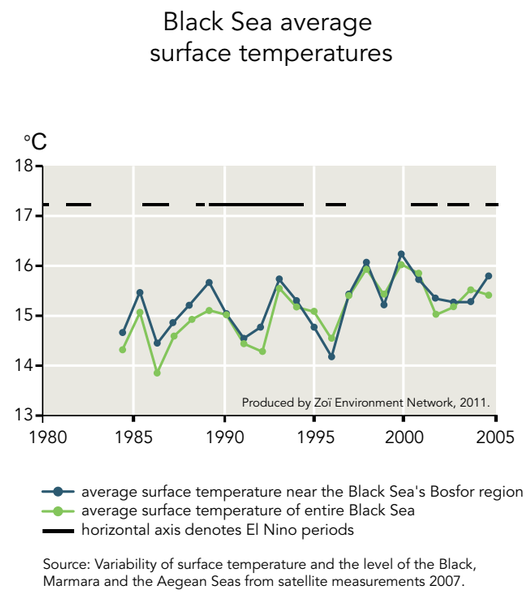


Figure 18: Black Sea average surface temperatures

The Ukrainian Hydrometeorological Institute conducted the last comprehensive assessment of the hydrometeorological regime in the Black Sea in 1985, though other research has been conducted since then (Figure 18). Research on the Black Sea coast of Ukraine (Odesa, Sevastopol, Feodosiya) found air temperature increases of 0.4-0.8°C per 100 years, although in some areas (Yalta, Ochakiv) the temperature trend appears to be flat. Average annual wind speeds declined during the second half of the last century, as did annual frequency of gale-force winds (15 m/sec). Average annual water temperature has increased (0.05°C/10 years) due to an increase of winter water temperature. Annual flows, precipitation, evaporation, water exchange through straits, and sea volume all experienced changes. Evaporation decreased due to increasing freshwater inflow into the sea.

In the Azov Sea the frequency of severe winters has declined, and mild winters are 2.5 times more likely nowadays. The number of ice-cover days in the Azov Sea has decreased, and some stations in the south (Mysovoye, Opasnoye) reported no ice at all in several winters. For the last 25 years the river freshwater inflow has increased, especially for the main river of the basin – the Don. Both increased freshwater inflow and precipitation act to decrease salinity. Evaporation has decreased due to lower wind speeds on the sea. Sea level in the Azov increased by 1.55 mm per year until recent decades when the rate rose to 7.20 mm and more per year.

5. ASSESSMENT OF CLIMATE CHANGE AND SECURITY IMPLICATIONS AND VULNERABILITY

The vulnerability assessment, which includes an assessment of security implications, determines how climate change related hazards in combination with other cumulative pressures may affect the environmental, socioeconomic and political conditions, and how these in turn may affect security and stability within and across borders. Critical to the assessment is a consideration of climate change adaptation capacity – the potential for a system or a society to respond effectively to climate change – and resiliency; and how they apply to governments, institutions, key sectors (such as food and energy), infrastructure, social dynamics, income diversity and migration patterns at the local, national and regional level.

Some of the relationships may be fairly straightforward, and some may be highly complex. Floods or extreme cold waves, for example, may cause immediate human and economic losses (which may be difficult to estimate), may trigger an energy or food crisis and may threaten livelihoods. Changes in the hydrologic cycle, in contrast, may cause environmental degradation over a longer time period, with repercussions for the economy, and food and power production for the growing population in the coming years. The security implications may be far-reaching and complicated by a variety of other factors. (See Chapter 1, Methodology, for a complete description of the process.)

Within this assessment a series of national meetings in each of the three Eastern European countries as well as a regional consultation meeting contributed to the participatory assessment of climate change and security implications and vulnerability. Stakeholders from various line ministries, and academic and civil society representatives gathered to discuss the most vulnerable economic sectors and socioeconomic challenges posed by climate change as well as the implications for security. Participants examined the issues from the viewpoint of human security: this encompasses economic, social and political security, food security, personal and community security, and environmental security. The regional consultations brought together experts, policymakers and representatives of the ENVSEC organizations. These consultations attempted to reconcile national perceptions of climate change across the region, and to identify regional commonalities and differences.

A review of the adaptive capacity and vulnerability of the countries of Eastern Europe and its neighbouring regions allowed for the identification of aspects that exacerbate security and which are induced by climate change in certain areas or climate change and security hotspots. (See Figure 19) These aspects are then followed by detailed descriptions of each identified hotspots.

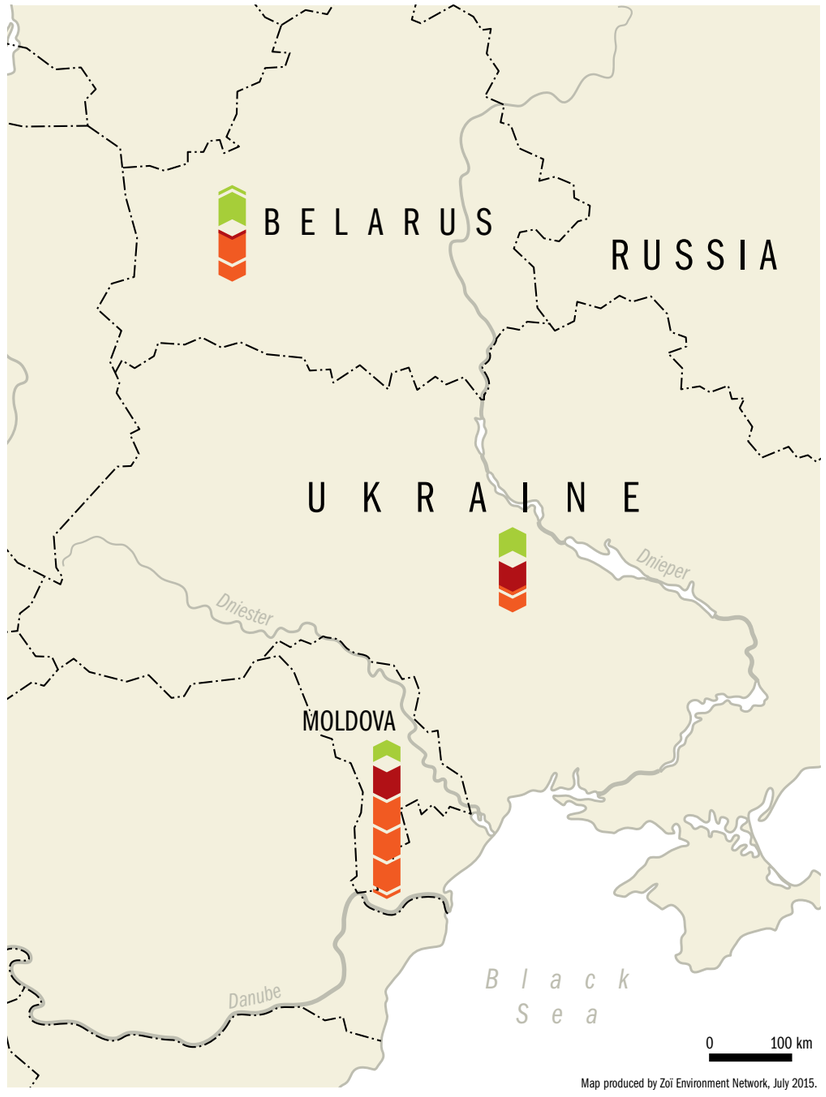


Figure 19: Index of vulnerability to climate change

5.1. Structural, socioeconomic and environmental consequences of climate change

5.1.1. Changes in human and livelihood security

Every activity with adverse implications on livelihoods and human well-being increases the level of insecurity. At the same time the capacities to meet and/or adapt to changes determines whether a particular person is safe or insecure.

There is little evidence regarding the implications of climate change for employment and livelihoods in the region, but likely changes in agriculture, forestry and tourism may lead to changes in employment in those sectors.

Any negative environmental changes have direct or indirect impacts on livelihoods. Sea level rise, salinization of coastal areas and soils, reduction in quality and diversity of marine products – all these and others changes will lead to deterioration of conditions for tourism in the Azov and Black Sea regions, the Crimean Peninsula, and deltas of big rivers – the Belgorod-Dnistrovski, Odesa, Ochakiv, Kherson, Skadovsk, Armiansk, Yevpatoria, Sevastopol, Yalta, Feodosia, Kerch, Melitopol, Berdiansk, Mariupol.

Catastrophic floods, bank erosion, flooding of settlements and recreation zones of the Dnieper, the Dniester, the Danube and the Pripyat and their tributaries will touch the livelihoods of the people living and working there (including those involved in tourism). Most of Ivano-Frankivsk and Chernivtsi and part of the Lviv and Zakarpatska oblasts in Ukraine suffered from major floods on the Dniester and the Prut Rivers in 2008, as did the Republic of Moldova. Extreme events in the Carpathians will have a significant impact on development in the tourism industry, and ski resorts in the Carpathians such as Bukovel, Slavske and Dragobrat, which are at risk of too little snow from winter to winter.

Small farms, which dominate in the agricultural sector of the region, are the first to suffer losses and damages (harvests, arable land, soil quality and infrastructure), and business insurance for small farms is not well developed or available. Many people in the region rely on agriculture as the sole source of income and livelihood.

Forestry is another major economic sector of the region facing changes – shifting natural borders, decreasing populations and habitats and losses in biodiversity and forest and plant productivity.

5.1.2. Additional pressures and competition over scarce natural resources

A large part of Eastern Europe is covered by various types of forests. Forestry has been identified as one of the most vulnerable sectors in the region due to climate change and it is therefore likely that human activities that depend on forests are affected as well.

The following major negative impacts in the forest sector, which are applicable for the whole region, are observed:

- An increase in the frequency and magnitude of forest fires, including the spread of radionuclides by forest fires in areas contaminated by the Chornobyl disaster
- An increase in the number of foci of pests and diseases, strengthening the intensity of damage to forests and increasing the areas of drying plants
- Degradation of forests, reduction of productive functions of forests, reduction of volumes of wood and non-wood forest products (berries, mushrooms, medicinal raw materials)
- The loss of forest biodiversity (including rare and endangered species of flora and fauna)
- The deterioration of environmental reclamation and protective functions of forests and agroforestry plantations (including water protection and sanitation functions, reduction of carbon sequestration potential, deterioration of soil and erosion control features, and reduction of the positive effects of forests on microclimate)

Forests occupy almost 40 per cent of Belarus and are an important part of the national economy. According to recent research conducted at Moscow State University, until 2050-2060 shifting forest boundaries will give Belarus a combination of forest-steppe and steppe, with the steppe mainly in the south. This situation could change, however, depending on the natural resistance and adaptive capacities of the native vegetation. Observations by the Institute of Experimental Botany in the Belovezhskaya Pushcha Park in Belarus showed unusually high increases in temperature, and decreased periods of snow cover, both of which can affect the water regime. Researchers concluded that groundwater levels are important for the health of the forests.

According to Belarus statistics, 5 000-23 000 plants die annually mostly because of drought. The decreasing trend in forest fires is attributable to good management and forest protection. Over the last 40 years the structure of forest cover has changed. In a negative trend, the percentage of pine and oak has decreased while the percentage of birch and alder has increased. The southern boundary of continuous distribution of spruce shifted to the north in some regions. The numbers of fir, pine and oak are expected to decrease. All these changes in forest composition are likely caused by climate change, and the forestry sector, which plays an important role in the Belarusian economy, may need to adapt to these changes.

The Republic of Moldova's forests play a crucial role in mitigation and adaptation: they lessen the effects of drought and floods, and they decrease soil erosion, land degradation and landslides (all threats to human settlements and ecosystems). The Republic of Moldova is located in a zone with high wildfire risks. Fires, especially those of herbaceous vegetation are very common in the Republic of Moldova and are dangerous for vineyards, orchards, forest generation and afforestation, as well as for municipalities. According to statistics for the period of 2004-2012, most forest fires happened in the middle and southern parts of the country.

Forests cover 16 per cent of Ukraine – both "protected" (mostly located in national parks and reserves) and "economic" (harvested for building materials and firewood). The climate change risks to forests are significant: habitats for some species and natural zones will change, causing some to disappear. The stability and functioning of forest ecosystems as well as the productivity of trees and other plants will decrease, and the balance of nutrients will change, leaving forest vulnerable to fire and diseases. The forests of the Carpathian Mountains and in the forest zone in the northern and central parts of Ukraine, including the Polesie and Chornobyl areas, as well as Eastern Ukraine are among those at risk. The 2015 forest fires in Chornobyl collectively covered more area than any fire since 1992.

The potential deterioration of shared and common ecosystems and water resources due to climate change could lead to discussions and disputes within and between countries.

Ecosystems play a major role in adaptation to climate change. Currently, the countries in the region face a host of ecosystem problems: long-term degradation of arable land, pastures and forests; ongoing isolation and extinction of populations; lack of monitoring; transboundary disputes; the complex relationship between water management and terrestrial ecosystems; and a general lack of time and capacity to improve. The success of adaptation measures for ecosystems depends on political willingness; the incorporation of adaptation measures into planning; the implementation and enforcement of legislative measures; an economic valuation of ecosystem services; and the use of international mechanisms of proportional compensation of related expenses and losses.

The huge ecosystem in the centre of Europe – the Carpathians – faces negative impacts of climate change that can and do affect human livelihood security and biological diversity. It provides important ecological corridors for migration of wild species of fauna and flora (a role that will have more value in the light of climate change), and is home to unique and rare species of European and world biological heritage. In the Ukrainian Carpathians, however, the understanding of the role of protected areas is weak, and ecological corridors in some places are not supported. In addition, recent ambitious plans to build small hydropower stations on the rivers of the Carpathians would pose the risk of upsetting the hydrological regime and destroying spawning areas (including for rare fish species), and diminish the prospects for developing green tourism industry. The negative impact on fish spawning in the Rika River in Zakarpatska oblast, Ukraine, in the springs of 2014 and 2015 captured the attention of the public, environmental activists and local authorities. Similar concerns halted construction on several building projects in the mountain districts of Ivano-Frankivsk oblast, Ukraine. Even though the fishery does not play an important role in the local food supply, it is crucially important for maintaining biodiversity and protecting unique types of fish in the region.

In Ukraine, natural resources management and decision-making led to local conflicts when the country considered the construction of hydropower stations over a wave of protests by ecologists and residents. The economic benefits of the project are perceived to come with negative environmental impacts including changes in hydrological regimes of small mountain rivers, damage to nesting habitat and biodiversity losses in water bodies, including threats to a trout listed in the Ukrainian Red Book of endangered species. It will also affect tourism, which is the main activity in the region and livelihood for the local population.

The steppes in southern Ukraine are also crucially important ecosystems that are suffering from desertification and long-term degradation, particularly due to climate change, and are losing biodiversity.

The Republic of Moldova, as the most vulnerable country in the region, experiences the negative impacts of ecosystems under increasing risk. Since sustainable and strong ecosystems rely on the highest adaptive capacities to climate change, the Republic of Moldova's experts identify three main approaches for supporting ecosystems on a sustainable basis: sharp increases in the area of stable ecosystems such as forests, wetlands and river protection zones through reductions in unstable landscapes such as farmland, monocultures and unused land; prevention of the fragmentation of ecosystems; and facilitation of the afforestation of private farmlands.

A dedicated project in Polesie – a subregion within Ukraine and Belarus with the largest European swampy areas – focuses on the preservation of such vulnerable ecosystems as wetlands, swampy areas and wet forests. Among the main climate change impacts here are forest and peat fires, soil erosion in both forest and agricultural areas in the Chernihiv oblast of Ukraine and the Gomel oblast of Belarus, and the deterioration of soil productivity in the Volyn oblast of Ukraine. The presence of the Rivne Nuclear Power Plant (near Rivne city) and the Chornobyl Exclusion Zone complicates the situation. Priority adaptation measures for five types of Polesie ecosystems were identified.

Changes in water flow are now apparent in all major rivers and their basins: variations in water levels and run-off, floods, losses in water biodiversity, scarcity and water deficits, water contamination and low quality. The assessment of the effects of climate change on the hydrological regimes of the major rivers of the region project that run-off of the Dnieper, Southern Bug, Dniester and Neman will increase during winter and decrease during other seasons by the middle to the end of this century, and that temperature increases of 2°C and precipitation declines of 10 per cent can cause a decrease of run-off in the rivers of 15-20 per cent.

5.1.3. Changes in agricultural productivity and food security

Impacts on agriculture have an obvious and direct connection to food security: the better conditions are for agricultural cultivation and crop productivity, the better the countries and their neighbours can be supplied with good quality food of sufficient quantity. Changes in food availability can impact on its prices and accessibility.

The positive impacts of climate change on agriculture in the region include increases in productivity and diversity due to longer growing seasons and more favourable conditions. Belarus and north-central Ukraine will benefit from warming temperatures in the near term: the warm season for agriculture will start earlier and last longer, and production will increase. Increases in average temperature of 1-2°C over the past 25 years helped increase fruit and vegetable production in northern Belarus, but experts report a loss to the Belarusian economy as a result of adverse and dangerous weather conditions.

The longer growing season in the Republic of Moldova will potentially increase grass yields, while higher temperatures will increase the potential for growing forage legumes. The longer growing season should also reduce the costs of keeping livestock. There may also be benefits for horticulture, both with respect to reducing costs of indoor production and increasing the range of horticultural crops that can be grown outdoors.

Ukrainian experts predict that rising temperatures in the southern part of Ukraine and the lengthening of agricultural seasons could allow farmers to raise two crops of potatoes in one year. Ukraine may be able to produce more winter wheat with the changes in seeding and harvesting times and use of less winter-hardy wheat varieties.

The negative climate impacts that lead to security issues include an increasing frequency of droughts and extreme precipitation, fire damage, desertification, the lowering of groundwater levels, the spread of new infections and parasitic diseases (unusual for certain regions), salinization, waterlogging and an increase in various fungal diseases due to warmer winters.

Agriculture in southern Belarus, including in the Polesie ecosystem, is a concern for the whole country. Hot, dry summers are weakening the plants, and the quality of potatoes, flax and cabbage are deteriorating. World Bank experts report that the Belarusian economy loses on average US $93 million per year as a result of adverse and dangerous weather conditions. Research conducted by Belarusian experts and experts at the WB found that the damage caused by unfavourable weather conditions is most significant in the agricultural sector.

In the southern part of the Republic of Moldova, rising temperatures combined with drier conditions are adding stress on water resources, and desertification is a growing concern. In Ukraine's southern region, increasing temperatures and decreasing precipitation are combining to cause desertification in the Kherson and Zaporizhzhya oblasts, as well as in the Crimean Peninsula. In all areas, the instability of weather represents a risk to agricultural production.

As preventive measures, both Ukraine and the Republic of Moldova are looking to modernize irrigation systems, introduce drought-resistant varieties, and improve erosion controls. The countries plan to improve water use efficiency and to introduce water-saving techniques to benefit agriculture.

5.1.4. Economic changes

Since the countries of Eastern Europe are mainly agricultural and are known as food suppliers worldwide, the conditions for food production will determine the food supply both domestically and for export. From the manufacturing point of view, the countries have the raw materials base for the production of their own economic goods, and for neighbouring countries, especially countries of the Commonwealth of Independent States (CIS). The manufacturing and agricultural sectors rely on and use a lot of energy, water and other resources. Any significant changes in resource availability and accessibility due to climate change will directly impact the amount of economic production and trade.

Expected climate change carries significant risk to the sustainable development of Eastern Europe. Not least of these concerns is the expected increase in the frequency and severity of flooding that may affect infrastructure and buildings. In addition, outdated building regulations may not provide sufficient protections against the new climate realities, and disruptions in the water regime may affect the water supply for industry, agriculture and the general public.

Sector-specific climate risks are also expected. In Ukraine, the sectors most at risk include energy, agriculture and water supply,[40] and in Belarus, the affected sectors include agriculture, forestry, energy, construction, transport and communication, housing and utilities.[41]

40 http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application /pdf/6nc_v7_ final_[1].pdf, p. 200
41 http://unfccc.int/files/ national_reports/biennial_reports_and_iar/submitted_biennial_reports/application/pdf/blr_nc6_resubmission.pdf, p. 179-180

Despite the risks to the energy sector, national experts emphasise the positive consequences of climate change: the reduction of heat energy production resulting from the shorter heating season. So, Belarus basically expects both positive and negative implications in the near future, with varied experiences throughout the country.

Climate change in the agriculture sector may affect agricultural output and exports. In the new agro-climatic zone forming in Belarus Polesie in the south, farmers are growing thermophile, drought-resistant and frost-resistant varieties of grain, early varieties of potatoes, corn for seeds, soy and other crops. The area vulnerable to droughts will increase in the south. Moisture supply needed for agricultural products will decline in these areas. To resolve this issue a new optimal structure of acreage for different cultures have to be applied, also the efficient using of fertilizer and plant protection products have to be considered.

Forecasts of changes in the productivity of the main tree species suggest increased productivity in north-eastern Belarus, with decreases in the south-west of the country.[42]

Changes in economic output and trade for the Republic of Moldova are determined by risks and vulnerability of agriculture. Temperature and precipitation changes, increasing demands for irrigation water – even as yields decline – and decreases in water supply associated with higher evaporation and lower rainfall may all have a negative impact on irrigated crops. Declining yields in rain-fed crops are more likely. Livestock is vulnerable both directly and indirectly to high temperatures, and productivity is expected to decline.

Climate change may, however, create additional opportunities, particularly in agriculture. Temperatures could increase during the growing season, the higher concentrations of carbon dioxide may enhance the growth of plants and in some areas climate change may increase the amount of rainfall and water resources.

The modest climate impacts on apples, grapes and vegetables are not expected to affect their status as export specialties of the Republic of Moldova or the dominant role of the food industry in the structure of economy, though frequent droughts covering the whole country are likely to raise the issue. The risk of inadequate water resources may be a limiting factor not only for agriculture, but for economic development in general. Developing and rehabilitating irrigation infrastructure will create construction development.[43] The absence of adaptation measures in the energy sector may result in mostly negative consequences including diminished hydropower resources. Deteriorating cooling systems may reduce the capacity of thermal and nuclear power plants. Other failures in the sector may result in increases in accidents and outages in power networks. Such problems are likely to reverberate throughout the economy. The shorter heating season will reduce the demand for heat energy production, and the amount of imported fuels (especially gas and coal) may decrease, but the increased demand for air conditioning in the summer may somewhat offset the reduced winter demand for heat.

Owing to the exceptional importance of food security, Ukraine conducted a series of research projects, mainly focused on the analysis of the productivity of basic grains. Climate change provides more favourable conditions for the cultivation of basic grains (winter and spring, early and later varieties) and may be a factor in the production of relatively high yields (especially in Polesie, in forest-steppe areas and on the steppes of the right bank of the Dnieper River). Production will be sufficient for food security and for increasing export potential. Development of related industries such as the production of machinery and fertilizers is likely to follow.

Long-term climate change is very likely to have mostly adverse impacts on forests, and on the production of wood and non-wood products. The increasing aridity of the climate affects the viability and sustainability of forests and, very likely, will provoke major fires and outbreaks of dangerous pests (especially dangerous for pure pine plantations established in the Dnieper sands and other steppe regions).

The development of social sectors (education, health and social assistance) is projected to be significantly higher in the 2021-2030 period than today based on the growth of household income and increases in state financial support.[44]

Most industrial facilities, such as mining and industrial sites in Donbas and southern Ukraine, are old and employ out-of-date technologies. Some of these facilities have been affected by the conflict in and around Ukraine.

5.1.5. Social tensions

In the 1990s Eastern Europe inherited a burdened environment to which climate change would likely add more stress on the agriculture, forestry, water and coastal resources. Additional stress could amplify any pre-existing social tensions and overwhelm institutional capacities, and thus major investments in climate change adaptation are needed for Eastern Europe to diminish the risks of upheavals.

The regional economy has gone through waves of deep shocks – the collapse of the Soviet Union, the spill-over effects of the financial crisis of 1998, the global financial crisis of 2008, and the current politically strained situation. These shocks have exhausted resources, and left infrastructure in many sectors and areas needing crucial investments.

42 http://unfccc.int/files/national_reports/biennial_reports_and_iar/submitted_biennial_reports/application/pdf/blr_nc6_resubmission.pdf
43 http://issuu.com/world.bank.europe.central.asia/docs/reducing_the_vulnerability_of_moldo
44 http://unfccc.int/files/national_reports /annex_i_natcom/submitted_natcom/application /pdf/6nc_v7_final_[1].pdf

There is ample room for strengthening security and stability in the region, and the failure to integrate such measures, including public health, may worsen the impact of climate change and environmental degradation on public well-being.

The loss of land to the Black and Azov Sea sharpens the social conflicts in this part of the region. Currently, problems related to harmonizing the interests of local communities and private entrepreneurs, local protests and cases of corruption are apparent in this area. Coastal areas in general are a valuable resource for the development of recreation.

In the Republic of Moldova farmers are clearly stressed by climate change. The lack of water for irrigation and the attendant economic losses may provoke conflicts between farmers and other groups. In addition, the hazards of climate change may disrupt progress in overcoming poverty in the country, which in turn may undermine development of a sustainable society.

Water problems – such as scarcity and the deteriorating quality of drinking water – may lead to community-level confrontations with local authorities.

Ukraine started the implementation of the state Energy Strategy of Ukraine, which aims to build a number of small hydropower stations on the Carpathian rivers and their tributaries. Ecologists regard the construction of small hydropower stations as a hasty and poorly justified plan that threatens ecotourism development and ecosystem functioning.

The situation could also be accelerated by droughts that lead to lower water levels, including in the Carpathians. Thus the water resources would be inadequate for maintaining the network of small hydropower stations.

5.1.6. Infrastructure vulnerability

Land resources and infrastructure in Eastern Europe are vulnerable to destruction and damage due to such extreme events as catastrophic floods and mud slides, and to erosion, contamination resulting from flooding of hazardous sites and desertification. The security consequences of these climate change effects may be either short- or long-term, and may include food, energy, or livelihood insecurity, among others.

The shifting of natural zones is projected to lead to land losses and degradation. In the southern part of the region, it will lead to desertification equal to land losses. A large proportion of soils in the Republic of Moldova and Ukraine agro-climatic zones are black soils. These soils have high organic matter content that is likely to increase with warmer temperatures. The soil fertility in the short term will increase while in the longer term soil fertility is likely to be reduced. Land erosion will lead to land losses.

National physical and electronic infrastructure is vitally important for supporting normal life in the countries, the loss or compromise of which could lead to severe economic or social consequences, or to loss of life. Extreme weather events, such as floods, heatwaves, storms and wildfires are known to damage infrastructure. Areas around large transboundary rivers, mountains and coastal zones of the Black and Azov seas are the most vulnerable. The 2008 flood affecting transboundary rivers shared by Ukraine and the Republic of Moldova damaged power and water utilities, communication and transport infrastructure and buildings. Due to floods on the one hand and failure to adhere to building codes on the other hand, the economic losses of house owners and the destruction of infrastructure built close to water bodies could be significant.

Forest fires can affect transport infrastructure (roads, railways) and destroy buildings. Strong winds damage trees and the power distribution networks in events too numerous to mention, especially in Ukraine and the Republic of Moldova. The Chornobyl forests fires in April 2015 are a notable example.

5.1.7. Changes in the spread of diseases

In Eastern Europe, the range of health effects associated with climate change is likely to include increased sensitivity to heatwaves, more chronic diseases and the transmission of new diseases. Heat-related mortality will become more prevalent than cold-related mortality. The elderly and those with chronic diseases are at greatest risk.

The World Health Organization has conducted climate change adaptation activities in Eastern Europe and other areas needing better integration between public health and climate change policy and better co-ordination and communication between climate change organizations. Statistical reporting in regard to climate change and its impacts on public health as well as the need for regular monitoring and database development are quite important.

The relationship between human health and humidity, precipitation and cloud cover, all of which have both negative and positive effects, is an area for further research in Belarus. The public health consequences of climate change in Belarus include increased incidence of dysentery and other intestinal infections (after floods), diminished water quality and higher numbers of mosquitoes and ticks as well as the diseases they carry – encephalitis and Lyme disease, among others.

In the Republic of Moldova, studies of the effects of climate extremes on human health considered the economic consequences (climate events and the resulting financial damage), the sanitary and hygienic consequences (depletion of water resources, habitat or unbearable conditions due to extremely low or high temperatures) and the direct impact on human health (deaths, lesions, intestinal infections, infirmity, acute respiratory diseases). The special studies conducted in the country identified a connection between mortality rates and higher temperatures, lower precipitation and a growing number of days with increased humidity. Statistically, excess mortality occurs when the high temperatures go beyond 25°C (average), 31°C (maximum) and 19°C (minimum).

The Ukrainian State Sanitary-Epidemiological Service includes among the negative climate change impacts diminished air and drinking water quality and increased waterborne and food-borne diseases. In Ukraine, as elsewhere in the region and the world, the elderly population is one of the most vulnerable groups. Climate change may also exacerbate the impact of industrial emissions on human health. In particular, emissions of sulfur dioxide from coal usage in industrial sites and plants requires further study, especially in consideration of the installation of new emissions capture technologies in the modernization of industrial sites and processes.

5.1.8. Changes in income and poverty

The impact of climate change on incomes and on poverty of those who rely mainly on nearby natural resources, as well as energy resources if their activities are energy-consuming, is likely to lead to insecurity of one type or another. Worldwide experts and leading organizations dealing with climate change issues recognize that poor countries will suffer more from climate change impacts in part because they have less capacity to prevent or adapt to the changes. The groups most vulnerable include elderly populations, those living in rural areas, and those with below-average incomes and living standards. There seem to be little or no comparable data or findings specifically available for the Eastern European region.

In the highly forested Carpathians and Western Polesie, the rural dwellers have lower household income, and are dependent on forest resources. Non-wood forest products that prefer wet conditions – mushrooms, blueberries and cranberries – are important not only as staples in the traditional diet, but also as additional income sources. The prospect of more droughts and heat will adversely affect the growing conditions for these products, and is likely to result in a loss of income.

In the southern coastal oblasts of Ukraine (Zaporizhzhya, Odesa, Mykolaiv oblasts) fisheries provide the main economic activity. The region supplies more than one-third of the country's water bio-resource products, and is likely to be impacted by climate change. At the Danube delta the growing period of the main commercial fish species and the number of days suitable for fishing may be extended, resulting in increased pressure on the populations of the main commercial species. Future changes in climate will not trigger a significant reduction in the Danube catch, though the quality may deteriorate. At the same time fish production in the Danube lakes and reservoirs may decrease due to the worsening of water exchange and lower water quality.[45]

The coastal regions of Ukraine, with unique natural conditions, an abundance of wildlife and a rich cultural heritage, offer seasonal summer tourism. A longer summer season may bring a higher number of visitors. At present, the Republic of Moldova's part of the Dniester, the Danube, Prut and Reut riverbank areas are poorly suited to tourism, but income from tourism can become a safety net for families in the years of low yields or loss of harvest in rural areas. Growing pressure on infrastructure may deepen existing problems with water supply. Seasonal winter tourism is important for mountain areas, and the low-lying Carpathians will be the most vulnerable to climate change. Tourist responses to marginal snow conditions remain largely unknown, and changes in weather extremes may also be critical. Artificial snowmaking increases water and energy consumption, and has physical and economic limitations, especially in small and low altitude ski areas (IPCC, 2014). The effects on income and well-being for the mountain population of the Ukrainian Carpathians will likely be adverse.

Milder climate changes in Belarus may create mostly favourable conditions for nature-dependent activities, but in the Republic of Moldova and Ukraine climate change is likely to reduce income from gathering and fishing, and increase poverty and disrupt traditional lifestyles.

5.1.9. Changes in migration

Short-term displacements occur in the region mainly as a result of extreme weather events. The countries of Eastern Europe are not yet experiencing internal climate migration, but these countries could become popular destinations for climate migration from other regions.

Areas with high population density need to become particularly resilient to climate change. The spread of disease is faster and the consequences of water or food contamination are graver because more people are potentially exposed to the hazards. The more crowded the living conditions are, the more vulnerable the people will be to whatever hazards are present.

The displacement and changes in migration due to climate change are not well studied yet in Eastern European countries, but climate change is likely to affect labour migration trends in Eastern Europe.

45 Climate Change Adaptation Strategy and Action Plan for Danube Delta, 2014, file:///Users/lesya/Downloads/danube_delta_adaptation_strategy.pdf

In Belarus, mostly favourable consequences for agriculture are expected, along with corresponding boosts in construction and agricultural machinery. New jobs created in response to this expected new demand may alter the labour migrant situation, as Belarusian men find construction work at home and no longer have to work abroad.

In Ukraine, seasonal agricultural workers have come from the Polesie and forest-steppe areas with labour surpluses to work in the southern steppe regions, but as crop production conditions in the northern and central parts of the country become more favourable, the flow of migrant workers may diminish.

If the Republic of Moldova experiences significant economic losses, particularly in agriculture, the flow of migrants to Europe may once again intensify.

Climate change is likely to cause other displacements as well. Persistent water shortages are likely to lead to long-term migration, while floods are likely to cause short-term displacements. Flooding of coastal zones may cause forced migrations. The map entitled "Vulnerability of the Ukrainian coastline" shows the areas near settlements potentially inundated by sea level rise.

Increased intensity and frequency of floods may lead to the relocation of inhabitants of river valleys, but longstanding attachments may draw some displaced persons back to their previous homes.[46]

Heatwaves and high temperatures may prompt seasonal displacements as well, especially from urban areas and big cities. In Ukraine, the National Ecological Center conducted an assessment of the vulnerability of several cities to climate change,[47] and recommended actions to be included in the national adaptation strategy, which is still under development by the Ministry of Ecology and Natural Resources of Ukraine.

Some experts in the region predict an international migration due to climate change (with people migrating from more vulnerable countries to Eastern Europe), as well as climate-induced migration through Eastern Europe in transit to EU countries. This issue requires additional research.

5.2. Adaptive capacity

The capacity of Eastern Europe to enhance its resilience will determine the effectiveness of its response to climate change and security risks. Strong, stable economies and effective governance improve adaptive capacity, and those ecosystems, regions, countries and economic sectors with a high capacity to adapt are less vulnerable. As Figure 14 demonstrates, the Eastern European countries all rank relatively low for exposure to climate change, but the Republic of Moldova ranks relatively high on the sensitivity scale, which accounts for factors likely to increase the impact of climate shocks. Currently, all three countries rank relatively low on adaptive capacity.

5.2.1. Financial capacity

In a clear acknowledgement of countries' responsibilities and readiness to meet the challenges of climate change, the countries of the region conduct planning and allocate budgets for climate change research and for the development of adaptation plans and measures. In light of the complexity of the socioeconomic problems and the range of sectors involved, these funds are sometimes insufficient to fully implement comprehensive strategies.

Budget funds allocated directly for resolving climate change issues as such are limited, though it is mistaken to suppose that no funds are allocated. In fact, in all three countries sectoral programmes are elaborated at the different levels (for almost all sectors) most of them indeed only partly implemented due to lack of resources. There are several regional thematic programmes, especially for transboundary rivers and mountains. These programmes indirectly touch issues of climate change and security in the region. The main impediment to assessing the budget funds allocated for activities related to climate change is the lack of proper documentation of these programmes. But the fact that these activities indeed are included in sectoral development programmes means that climate change issues are taken into consideration.

In light of EU Association, the Republic of Moldova and Ukraine currently are focused on implementation of the EU Flood and Water directives, a step that opens opportunities for improving legislation and practices. Belarus is on the same path to implement EU Water directives, and in 2014 adopted a new water code that establishes a basin approach to river management and public participation in decision-making regarding water resources as essential first steps. In Belarus budget money goes to support the energy sector for such projects as energy efficiency and the development of renewable energy.

International funds to the region play a major role, and multilateral climate change funding is expanding beyond the Global Environment Facility. The Green Climate Fund targets both mitigation and adaptation in developing countries, and other funds focus exclusively on adaptation. The Clean Development Mechanism, which supports emissions reduction projects, has been effective in some countries, but has proven to be too complicated in others. UNFCCC plans to introduce new trading mechanisms.

The European Commission Directorate-General for Climate Action (DG CLIMA) helps the EU deal with the consequences of climate change, and supports climate policy co-operation among the EU eastern partners. Established in 2010, DG CLIMA will analyse national climate policies in the 12 countries of Eastern Europe (including Belarus, the Republic of Moldova and Ukraine), Caucasus and Central Asia and identify possible entry points for EU climate policy and climate dialogue. This climate and security analysis together with targeted country missions and frequent dialogue with DG CLIMA and other EU institutions will support Eastern Europe countries to strengthen their national climate policies.

Clima East is an EU-funded project package assisting the Eastern Neighbourhood Partnership Countries and Russia in developing approaches to climate change mitigation and adaptation. The project consists of two components: the first, implemented by the UNDP, consists of a number of Pilot Projects that support the development of ecosystem-based approaches to climate change; the second is a policy component that seeks to foster improved climate change policies, strategies and market mechanisms in the partner countries by supporting regional co-operation and improving information access to EU climate change policies, laws and expertise. The project will be implemented within four years.

The European Commission is funding a forest protection programme in Eastern Europe, the Caucasus and Russia with the goal of ensuring that the region's forests contribute "to climate change adaptation and mitigation, to ecosystems and biodiversity protection, and to sustainable livelihoods and income sources for local populations and national economies." The WB is implementing the programme in partnership with the World Wide Fund for Nature (WWF) and the International Union for the Conservation of Nature.

Other projects related to climate change, hazard risk reduction and security issues are implemented under the umbrella of the Global Environment Facility (GEF), the WB and United Nations programmes.

5.2.2. Institutional capacity

In Belarus, the State Commission on Climate Change, established by the Council of Ministers in 2006, is responsible for co-ordination among ministries and agencies on climate change activities. The Ministry of Natural Resources and Environment Protection is the main body responsible for climate change policy, including adaptation, in the country. The National Academy of Science and the State Hydrometeorological Service play an important role in conducting climate research and analytical studies in the relevant sectors. The Republican Research Unitary Enterprise, Bel R&D "Ecology", among other scientific institutions, was engaged to prepare the latest national communication to UNFCCC.

In the Republic of Moldova a special Office on Climate Change was established with the aim of meeting its commitment under the UNFCCC and the Kyoto Protocol. The Office closely cooperates with the Ministry of the Environment and other ministries and agencies, and is financed through international projects and fundraising. The Office also implements projects on climate change adaptation and mitigation by involving national and international experts. The Office is responsible for regular reporting on GHG emissions and participates in the process of preparation of the UNFCWCC national communication. With the assistance of the Office, the Republic of Moldova adopted a National Adaptation Strategy in 2014.

By 2015, the State Environment Investment Agency of Ukraine, under the Minister of Ecology and Natural Resources, was the main body responsible for climate change policy in Ukraine, including implementation of UNFCCC and the Kyoto Protocol, GHG inventory and the implementation of adaptation and mitigation programmes and projects. Because of the latest political changes and developments in the country, the agency was disbanded and a new department was established within the Ministry of Ecology and Natural Resources for such functions.

Other Ukrainian organizations are involved in the implementation of the UNFCCC as needed. For instance, a consortium of governmental and scientific institutions, including the ministries of environment and emergency situations, the hydrometeorological institute and the National Scientific Academy, was established to prepare the national communication. Other sectoral ministries, agencies and scientific institutes are involved in specific sectoral research.

Even where there is regular employee turnover, as in Ukraine, Eastern Europe has institutions dealing with climate change issues in place. Maintaining these activities is extremely important in light of the current challenges, as is developing and keeping a well-educated, knowledgeable and informed staff by having country experts continue to participate in education courses and international conferences, and to host international colleagues.

5.2.3. Regional processes

Eastern Europe countries are parties to a number of environmental conventions and agreements that have direct or indirect connection to climate change issues. All three countries participate in the World Meteorological Organization, which gives them opportunities to exchange

46 John R. Gold. An Introduction to Behavioral Geography (Russian editing), 1990, Moscow, p.230, p. 270
47 http://climategroup.org.ua/wp-content/uploads/2014/07/ukraine_cc_vulnerability.pdf

hydrometeorological information. Also such international organizations as the GEF, World Bank, UN Environment, UNECE, OSCE, REC all implement projects on climate change at the global and regional levels, including some that are under the umbrella of the Environment and Security Initiative. The Swedish International Development Co-operation Agency (SIDA), Germany's International Co-operation Agency (GIZ), and the Austrian Development Agency (ADA) are quite active in the region. The countries participate in UNFCCC and IPCC activities by taking part in conferences, meetings and working groups.

Belarus is a party to the Global Climate Observing System and the World Climate Research Programme. In 2006 Belarus joined the Agreement on the Antarctic and conducts meteorological observations there. Belarus in close co-operation with the Federal Service on Hydrometeorology and Monitoring of Russia implements projects on hydrometeorological observations, has signed the Concept of Hydrometeorological Safety in the Commonwealth of Independent States, and regularly reports to the Interstate Statistical Committee of the CIS. Transboundary co-operation on emergency situations exists between the countries at different levels: the Ministry of Emergency Situations of Belarus assisted the neighbouring countries Russia and Ukraine in fighting forest and peatland fires.

Belarus cooperates with Sweden, Finland, Denmark, Estonia, Latvia, Poland, Norway, Germany and Lithuania in the framework of the EU technical aid project BALTRAD on meteorological observations of the Baltic Sea, the main ideas of which are to develop a unique meteorological radio-location system for data transmission and the installation of automated flow stations.

The Environmental Policy Concept of the Republic of Moldova anticipates that the country will sign bilateral protocols on co-operation with CIS and EU countries, and will establish cross-border co-operation within European regions. In 2010 the Republic of Moldova joined Ukraine as a full member of the Energy Community Treaty. There is also close co-operation within the working group on environment and climate change, which is part of EU Platform 2, "Economic Integration and Convergence with the EU Policies", a device that provides guidance on sustainable development and related issues for the Eastern Partnership. The Millennium Challenge Corporation, an independent United States foreign aid agency, implements climate action projects in the Republic of Moldova.

The Republic of Moldova, Romania and Ukraine have signed a number of bilateral and trilateral agreements on the protection and sustainable use of the waters of the Prut, the Danube and the Dniester rivers, and are implementing joint programmes (although the Dniester basin treaty is not yet ratified by Ukraine).

Ukraine is also one of seven parties to the Framework Convention on the Protection and Sustainable Development of the Carpathians, a treaty-based, multi-level governance mechanism that provides a framework for co-operation and multi-sectoral policy co-ordination (The other parties are the Czech Republic, Hungary, Poland, Romania, Serbia and the Slovak Republic). The Convention serves as a forum for dialogue among local communities and non-governmental organizations, governments and EU and United Nations institutions. Ukraine also makes climate observations at its Vernadsky Antarctic station.

In response to the challenges of climate change, the Carpathian Convention established the CARPIVIA project (Carpathian integrated assessment of vulnerability to climate change and ecosystem-based adaptation measures). The objectives of the CARPIVIA project are to identify and assess potential adaptation measures, and to contribute to regional or national adaptation strategies.

Ukraine is also the only Eastern Europe country to be a party to the Black Sea Commission, which implements the Convention on the Protection of the Black Sea Against Pollution. The Strategic Action Plan of the Black Sea Commission identifies climate change as a cross-cutting issue. One management target of the plan is to assess the impacts of climate change on the Black Sea ecosystem and on the sustainable development of the region.

Ukraine and the Republic of Moldova participate in the International Commission for the Protection of the Danube River (ICPDR), a transnational body that implements the Convention on Co-operation for the Protection and Sustainable Use of the Danube River (Danube River Protection Convention) and works to ensure the sustainable and equitable use of waters and freshwater resources in the Danube basin. ICPDR has developed a climate change adaptation strategy in the basin, one chapter of which is dedicated to the Danube Delta adaptation strategy recently launched by the WWF.

Among its many functions, the ICPDR established the Tisza Group for the co-ordination and implementation of a river basin management plan and the sustainable development of the Tisza River basin. Ukraine, Romania, Slovakia, Hungary and Serbia share the basin – the largest sub-basin of the Danube – and have a history of co-operation on Tisza matters. Droughts and severe flooding, along with the attendant landslides and erosion, are longstanding problems on the Tisza, and the collaborative efforts of the Tisza Group to prepare for these events are tantamount to climate change adaptation. The European experience with flood prevention and the use of modern communication techniques for issuing warnings on the Tisza are a model for river basins in the region. On April 11, 2011, in Uzhorod (Ukraine) under the auspices of the Ukrainian Presidency in the ICPDR the high level representatives of the five Tisza River basin countries signed the Memorandum "Strengthening Co-operation in the Tisza River Basin: Towards the Integrated Tisza River Basin Management Plan Implementation to Support the Sustainable Development of the Region.

5.2.4. Resilience

Throughout the region, countries, communities, large and small enterprises as well as individuals face the challenges of climate change, and will eventually need to develop their own adaptive strategies. These strategies should consider potential effects on other vulnerable sectors or communities to avoid the situation where adaptation in one place adds stress in another. With the adverse effects of climate change being a threat to all, the countries of the region should find ways to collaborate on joint actions and investments.

A significant power and responsibility rest with national governments, which will need to considerably strengthen their understanding of climate change and their climate-related policies to address the problems as well as their consequences for various aspects of security. The countries should pursue a diverse range of climate actions from the national to the local levels, and governments should work with the international community and a broad range of donors to develop and implement the actions. In particular the EU is likely to remain for the foreseeable future an important source of inspiration, expertise and much-needed financial resources to help Eastern European countries achieve tangible progress.

Persistent poverty among the rural population may become a destabilizing force, and affordable technical approaches to adopting new agricultural practices, combined with information on climate change, may produce incremental progress towards economic security in rural areas. Such a strategy may prepare farmers for drought years, and help introduce improved crop selection, more crop diversity and more effective crop rotations.

The insurance industry may be able to play a larger role across all sectors in the recovery from extreme events. It should adopt comprehensive coverage to assist all sectors in the recovery from extreme events, to reduce drought risks and to improve economic and food security.

Communities throughout the region can make no-regrets investments in resilience in the water, agriculture and energy sectors, and adopt precautionary principles such as preventing settlement of disaster-prone areas. Policies and standards for construction and long-term investments can consider climate change, and lead to better outcomes. Taken together, these steps would move the countries of the region in a direction consistent with the global momentum for a green economy that would maintain competitiveness and burnish the image of the countries.

Awareness and knowledge are the foundation for an optimistic future, and the countries should conduct broad public education campaigns to raise awareness of climate change and to provide the foundation for effective actions and long-term solutions.

5.2.5. National climate change policies and plans

Belarus developed a national policy (action plan and strategy) for implementation of the Kyoto Protocol to the UNFCCC by 2012 and a state programme of measures to mitigate climate change for 2013-2020. A list of regulations on GHG inventories were developed and adopted. Belarus has organized its project activities for reducing the impact of climate change into a system that includes regulations on the procedure for the submission, review and monitoring of joint implementation projects on voluntary reductions of GHG.

Belarus has maintained a consistent policy on climate change through successive government programmes for 2008-2012 and 2013-2020. Every year since 2002, the country has prepared an annual report on GHG emissions, and has submitted periodic national communications to the UNFCCC. The sixth report is the most recent, and it was published in 2014.

Climate change adaptation activities in Belarus include water management projects on the Dnieper, Neman and Pripyat rivers. Additionally the strategy on adaptation to climate change in the forest sector was elaborated. In 2015 the Concept of the Strategy on adaptation to climate change in agricultural sector of Belarus was elaborated within the EU Clima East project. The elaboration of the National Strategy on adaptation to climate change is under discussion.

The Republic of Moldova has developed and adopted a National Climate Change Adaptation Strategy, and is initiating the integration of climate change issues into other existing sectoral strategies. After the Cancun Climate Change Conference, the Republic of Moldova formulated national adaptation plans that identify the country's medium- and long-term adaptation needs, and is working on implementation. Additionally, the Association Agreement between the Republic of Moldova and the EU, ratified in 2014, describes the co-operation between parties on environmental matters, including on climate change.

The Government Activity Programme of the Republic of Moldova called "European Integration: Freedom, Democracy, Welfare 2013-2014" contains an environmental protection chapter that introduces the goals and objectives of the government on climate change and the exploitation of natural resources.

The Republic of Moldova adopted the following important legislative documents:

- National Development Strategy 2020
- Energy Strategy-2030
- Small and medium enterprise sector development strategy for 2012-2020
- Roadmap for improving competitiveness
- Agricultural Development Strategy 2014-2020
- Environmental Strategy 2014-2023

The Republic of Moldova Environmental Strategy 2014-2023 pays special attention to mitigation and adaptation to climate change in all sectors of the national economy.

According to the Law on National Security of Ukraine the environment is a part of national security. About 70 legal acts describe the area of climate change (including mitigation and adaptation measures) and security, and recently these issues have been considered quite often. Among the legal documents relevant to climate change are the following:

- Fundamental Principles (Strategy) of Ukraine's State Environmental Policy for the Period until 2020
- Sustainable Development Strategy "Ukraine- 2020"
- National Action Plan for Environmental Protection for 2011-2015
- National Plan on Realization of the Kyoto Protocol
- Strategy of National Security of Ukraine: "Ukraine in the Changing World"
- Resolutions by the National Council of Security and Defense of Ukraine covering issues of climate change, such as adaptation, greenhouse gas emissions, fire security, natural disasters and drinking water issues

The National Council of Security and Defense held several special sessions on environment, climate change and security, and considered the following issues: implementation of UNFCCC, 2007; floods in western Ukraine, 2008; actions on fire prevention, 2010; consideration of IPCC recommendations on GHG inventory, 2011; and water resources issues, waste management and environmental monitoring, 2013. The Council continuously monitors impacts of processes related to climate change and national security, checks implementation of its resolutions and ensures participation of its representatives in relevant interdepartmental commissions and working groups.

Two drafts of the National Adaptation Plan were prepared, but the lack of financial resources for implementation remains an obstacle to approval and implementation. In 2012 the Plan of Urgent Adaptation Actions was adopted and some of the measures were implemented. Nine regional workshops on development of adaptation plans were conducted in different oblasts of Ukraine. Research on climate change is continuing, and includes projections and the studies of impacts of climate change on energy, agriculture and public health.

UNECE has initiated preparation of a strategy on disaster risk reduction, and has established a dedicated joint expert group. UNECE plans to introduce this strategy to the countries. In addition, Ukraine plans to integrate the Sendai Framework for Disaster Risk Reduction 2015-2030 into its national policies.

Energy sector GHG emissions in Belarus declined from 73.48 per cent of total emissions in 1990 to 60.88 per cent in 2011, but still represent the lion's share of the total (Figure 20). Agriculture is next in both years – 22.02 per cent in 1990 and 26.87 per cent in 2011. The share of waste grew from 1.85 per cent in 1990 to 7.43 per cent in 2011.

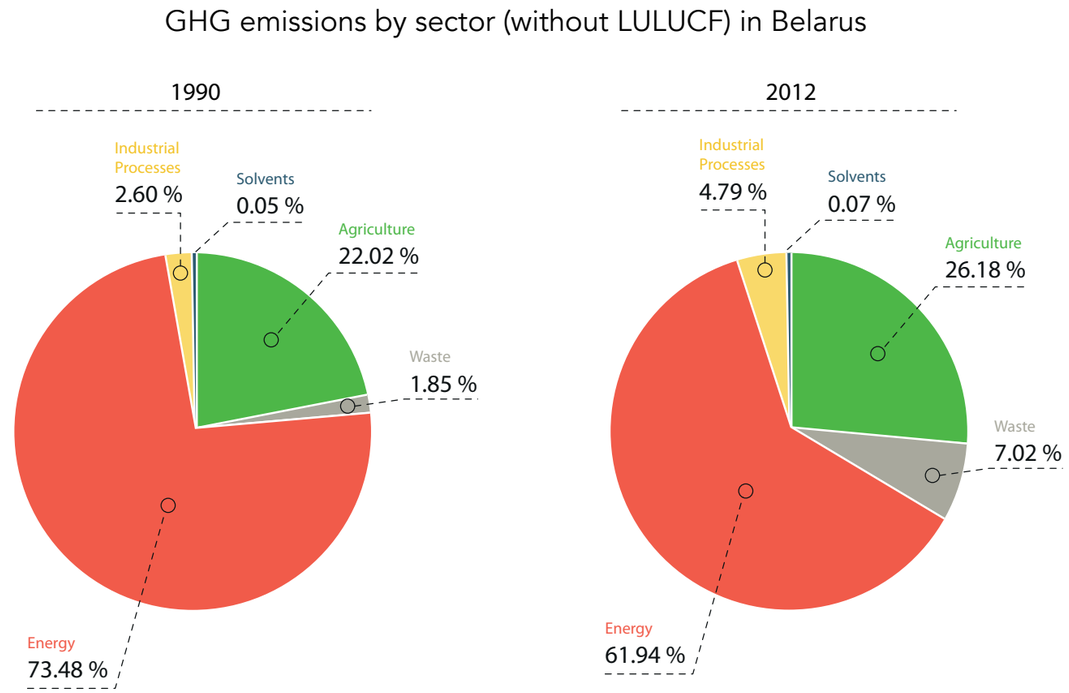
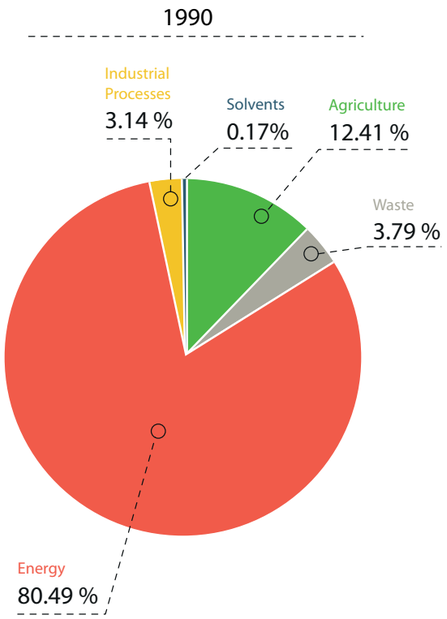
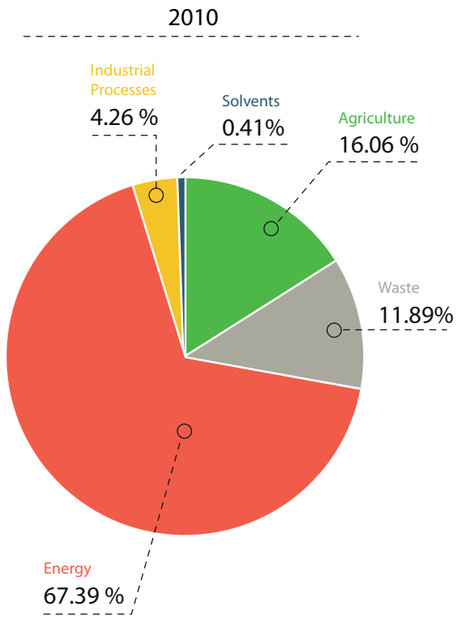


Figure 20: GHG emissions by sector (without LULUCF) in Belarus

In accordance with its ratified EU Association Agreement, the Republic of Moldova's Ministry of Environment, in wide consultation with stakeholders, has produced a Low Emission Development Strategy designed to place the country on a low-carbon, sustainable development path. This strategy provides a national context for mitigation efforts, identifies implementation procedures and timeframes, and includes provisions on monitoring, reporting and verification. It also provides for the quantification of the emissions reductions by mitigation measure, and specifies the financial requirements for implementation.

Between 1990 and 2005, energy sector GHG emissions in the Republic of Moldova declined as a proportion of overall emissions from 80.49 per cent to 65.00 per cent (Figure 21). Agricultural emissions grew from 12.41 per cent to 17.91 per cent over the same period. Waste emissions grew markedly – from 3.79 per cent to 11.78 per cent of total emissions.



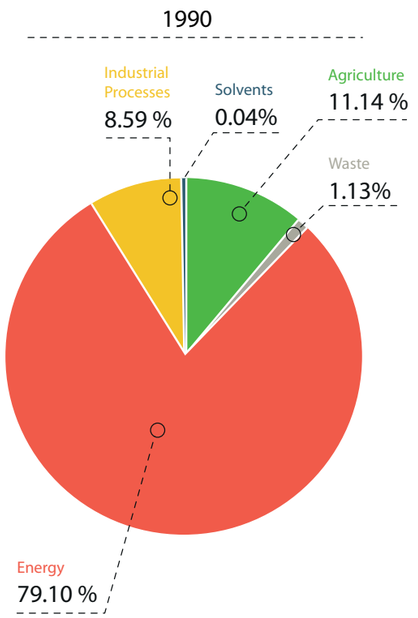


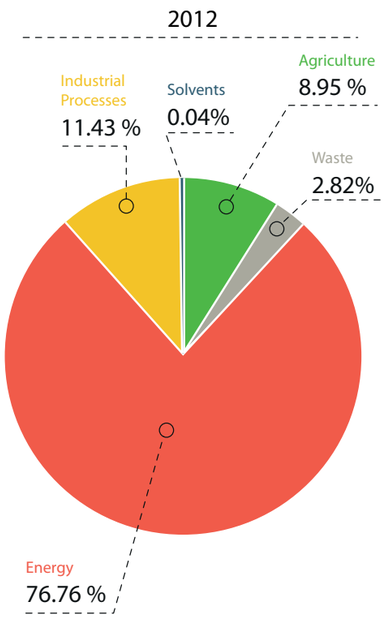
Source: UNFCCC.

Produced by Zoï Environment Network, 2015.

Figure 21: GHG emissions by sector (without LULUCF) in the Republic of Moldova

The emissions profile in Ukraine remained fairly consistent between 1990 and 2001, with the largest share coming from the energy sector (Figure 22). In 1990, the agriculture sector was second with 11.14 per cent of total emissions, while industrial processes accounted for 8.59 per cent. Those two sectors reversed positions in 2011 with agriculture accounting for 9.01 per cent and industrial processes accounting for 12.15 per cent of total emissions. Donbas remains the biggest emitter of GHG emissions, but the situation will change due to recent developments in that region, including in the economic sector. (See Figure 23)





Source: UNFCCC.

Produced by Zoï Environment Network, 2015.

Figure 22: GHG emissions by sector (without LULUCF) in Ukraine

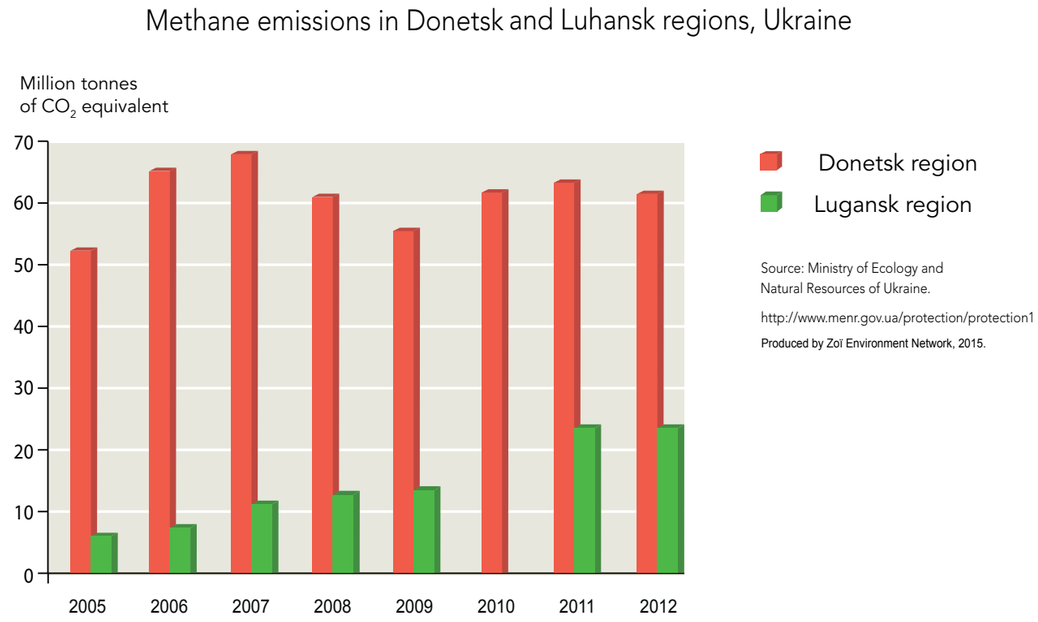


Figure 23: Methane emissions in the Donetsk and Luhansk regions of Ukraine

6. CLIMATE CHANGE AND SECURITY HOTSPOTS

Climate change and security hotspots are areas with ongoing tensions or environmental concerns where climate change is expected to undermine social or economic stability, threaten infrastructure or livelihoods, or compromise security by exacerbating political or social tensions, conflicts or instability.

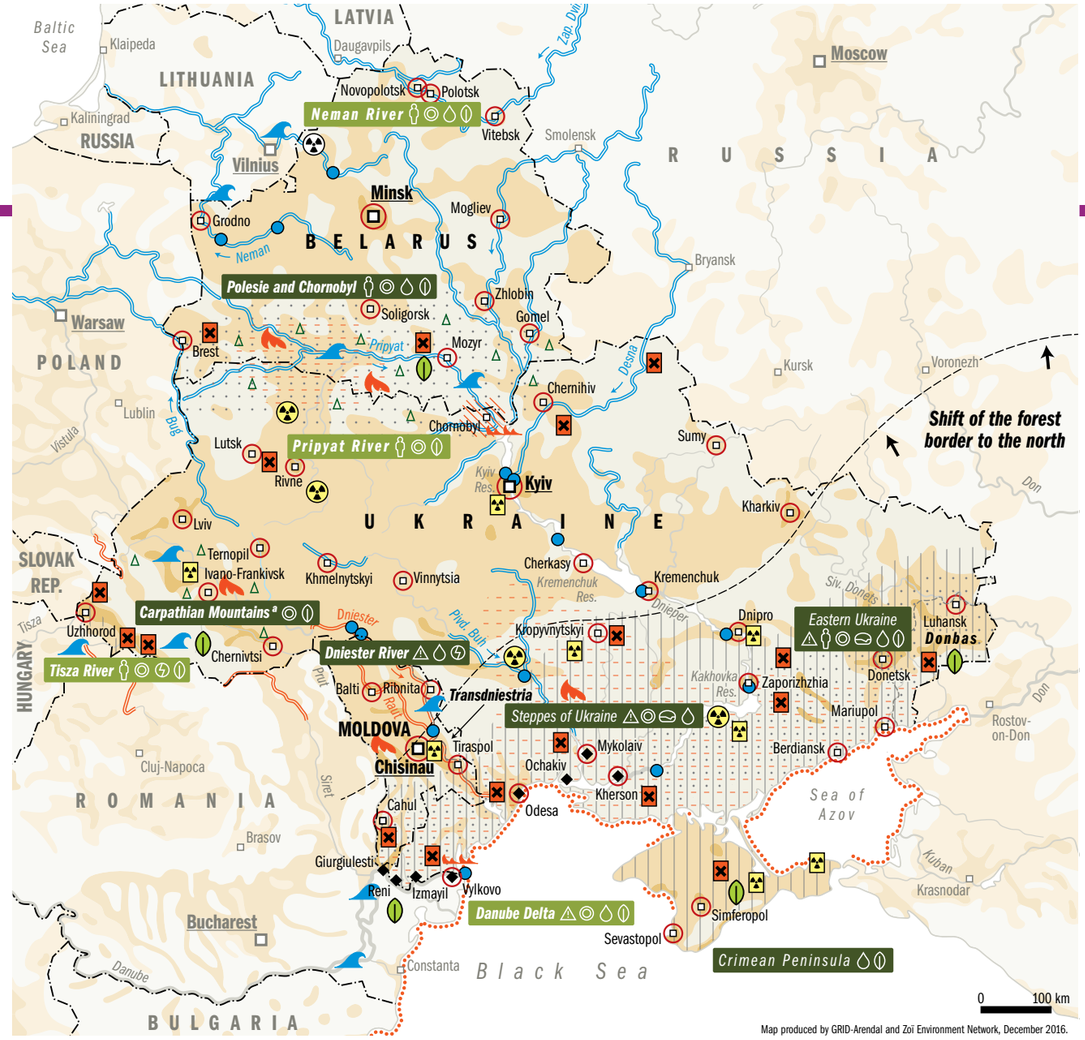
Defining climate change and security hotspots

This project identifies and assesses climate change and security hotspots across Eastern Europe, Central Asia and the Southern Caucasus. These hotspots are identifiable in geographic terms, and are characterized by ongoing tensions, environmental concerns or both. In each of these hotspots, climate change through one or more pathways is expected to undermine social or economic patterns, threaten infrastructure or livelihoods, or compromise security by exacerbating political or social tensions, conflicts or instability. Areas with weak institutions or lacking the effective mechanisms for transboundary environmental and security co-operation are especially vulnerable.

The analysis of hotspots, which has been discussed with stakeholders in the countries during several consultations, recognizes the value of natural resources both economically and in terms of security, and considers the tensions associated with the value of resources. Such tensions may arise from criminal activity conflicting with legitimate uses or from questions of who can use a resource, and how. How climate change may affect these situations is of particular interest.

The hotspots included here (Figure 24) reflect the judgement of the project analysts and the stakeholders as well as the outcomes of the national and regional consultations conducted in 2014 and 2016. The analysis considered the following:

- Existing or prospective vulnerability to climate change
- Existing instability or security risks
- Analytical conclusions regarding the connections between climate change and security
- Other existing political, socioeconomic and environmental factors



Map produced by GRID-Arendal and Zoï Environment Network, December 2016.

Climate change and security hot-spots in Eastern Europe

Republic of Belarus, Republic of Moldova and Ukraine

Areas with climate change and security risks by 2030

- High — Abc — Regional/transboundary hotspots
- Medium — Abc — National hotspots
- Urban areas and cities facing heatwaves, infection outbreaks, air and water pollution, fresh water scarcity, vulnerability of urban green zones

Category of security implication

- Social insecurity
- Human health insecurity
- Economic and livelihood insecurity, damage to infrastructure
- Food insecurity
- Energy insecurity
- Water insecurity, water resources scarcity
- Land degradation, biodiversity, cultural and natural heritage

Population density (inhabitants per km²)

5 — 50

Predicted change in annual river flow for 2071-2100 compared to 1961-1990

- more (+5 to +20%)
- no change/no information
- less (-5 to -10%)
- Storage of pesticides or fertilizers; flood contamination risks from pesticides/fertilizers
- Storage of radioactive waste
- Ports with risk potential
- Existing nuclear power plant
- Projected nuclear power plant
- Chornobyl Exclusion Zone
- Hydropower plant
- Water deficit (drinking water, and water for industry and irrigation)
- Soil erosion and degradation of soil productivity
- Desertification
- Fire-prone area
- Reed fires
- Risk of floods
- Forest degradation, declining spruce area
- Impacts on fauna and flora
- Shift of forest border
- Sea and coastal area: increase of sea level, salinization of coastal areas, changes of the coastline, soil salinization, deficit of safe drinking water, reduction of quality and diversity of fisheries
- [a] Carpathian mountains:
  - Shorter winters with less snow cover and higher temperatures - economic losses from tourism
  - Projected small hydropower stations that will likely affect the hydrology regime, biodiversity (including fish) and tourism
  - Projected increase in precipitation

Sources: Compilation of materials of European Environment Agency; ENVSEC projects on the Dniester and the Neman rivers; "Climate Change in Eastern Europe"; experts' opinion and analyses. The map was consulted with the participants of national consultations in the Republic of Belarus, the Republic of Moldova and Ukraine, as well as on the regional consultation on climate change and security.

Figure 24: Climate change and security issues in Eastern Europe

6.1. Regional/transboundary hotspots

Regional hotspots have regional security implications, and may extend across ecosystems in more than one country. The regional Eastern Europe hotspots include urban areas, the Carpathian Mountains, Polesie and Chornobyl, and five major waterways.

6.1.1. Urban areas

With their large population concentrations, urban areas are in some ways more vulnerable to the manifestations of climate change than other areas. In Belarus the main impacts of climate change in urban areas are heatwaves, infection outbreaks and air and water pollution. Cities with populations over 100 000 are classified as vulnerable areas with possible social security implications. National experts in the Republic of Moldova emphasize social problems, infrastructure, general vulnerability and air pollution as problems of large cities, such as Chisinau, Balti, Rezina, Soroca and Cahul. Rising temperatures are more likely to affect urban agglomerations in Belarus and northern-eastern Ukraine (IPCC, 2014a). Possible security implications are projected for large Belarusian cities, such as Navapolatsk, Polatsk, Mahilyow, Minsk, Vitebsk, Orsha, Maladzyechna, Lida, Hrodna, Baranovichi, Brest, Homyyel, Zhlobin etc., due to heatwaves, infection outbreaks and air and water pollution.

In Ukraine, the issue of cities and climate change is well understood. National experts identify heat islands within cities, and consider how extreme events may have heavier impacts in areas of higher population density. The main potential negative effects include heat stress; flooding; reductions in the area and species compositions of urban green areas; reductions in the quantity and quality of drinking water; an increase in the number of infections and allergic diseases; and disruptions of normal power operations and infrastructure systems. Certain major cities – Ternopil, Poltava, Donetsk, Lviv, Odesa, Khmelnytskyi and Uzhgorod – are subject to vulnerability assessments and the development of adaptation measures mainly within international initiatives, and as a part of preparation of a national adaptation action plan.

The climate change adaptation action plan for cities developed adaptation measures to the various adverse effects, and sorted the measures into seven groups based on expected effects, and within each group distinguished subgroups of recommendations by type – engineering, construction, architectural, economic, organizational and general.

With their high sensitivity to climate change and their population densities, cities are potentially more vulnerable to insecurities arising from climate-related events – heatwaves and floods in particular.

Green zones in cities and industrial areas contribute significantly to comfortable living conditions for urban populations, but these zones are under significant anthropogenic impacts (recreation, pollution from vehicles and industrial emissions, litter), so that they are particularly vulnerable to climate change. Adaptation in these zones relies on scientifically selected tree and shrub species that are stable in an urban environment, a system of harvesting to improve the sustainability of urban forests, and regulation of economic activities in the green zones.

The short and long-range risks in the Eastern Europe urban areas are high.

6.1.2. The Carpathian Mountains

The Carpathians Mountains extend about 1 500 kilometres across Central and Eastern Europe, and provide habitat for Europe's largest populations of brown bears, wolves, chamois and lynxes, and for more than one third of the continent's plant species. The Carpathians form a huge ecosystem that provides eco-corridors for numerous fauna and flora and are home to endemic species listed in the Red Book of Ukraine.

The Carpathian region has a high risk of flooding and thunderstorms (Figure 25), and is sensitive due to environmental, social and economic factors.

Regional climate change projections suggest more irregular rainfall and a warmer climate in the Carpathian basin. The Carpathian Mountains will experience an increase of 3.0°C in the north-western part and 4.5°C in the south during this century compared to the period 1961-1990 (CARPIVIA project). Most studies indicate an increase in winter precipitation and changes in snow cover. Regional studies also point to periods of lower precipitation in the summer resulting in lower summer river flows, while at the same time, extremely high precipitation over short periods of time is also expected in summers. This more intensive, short-duration precipitation will lead to increased risk of erosion and landslides. These processes will aggravate the risks of floods and increase the chances of damage caused by floods, and will in turn negatively affect water quality.

A small increase of winter precipitation and a significant decrease of summer precipitation are projected. Although the mean annual values of precipitation will remain almost constant, summer precipitation is projected to decrease by 20 per cent or more, and winter precipitation in most areas is expected to increase between 5 per cent and 20 per cent this century. These changes will have profound consequences for the environment, for the economy and for human health and well-being.

The Carpathian Mountains under climate change pressure

- Reduction of spruce areas, drying out of first and second generation of pine-trees
- Extreme weather events (strong rains, flash floods, etc.) followed by infrastructure damage, economic and human losses
- Increasing frequency and intensity of floods
- Decreasing of winter period and snow coverage and its stability, increasing winter temperature – economic losses from tourism
- Krasiya: Winter tourism centres, tourism industry losses, economic losses
- Loss of depth in small rivers
- Natural borders shifting north – changes in traditional agricultural lifestyle and business
- Ecological vulnerability and biodiversity losses, tensions due to competition for resources
- Urban areas and cities facing heatwaves, infection outbreaks, air and water pollution, fresh water scarcity; vulnerability of urban green zones
- Storage of radioactive waste
- Projected small hydropower stations could impact on biological diversity and touristic attractiveness

Source: Climate change in Eastern Europe (2011); expert opinion.

Figure 25: The Carpathian Mountains

In general, lower river discharges and drought periods as well as water scarcity events are expected to increase. Groundwater recharge is likely to decline, while more frequent droughts in summertime will reduce flows and result in water shortages. Less snow cover will impact both flooding and the deterioration of the water quality. On the other hand the number of floods in the mountains has increased in recent years, a trend that is expected to continue. Erosion and slope slides related to floods could increase social stress. Tonnes of litter in the landscape, in mountain riverbanks and in tourist areas make the environment less attractive and impede natural river flows, and may introduce toxics and biogenic hazards into the ecosystem.

The likely effects of climate change on forests, fauna and flora include shifts in species composition towards more drought-resistant trees at lower altitudes and increased vulnerability to pest and pathogenic damage and to fire. The tree lines will move upwards, and the northern limit of species will migrate northwards. The degradation of forests, the reduction of productive functions of forests, the reduction of volumes of wood and non-wood forest products (berries, mushrooms, medicinal raw materials) are foreseen. The deterioration of environmental reclamation and protective functions of forests and agroforestry plantations, including water protection and sanitation functions, is expected. Some species and communities might collapse, including those that are listed in the Red Book. Intensive illegal logging that covers whole of the Ukrainian Carpathians confirms the Carpathians as a climate change and security hotspot.

Seven countries cooperate under the Carpathian Convention on the Protection and Sustainable Development of the Carpathians to preserve the region from different environmental problems and to save this area with its unique nature, culture and heritage. Climate change is the most recent issue requiring a timely response by the countries. In this regard a dedicated Working Group under the Convention developed a Strategic Agenda on Adaptation to Climate Change in the Carpathian region, including thematic protocols referring to climate change issues while elaborating their programmes.

The Carpathians remain an area of concern due to their vulnerability to powerful floods and other extreme weather events that damage infrastructure and cause economic and human losses. Ecosystems and biodiversity of the mountain range are insecure, and winter tourism faces economic losses that may lead to livelihood insecurity.

The short and long-range risks in the Carpathian Mountains are high.

6.1.3. Polesie and Chornobyl

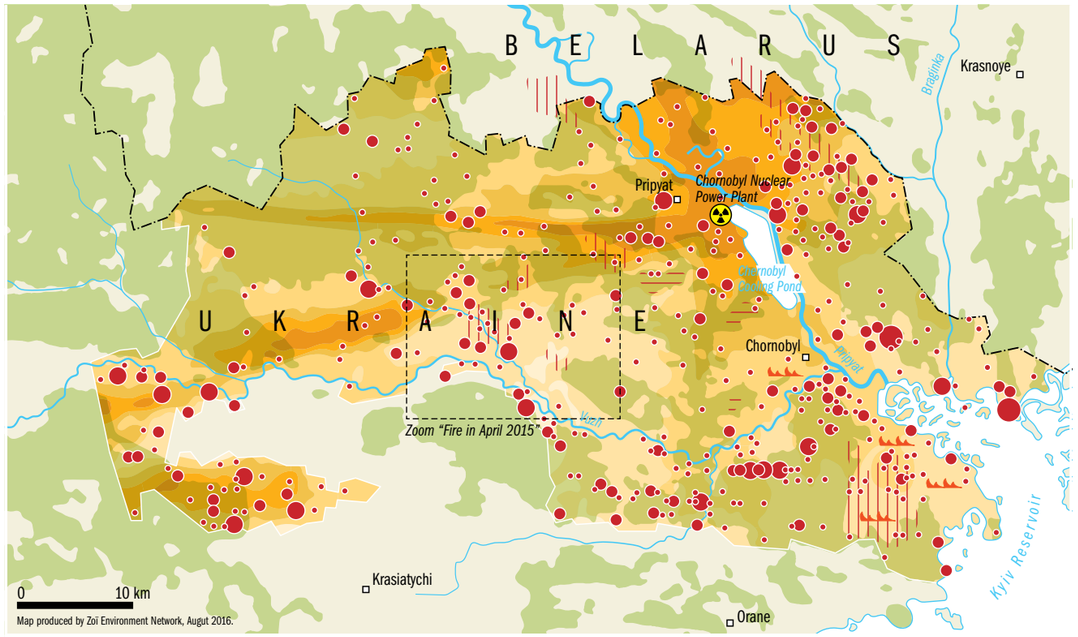
Polesie is a large natural and historic region in Eastern Europe. It is the largest forest area, and provides home to hundreds species of fauna and flora. Polesie starts near the Polish-Belarusian border, lying on the northern part of Ukraine and the southern part of Belarus and ending in Russia. (Figure 26) Large parts of the region were contaminated after the Chornobyl disaster and the region now includes the Chornobyl Exclusion Zone and Polesie State Radioecological Reserve in Belarus.

From the 1960s through the 1980s, Belarus converted much of its part of the Polesie to agricultural purposes by draining wetlands and changing the course of rivers. These and other water control measures damaged the natural ecosystems, eroded soils and started the process of desertification. In the face of more frequent and severe droughts and floods brought on by climate change, the area is alternately threatened by both too much and too little water. Flooding causes serious erosion and makes Polesie that much more vulnerable to subsequent droughts, and this cycle is likely to result in persistent desertification.

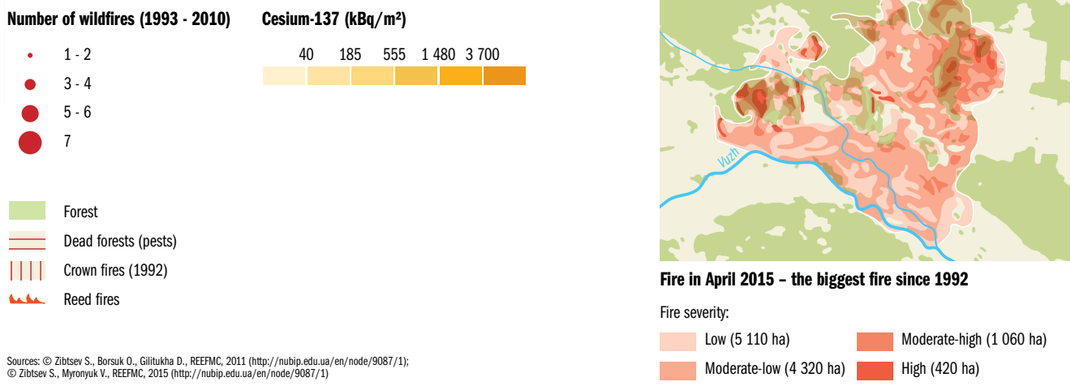
As an environment and security hotspot, Polesie shows evidence of climate impacts – increasing numbers of flood events affecting livelihoods; swamping in rivers and lakes; and decreasing numbers and diversity of fauna and flora. Northern and north-eastern parts of Polesie are vulnerable to fires and droughts due to temperature increases, the lack of precipitation and water deficits.

Climate change is most likely to figure in the future spread of radioactive contamination from the Chornobyl Exclusion Zone through changes in precipitation patterns and water regimes, and especially through the flooding that follows extreme rainfall events. Radioactive substances contaminate the rivers in the Chornobyl Exclusion Zone (mostly in the sediments). (Figure 26.) Droughts may also play a role by increasing the dryness of the soil and creating dust that moves easily through the environment. Moreover, high temperatures and drought in the Chornobyl forests will increase the risk of fires with the potential to spread radioactive contamination over larger areas and with consequences for human health. Additionally, forest productivity will decline and areas of forest coverage could decrease. A high level of contamination in forest food products, such as mushrooms and berries, affects food and human health security. The lack of regular environmental monitoring of the most contaminated areas undermines the capacity to provide timely warnings on emergency situations and to mobilize preventive actions.

The short and long-range risks in Polesie and Chornobyl are high.



Wildfires in the Ukrainian part of the Chornobyl Exclusion Zone



Sources: © Zibtsev S., Borsuk O., Gilitukha D., REEFMC, 2011 (http://nubip.edu.ua/en/node/9087/1);
© Zibtsev S., Myronyuk V., REEFMC, 2015 (http://nubip.edu.ua/en/node/9087/1)

Figure 26: Wildfires in the Ukrainian part of the Chornobyl Exclusion Zone

6.1.4. The Tisza River

The Tisza River is the longest tributary of the Danube, flowing for 966 kilometres through Ukraine, Romania, Slovakia, Hungary and Serbia. With a catchment area of more than 157 000 km², the Tisza River basin is the largest sub-basin of the Danube River basin, and is home to 14 million people including 1.25 million in Ukraine. (The catchment area within Ukraine is 12 777 km². The length of the river is 265 km.) The diverse landscapes of the basin support rich biodiversity and provide habitat for some species of flora and fauna no longer found in Europe, including the unique mayfly species – the "Tisza flower".

The Ukrainian part of the Tisza basin lies mainly in forested areas of the Carpathian Mountains (Figure 27) where the climate is moderately continental. As a mountain river in Ukraine, the Tisza is prone to flooding and to localized landslides mainly attributable to unsustainable forest practices. Typically, Tisza floods in Ukraine last from 2 to 20 days while larger downriver floods last as long as 100 days; 65 per cent of the floods in the basin occur between May and October. The number of floods has increased over recent decades. In the Zakarpatska oblast in western Ukraine the extensive flood protection system includes 319 km of embankments, as well as bank-strengthening structures, 766 km of river dams, regulated reaches, pumping stations with general pumping capacity of 108 m³/s and the ability to pump water from an area of 184 000 ha, and small reservoirs and ponds (which are not capable of handling floods). Hydropower stations in the Ukrainian part of the Tisza basin have an installed capacity of approximately 31 600 kW.

River engineering has reduced the length of the Tisza River and some of its tributaries, with a resulting loss of the natural floodplains and wetlands that regulate floods. These conditions exacerbated the extreme flooding in the Tisza River basin in recent years.

High water in 2000 caused an accident at the goldmine at Baia Mare in Romania near the border with Ukraine's Zakarpatska oblast. The pollution of the river with heavy metals and cyanide led to extensive fish deaths.

Institutional management and international co-operation within the basin are quite strong and contribute to adaptive capacity, and the countries of the basin have a long history of co-operation – the 1986 agreement on the protection of the Tisza and its tributaries, for example, and in 2000, the establishment of the Tisza Forum to address flood issues from a perspective in line with EU water policy. The 2010 flood and drought strategy in the Tisza River basin and the 2011 Integrated Tisza River Basin Management Plan were adopted.

At the same time the Tisza River basin is still considered a hotspot due to the number and magnitude of floods, including flash floods, and especially because it is a transboundary river (where every potential flood can affect the Ukrainian territories and neighbouring countries of the European Union). Flood events in Ukraine affect livelihoods and infrastructure in neighbouring countries, and the Tisza River provides a pioneering example of the implementation of effective flood prevention measures in Ukraine. The basin is considered an area with major biogenic and household contamination for both surface waters and groundwater.

The short range risks in the Tisza River basin are high, and the long-range risks are medium.

Vulnerability of the Tisza river basin to climate change

Places with the potential danger due to climate change

- Operating industrial enterprises
- Closed industrial enterprises
- Insufficient capacity of municipal wastewater facilities
- Collector system only; no wastewater treatment

Storage of pesticides or fertilizers

- Specific location
- General area

Pollution

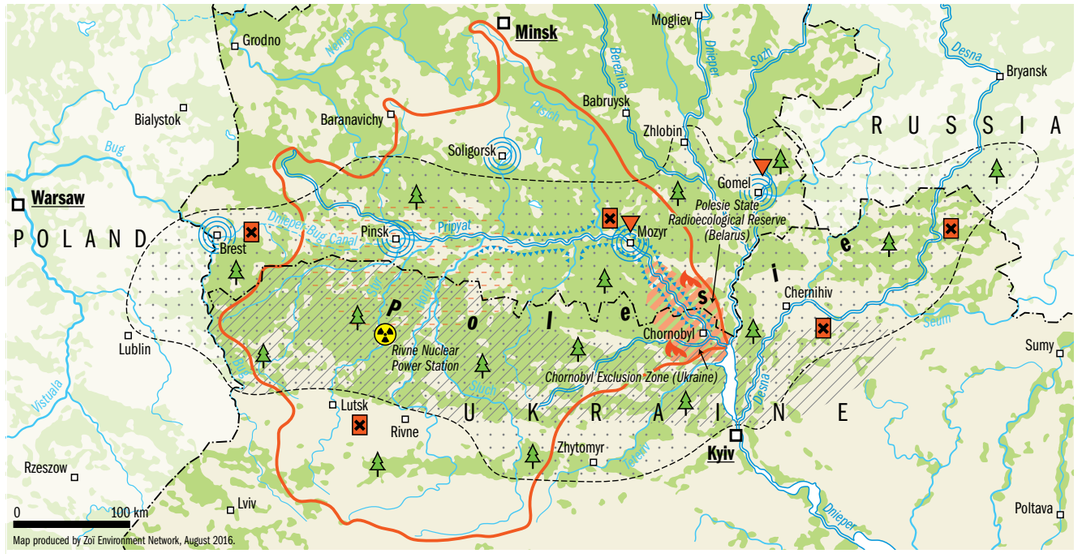
- Risk of pollution in case of floods
- Industrial waste pollution of groundwater due to floods and flash floods
- Problems with drinking water quality
- Priority areas for flood protection
- Invasive species
- Infrastructure damage, economic and human losses
- Tisza river floods
- Small and mid-sized hydropower stations
- Urban areas and cities facing heatwaves, infection outbreaks, air and water pollution, fresh water scarcity and problems with water quality; vulnerability of urban green zones
- Forest

Source: Experts' compilation of materials (http://climategroup.org.ua/wp-content/uploads/2013/07/resume_climatechange_ukr.pdf; http://nbuv.gov.ua/j-pdf/vnanu_2009_2_12.pdf; http://carpaty.net/?p=13468&lang=uk; http://climategroup.org.ua/wp-content/uploads/2015/02/ad_Uzgorod_City_A4.pdf; http://climategroup.org.ua/wp-content/uploads/2014/07/ukraine_cc_vulnerability.pdf).

Figure 27: The Tisza River basin

6.1.5. The Pripyat River

As the main tributary of the Dnieper, the Pripyat is itself one of the longest rivers in Europe –761 kilometres with a catchment area of 121 000 km² and an average annual discharge of 13 km³. The Pripyat is a transboundary river with 57 per cent of the river basin belonging to Ukraine and 43 per cent to Belarus (Figure 28).



Polesie and the Pripyat river

- Risk of floods
- Chornobyl Nuclear Power Plant Zone of Exclusion
- Forest and peat fires
- Degradation of black alder and ash forest; declining of spruce area and forest productivity, especially birches, pines, spruces, oaks and ashes
- Economic and income losses for local people
- Soil erosion and degradation of soil productivity
- Desertification
- Contamination by pesticides in case of floods
- Technogenic pollution in case of floods
- Fresh water deficit and health insecurity in urban areas
- Forest
- Basin border of the Pripyat river
- Polesie

Predicted change in annual river flow for 2071-2100 compared to 1961-1990

- more (+5 to +20%)
- no change

Sources: Ministry of Emergency Situations of the Republic of Belarus (http://chernobyl.gov.by/index.php?option=com_content&view=article&id=94&temid=30); State agency of Ukraine on exclusion zone management (http://dazv.gov.ua); experts' opinion.

Figure 28: Polesie and the Pripyat River basin

The Pripyat and its tributaries are characterized by a high frequency of flooding due to snow melt and high rainfall. On average, floods on the upper Pripyat happen every 2-3 years and over the last 50 years, 12 catastrophic floods have been recorded. These floods caused significant economic damage in both countries including the destruction of buildings and the flooding of settlements, factories and agricultural lands. People also lost their lives.

The upper Pripyat water is discharged in Ukraine and – through the Dnieper-Bug canal – in Belarus. The Vyzhevsky floodgate plays an important role, as it collects and transports water to the channel, and helps reduce the risk of flooding in Ukraine in high-water periods, but it also increases the flood risk for the Belarusian part of the system, including for the infrastructure of the channel. In low-water periods the upper Pripyat often lacks sufficient water to maintain good natural ecological conditions. As preventive measures ENVSEC projects initiated joint water management in the basin, developed a monitoring and emergency warning system, and helped Belarus and Ukraine prepare and adopt rules for the Beloozerskaya water system.

Concerns about the Rivnenska nuclear power station on the bank of the Styr River, a tributary of the Pripyat, led to a special project to assess the risks of floods in conjunction with a power station failure. As a result Ukraine adopted the latest European flood communication system in the power station: warnings are sent to residents in vulnerable areas via text messages.

Extreme events, such as floods, affect agriculture and food security, infrastructure and economic security, and livelihoods and life security, and can be considered as a security issue in the basin. In both the medium and long term, the risks in the Pripyat River hotspot fall between medium and high.

6.1.6. The Danube Delta

The Danube River is an international waterway that rises in Germany and flows 2 872 kilometres to the Black Sea. It is the longest and second largest river (after the Volga) in Europe. The total area of the basin is over 800 000 km², and is home to more than 80 million people. The population density is 102 people per km². Along its course, the Danube is a source of drinking water for about twenty million people. The Danube delta is shared by Romania, the Republic of Moldova and Ukraine (Figure 29), and occupies an area of over 5 000 km².

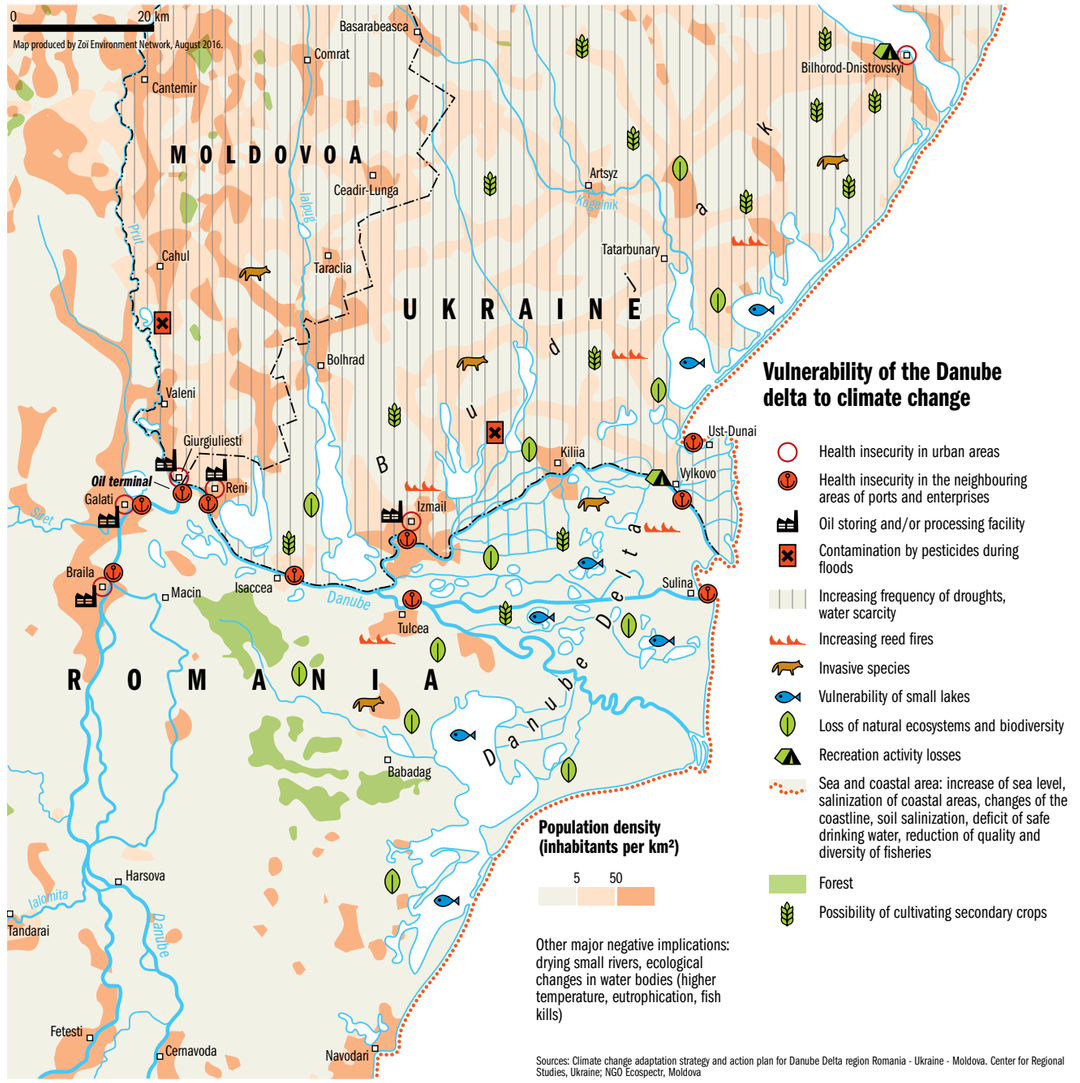


Figure 29: The Danube delta

A projected longer growing season may bring benefits to agriculture, and allow cultivation of a second crop or new crops with higher heat demands. Less rainfall in summer, however, may become a limiting factor for some staples. Water for irrigation and drinking water supply will have to be carefully managed as the quality of surface water and groundwater is expected to deteriorate. A warmer climate is likely to be beneficial for wintering birds, reptiles and large mammals but may negatively affect amphibians. Warmth-loving invasive species will have a competitive advantage over native ones – in recent years the jackal has moved further north.

Natural disasters have become more frequent in the Danube delta over the last 10 years. Frequent floods, long periods of drought, deteriorating water quality and declining fish reserves, and deterioration of unique biodiversity are the likely main impacts of climate change. In addition, numerous industrial sites, oil terminals and ports located in the Danube Delta increase the industrial risks and possible pollution of the area due to accidents.

The Danube Delta has an abundance of reed – an important economic and ecological species. From the economic point of view the collection of reed is a traditional activity and the main seasonal income for local people. Reeds are used for producing natural roofs, and have recently been promoted as a biological fuel. From the ecological perspective, reeds provide habitat for rare birds and contribute to the functioning of the wetland ecosystem. Hotter temperatures and unauthorized fires on nearby agriculture lands have damaged the reeds, and may spread to larger areas and affect infrastructure and private buildings.

The European Commission and the World Wide Fund for Nature conducted a special study of the Danube delta. The study considers vulnerability to climate change under various scenarios and forecasts, as well as the climate change impacts on economic sectors, human health and ecosystems. A bilateral Romanian-Ukrainian Danube delta Biosphere Reserve and basin-wide platforms are bringing together key stakeholders and users of natural resources. In addition, the International Commission for the Protection of the Danube River adopted a climate change adaptation strategy for the Danube basin in late 2012.

The Danube delta is considered an environment and security hotspot due to a combination of negative impacts on livelihood, threats to the health and lives of people due to floods, changes in the unique biodiversity of the delta, as well as disputed economic development. The economic condition in the area makes the situation even more complicated: high unemployment, low average income and old dysfunctional infrastructure impede the development of agriculture, fisheries and other sectors, and climate change may increase tensions in the region.

Both the short-term and long-term risks in the Danube delta are medium.

6.1.7. The Dniester River

The Dniester River rises in Ukraine, flows into and through the Republic of Moldova – where it forms the boundary with Transdniestria – and returns to Ukraine where it drains into the Black Sea near Odesa (Figure 30). The length of the Dniester River is 1 362 kilometres, with a basin area over 70 100 km^2. The average annual discharge is 310 cubic metres per second.

The Dniester waters support significant economic activities – mining, oil refineries, chemical plants and other industry, hydropower, textiles and agriculture – and also supply drinking water for Odesa (a city of 1 million people), Chisinau and other cities and settlements in the basin.

Climate models predict a significant decrease of water resources in the Dniester basin including the lower tributaries in the Republic of Moldova, some tributaries in the Vinnytsia region and all the tributaries in the Odesa region, though in the short term the run-off will be increased by 20 per cent. Warming will lead to instability of the snowpack and a decrease in the flow of melt water. Higher water temperatures and lower oxygen levels are likely to result in ecosystem changes and the degradation of drinking water supplies. More floods are projected for the area.

Ukraine benefits from receiving electricity from the Novodnistrovsk hydropower station, located close to the Ukrainian-Moldavian border, while there have been concerns in the Republic of Moldova that hydropower operations may have affected biodiversity in the Republic of Moldova, and that flows in the spring are too low, too cold and of insufficient quality to support the spawning of fish. Furthermore the new power generating unit of the hydropower station is about to be launched. In Ukraine there have been concerns about possibly deteriorated water quality downstream of the Republic of Moldova and of damage to biodiversity in the lower Dniester, particularly in Odesa.

Joint management and protection on the part of the countries sharing the Dniester would help avert disputes between the parties, reduce economic losses and damages, and provide for more effective adaptation to further climate change. In 2012 the countries signed the "Treaty between the government of the Republic of Moldova and the Cabinet of Ministers of Ukraine on co-operation in the field of protection and sustainable development of the Dniester River basin", but the treaty is not yet in force, pending ratification by Ukraine's parliament, and moving ahead with implementation is difficult in the absence of ratification. The Transdniestrian conflict makes the process of negotiation on the joint management of the basin more difficult.

Dniester river basin vulnerability to climate change

Projected changes in run-off 2021-2050 vs 1971-2000

- no change
- less (-5 to -20%)
- Water deficit (drinking water, and water for industry and irrigation)
- Soil erosion and degradation of soil productivity
- Areas particularly vulnerable to floods
- Storage of radioactive waste
- Forest
- Sensitive wetland, floodplain and riverside forest ecosystems
- Impact on fish and wildlife populations and habitats, invasive species
- Hydropower plants
- Impacts of increased average temperature and summer heatwaves on ecosystems
- Urban areas and cities facing heatwaves, infection outbreaks, air and water pollution, fresh water scarcity, vulnerability of urban green zones
- Sea and coastal area: increase of sea level, salinization of coastal areas, changes of the coastline, soil salinization, deficit of safe drinking water, reduction of quality and diversity of fisheries
- Basin border of the Dniester river

Source: ENVSEC project "Reducing vulnerability to extreme floods and climate change in the Dniester river basin".

Figure 30: The Dniester River basin

The Dniester suffers numerous ecological problems that can be exacerbated by climate change to a degree that brings new security issues to the countries' economies and affects livelihoods. The problems include erosion by water, degradation of riverbanks, inadequate and declining water quality, a deficit of water resources, eutrophication, loss of biodiversity in aquatic ecosystems, diminishing biological resources and deterioration of the already poor forest cover. Inadequate water management can leave downstream users with insufficient resources for their needs. Also water scarcity could initiate internal population movements, mainly from the arid villages to the towns. Potential intersectoral or transboundary disagreements regarding the management of water resources may arise as a consequence of the increased stress that climate change puts on the river basin and its ecosystem.

Both the short-term range and long-term risks in the Dniester River hotspot are high.

6.1.8. The Neman River

The Neman River rises in central Belarus about 55 kilometres southwest of Minsk, and flows into Lithuania defining a short stretch of border between the two countries on its way to the Baltic Sea (Figure 31). The Neman also forms a 116-kilometre border between Lithuania and Russia's Kaliningrad oblast. The river basin occupies almost 100 000 km^2, about 35 per cent of which lies in Belarus.

Vulnerability of the Belarusian part of the Neman River basin

- Machine-building
- Chemical industry
- Constructing materials production
- Food processing industry
- Light industry
- Pulp and paper industry
- Hydropower plants
- Projected nuclear power plant
- Agriculture
- Fish industry
- Recreation
- Issues of drinking water quality
- Forest
- Basin border of the Neman river

Predicted change in annual river flow for 2071-2100 compared to 1961-1990

- more (+5 to +20%)
- no change

Source: ENVSEC project "Management and climate change adaptation in the Neman river

Figure 31: The Neman River

Research conducted by the Belarus Department of Hydrometeorology between 1961 and 2010 showed an increase in annual air temperature, an increase in winter rainfall and a decrease, and earlier onset of spring flood run-off. Some of the forecasts suggest that annual temperature is likely to increase by 1.4-1.7°C by 2050, with more of an increase in winter and less in summer. The run-off is projected to increase up to 40 per cent in winter, and will sharply increase the risk of flooding in the upper part of the basin, as well in Russia's Kaliningrad region downstream. Maximum flow reduction could be up to 10-20 per cent.

Large industrial and agricultural enterprises account for the high use of Neman water. Belarus operates 10 small hydropower plants on the river, and Lithuania operates 32. The operations of a nuclear power plant, which could be launched as soon as 2018, could increase the risk of possible impacts on the water regime through water withdrawals for cooling, and may increase the temperature in the river through the discharges of warmer water. Some experimental calculations showed that the average annual consumption of water in the river Vilija will be only 0.2 per cent of the annual volume of river flow. It followed that the negative impact of water withdrawal by the nuclear power station on the ecosystem of the river Vilija will be minimal, local and barely noticeable.[48] In periods when river flow is lower than normal, both the withdrawals and the discharges may be problematic.

The higher air temperatures are likely to increase water temperatures as well. Higher water temperatures will affect water quality by decreasing the content of dissolved oxygen in summer and increasing general mineralization. The expected increase in the number and intensity of extreme weather events will likely come with the damages associated with droughts and flooding.

Heavy rains, droughts, late frosts and floods are projected as the main climate change impacts in the basin. All these impacts will have further implications for the water-agriculture-energy nexus, and may result in damage to infrastructure with economic losses including the loss of livelihoods. A comprehensive study on the vulnerability of ecosystems and the agriculture, forestry and industry sectors to climate change was conducted, and a Strategic Framework for Adaptation to Climate Change in the Neman River Basin was published in 2016 as part of a joint project of UNECE and UNDP within the ENVSEC framework. Within the same project, a technical protocol on co-operation in the protection and use of the water resources of the transboundary Neman river basin between the Ministries of Environment of Belarus and Lithuania was negotiated and sent for consideration to relevant authorities in both countries.

In the medium term, the risks in the Neman River hotspot fall between medium and high, and in the long term, the risks are medium to low.

6.2. National hotspots

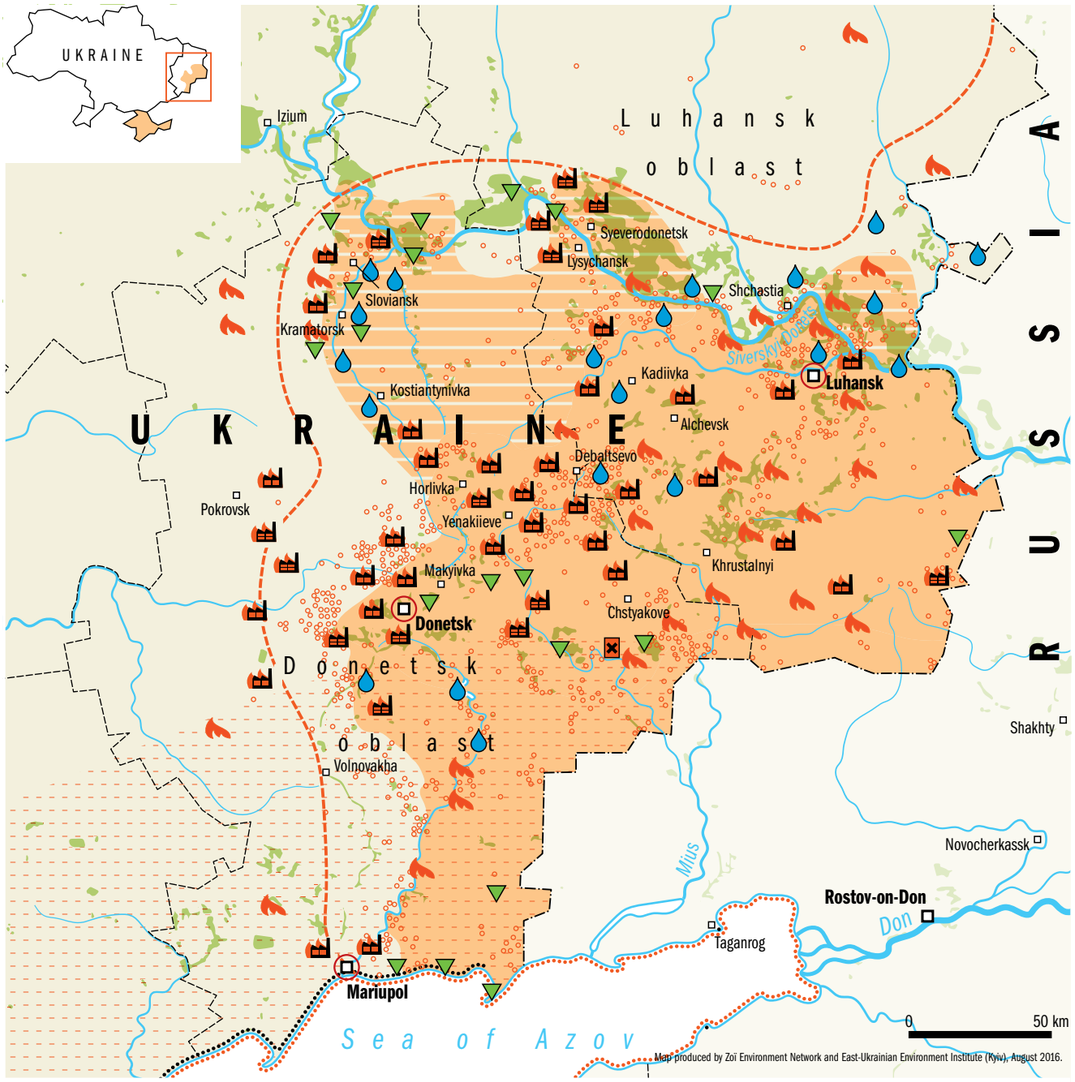
All of the Eastern Europe hotspots that are designated as national rather than regional are in Ukraine – Eastern Ukraine, the steppes and the Crimean Peninsula. The climate change and security hotspots that involve Belarus and the Republic of Moldova are all regional in scope.

6.2.1. Eastern Ukraine

The Donetsk oblast occupies only 4.4 per cent of Ukraine's territory, but accounts for more than half of the country's coal reserves and production of steel, coke and pig iron, and has about 300 deposits of mineral resources. The area is home to more than a thousand enterprises in the mining, metallurgical and chemical industries, the energy sector and heavy machinery. About 78 per cent of the industry in Donbas – an industrial region known for coal and metals – may be considered environmentally hazardous. The major harmful air emissions include carbon dioxide, ammonia, methane and sulphur dioxide. In 2009 methane emissions in the oblast totalled 350 000 tonnes, or about 42 per cent of the total emissions in Ukraine.

Industrial emissions in the Donetsk oblast contribute to warming, and the oblast also experiences the negative effects of climate change on agriculture and food security (Figure 32). In addition, sea level changes in the Azov-Black Sea system are expected to cause coastal erosion. In its 2008 State of Environment Report, the State Department for the Environment in the Donetsk oblast identified "pollution of air and river basins, the accumulation of industrial and household waste, and the need to adapt to climate change" as its most urgent priorities in the region. From 2009 through 2012 Donetsk oblast had official support for 25 joint implementation projects under the Kyoto Protocol, with a total volume of 33 million tonnes of carbon equivalent, but when the Kyoto process was stopped, all joint implementation projects were frozen.

48 *Assessment of the Environmental impact of the Nuclear Power Station, p.406, http://dsae.by/dadvfiles/000042_918921_3.rar*



Eastern Ukraine environmental deterioration due to conflict

Damage to industry with likely environmental consequences

- Reported disruption of specific industrial operations at factories, coal mines, etc. (interruption of gas or energy supply, logistics, damage to infrastructure) with potential environmental impact
- Widespread impact on soil and agricultural land, water and electricity* supply

*In areas with the interruptions of electricity supply, the potential risks include instantaneous release of gases accumulated in coal mines during the interruptions, as well as increasing water-level in mines leading to the contamination of groundwater, i.a., with toxic and radioactive substances

Armed conflict background

- Territory under separatist control
- Territory formerly under separatist control
- Areas of concentrated fighting, 2014/15
- National borders
- Oblast (provincial) borders

Direct impact on the environment and water supply

- Damage to protected areas
- Disruption of water supply communications
- Major forest fires
- Storage of pesticides or fertilizers; contamination by pesticides in the event of flooding
- Desertification
- Urban areas and cities facing heatwaves, infection outbreaks, air and water pollution, fresh water scarcity; vulnerability of urban green zones
- Sea and coastal area: increase of sea level, salinization of coastal areas, changes of the coastline, soil salinization, deficit of safe drinking water, reduction of quality and diversity of fisheries
- Erosion of the coastal line

Vegetation and water systems

- Forests
- Rivers and lakes
- Water supply canals

Sources: official information, media reports, expert data and assessments, direct interviews.

Figure 32: Eastern Ukraine environmental deterioration due to conflict

The developments in Eastern Ukraine have had adverse effects on the environment of the Donetsk and Luhansk regions. One of the most dangerous aftermaths in Eastern Ukraine is the higher risk of environmental pollution from affected industrial enterprises. Direct damage to industrial infrastructure and equipment, and emergency shutdowns due to destruction and lack of raw materials, energy supplies and electricity lead to higher risks of negative impacts on the environment of the region. Some cases may result in emergency peak emissions and the release of hazardous substances; others have a more lasting impact on the environment as treatment efficiency decreases and low-quality raw materials are used.

The large number of affected industrial enterprises were production facilities such as coke smelters, steel plants, oil refineries, chemical production facilities and thermal power stations, all of which are potentially highly hazardous to the environment.

Throughout the conflict in Eastern Ukraine electricity shutdowns at coal mines have been repeatedly documented. In several instances, disruptions in electricity supply to pumping stations and water removal systems resulted in complete flooding of mines, the overflow into nearby areas and the contamination of groundwater.

As a result of mine flooding and spills of fuels and lubricants (which often happens in the conflict zone), there is an increasing risk of soil contamination. The presence of land mines and unexploded ordnance in some areas makes it impossible to use these areas for farming. Given that arable land in the Donetsk region, for example, is about 64 per cent of its territory, such actions can lead to a significant drop in the quality of agricultural production and farming land degradation and, alongside climate change impacts, can significantly increase social and environmental risks.

Water utilities and infrastructure have been affected. The infrastructure at several pumping stations, transmission and distribution networks was damaged at Seversky Donets-Donbass canal, which supplies water to most of the Donetsk region. Such events may lead to drinking water shortages in Eastern Ukraine, which experiences water shortages even in time of peace, and may contribute to the deterioration of sanitation in the region.

Since it is difficult or impossible for forestry enterprises and emergency services to adequately operate in the conflict zone, there has been a significant rise in the average size of wildfires, and as a result of combat, an increase in the number of fires as well. Nature reserves in Donbass are being affected by the construction of fortifications and the cutting of forest plantations and shelterbelts, increasing the risk of degradation of agricultural land. This process can also affect territories of adjacent Ukrainian oblasts - Zaporozhye, Dnepropetrovsk and Kherson.[49]

The developments in Eastern Ukraine and the political instability in the region hinder the implementation of climate mitigation activities and effectively eliminate the potential for adaptation. In combination with the climate change impacts, the conflict aftermaths can escalate migration and exacerbate the socioeconomic situation in the Donetsk and Luhansk oblasts and neighbouring regions of Ukraine and beyond.

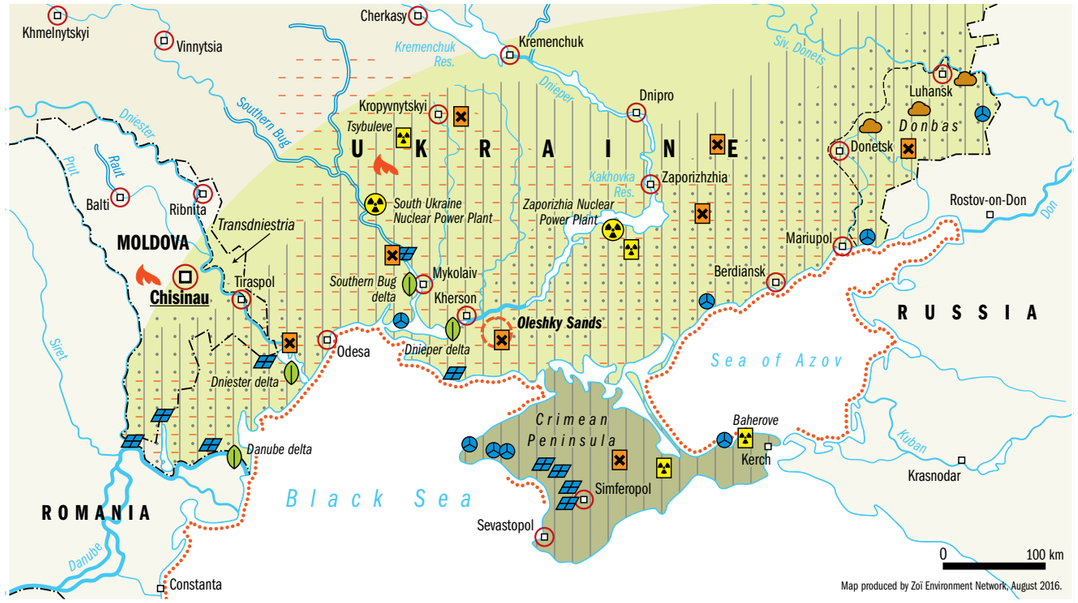
The short and long-term risks in Eastern Ukraine are high.

6.2.2. The Steppe zone of Ukraine

The Ukrainian steppes – the other most important stretch of south-eastern Ukraine – suffer from faster and more severe climate change than other areas. The National Academy on Agrarian Science of Ukraine reports that in recent dec-

49 www.toxicremnantsofwar.info/ukraine-conflict-environmental-damage-and-pollutants

ades increased temperature and decreased rainfalls in the south-eastern part of Ukraine have caused more frequent and severe droughts, and that there was no rainfall for four to five months during the spring-summer period. Scientists stress that a continuation of the existing climate trends over the next 20 years is a real threat to intensive agriculture not only for the steppe zone, but also for more than half of the arable land in the country and almost two thirds of the area of the modern forest-steppe zone of Ukraine (Figure 33).



The steppe zone of Ukraine

- Storage of radioactive waste
- Storage of pesticides
- Nuclear power plants under potential danger
- Wind park
- Solar park
- Fire-prone area
- Changes in ecosystems
- Fog and smog
- Urban areas and cities facing heatwaves, infection outbreaks, air and water pollution, fresh water scarcity; vulnerability of urban green zones
- Losses of rich and unique steppe species of fauna and flora
- Water deficit (drinking water, and water for industry and irrigation)
- Soil erosion and degradation of soil productivity
- Desertification
- Sea and coastal area: increase of sea level, salinization of coastal areas, changes of the coastline, soil salinization, deficit of safe drinking water, reduction of quality and diversity of fisheries

Predicted change in annual river flow for 2071-2100 compared to 1961-1990

- more (+5 to +20%)
- no change / no information

Figure 33: The Steppe zone of Ukraine

Climate change forecasts for the steppe zone for the next decades include:

- A loss of 15-21 million hectares of arable land
- A shortfall in annual gross yield of 24-40 million tonnes of high-quality grain and other food crops traditionally produced in steppe zones
- Uncontrolled human migration from the steppe zone to the more northern regions of the country
- Increased heat discomfort in the south

A protected areas network in the area strives to create conditions for the survival of hundreds of steppe plant and animal species. Also, as a party to the United Nations Convention to Combat Desertification, Ukraine elaborated and approved a national plan to combat land degradation and desertification, which, among other things, assists in protecting an area vulnerable to climatic changes.[50]

Significant losses of arable land in an intensively farmed region can lead to food and livelihood insecurity, and because of the importance of the agricultural sector to the economy and the established pattern of human migration, economic insecurity may spread. As the main driver for this pressure, climate change represents a serious element in the prospective security of the region.

The short and long-term risks in Steppes zone of Ukraine are high.

6.2.3. The Crimean Peninsula

The Crimean Peninsula (including the Black Sea and the Sea of Azov areas) is characterized by increasing high temperatures, water deficits, intensifying extreme events, desertification and salinization, exacerbation of infectious diseases as well as a high level of water and energy consumption. The northern part of the Crimean Peninsula faces challenges with water for irrigation from mainland Ukraine and possible conflict over energy due to the recent political developments. A lot of Ukraine's protected areas are located in the Crimean Peninsula; the management and protection of these areas are vitally important.

The short and long-term risks in the Crimean Peninsula are high.

The following table summarizes the climate and security hotspots described in this chapter.

Table 1: Summary of climate change and security hotspots

Hotspot	Political, socioeconomic and environmental conditions and trends	Climate change hazard	Security implications	Security risk: 2030/ 2050-2100	Adaptive capacity
Regional/transboundary hotspots					
Urban areas	High concentration of population, industry, infrastructure High consumption and production of electricity Dependence on centralized power, water and gas supply Air pollution, water supply issues Poor waste management Disturbances in sources of potable water	Higher temperatures, heatwaves and cold waves Extreme events Wildfires	Livelihood insecurity Human health insecurity, including health risks in areas in proximity to Chornobyl Economic insecurity Damage to infrastructure	High/High	Medium and/or Strong High education level of population, public awareness growth potential New construction activities that allow for implementation of engineering and architectural measures to mitigate climate change

50 http://zakon5.rada.gov.ua/laws/show/271-2016%D1%80?test=4/UMfPEGznhhimv.ZiDejg1WHI4p.s80msh8Ie6

Hotspot	Political, socioeconomic and environmental conditions and trends	Climate change hazard	Security implications	Security risk: 2030/ 2050-2100	Adaptive capacity
Regional/transboundary hotspots					
The Carpathian Mountains	Mountainous cross-border region Relatively low level of economic development Low population density, preserved authenticity of ethnographic groups Developed mining activity in foothill areas Headwaters of the Tisza and Dniester, and tributary of the Danube rivers	Increase in ambient air temperature and extremely hot tempera-tures, especially in the sub-Carpathian region Changes in precipitation patterns - increase in trans-Carpathian and decrease in sub-Carpathian region	Land degradation and loss of cultural and natural heritage as well as biodiversity disruptions and possible losses Livelihood insecurity Damage to infrastructure Economic insecurity, due to decreasing tourist attractiveness	High/High	Medium Ongoing international co-operation (Carpathian Convention) Operating cross-border biosphere reserves Development of activities dependent on natural resources
Polesie and Chornobyl	Cross-border region Low population density, and mostly rural population Change in natural landscapes due to reclamation	Increase in adverse weather events Frequent droughts	Human health insecurity Economic insecurity Water insecurity Land degradation, losses in biodiversity, and natural heritage, including increased fire risks and degradation of forests Growing risks of climate-related disasters in Polesie	High/High	Low in Chornobyl Medium in Polesie Positive changes of agriculture efficiency
The Tisza River	High population density, unemployment, labour migrants Low official income level, vulnerable social groups	Slight temperature increase, significant precipitation growth and recurrent floods and mud slides	Economic and livelihood insecurity including losses from flooding Social insecurity (tensions) Human health insecurity, and/or human losses Energy insecurity Land degradation, includ-ing additional pressure and competition over scarce natural resources	High/ Medium	Medium Developed river basin management plan and sustainable development of the Tisza River basin High potential regarding financial support

Hotspot	Political, socioeconomic and environmental conditions and trends	Climate change hazard	Security implications	Security risk: 2030/ 2050-2100	Adaptive capacity
Regional/transboundary hotspots					
The Pripyat River	Cross-border region with joint river water management Low population density, and mostly rural population Change in natural landscapes due to reclamation	Increase in adverse weather events Frequent droughts	Human health insecurity Economic and livelihood insecurity Land degradation, losses in biodiversity and natural heritage including through increased fire risks	Medium/ Medium	Medium Management projects in Pripyat River basin Positive changes in agriculture efficiency
The Danube Delta	Compact transboundary region Rich diversity in biology, landscape and culture High unemployment and relatively low incomes	Insignificant changes in temperature, precipitation and sea level rise	Economic insecurity and livelihood, including loss of sources of income and increased poverty or diminished well-being Water insecurity and additional pressure and competition over scarce natural resources Land degradation, biodiversity disruptions and possible losses, as well as an increase of invasive species, and loss of cultural and natural heritage Social insecurity including increased social tension and conflict	Medium/ Medium	Medium Strategies on adaptation to climate change for the Danube River and Delta Operating biosphere reservoirs
The Dniester River	Existing security concerns, frozen conflict Mostly rural High unemployment, labour migration	Increase in recurrence and intensity of floods along with rise in aridity Increase in frequency of extreme temperatures	Water insecurity Energy insecurity Social insecurity	High/High	Medium or Weak Difficulties of co-operation with Transdniestria on adaptation Development of joint basin management plan in progress

Hotspot	Political, socioeconomic and environmental conditions and trends	Climate change hazard	Security implications	Security risk: 2030/ 2050-2100	Adaptive capacity
Regional/transboundary hotspots					
The Neman River	Cross-border Belarusian and Lithuanian region Multi-ethnic region Significant biological and landscape diversity Agricultural and industrial specialization Use of surface water for water supply needs	Increase in temperature Reduction in precipitation Increased droughts and floods	Human health insecurity, and human losses Economic and livelihood insecurity, including economic threats to agriculture Land degradation, biodiversity losses and losses in natural and cultural heritage, including threats to species and forests Water insecurity	Medium/ Medium	Medium Cross-border co-operation International projects regarding climate change adaptation Centralized state power, government efficiency Low adaptation potential of meadow and forest ecosystems

Hotspot	Political, socioeconomic and environmental conditions and trends	Climate change hazard	Security implications	Security risk: 2030/ 2050-2100	Adaptive capacity
National hotspots					
Eastern Ukraine	Existing security concerns and ongoing insecurity in certain areas of Donetsk and Luhansk regions Areas suffering from water shortages Industrial concentration and high urbanization level Fires at industrial sites	Risks of biodiversity loss, soil and wind erosion and desertification Reduction of agricultural land Public health insecurity	Economic and livelihood insecurity, damage to infrastructure, as well as industrial safety risks Food insecurity Social insecurity including increase in social tensions and migration Water insecurity Land degradation and risks of biodiversity loss, desertification, reduction of agricultural land Human health insecurity	High/High	Weak Low adaptive capacity in the region
The Steppe zone of Ukraine	Water scarcity, desertification, soil and bank erosion, sea level rise Loss of biological diversity High agricultural development Losses of unique and rare biological species	Increased aridity Rising temperatures Heatwaves and cold waves	Social insecurity Economic and livelihood insecurity Food insecurity Water insecurity	High/High	Weak and/or Medium Strong economic potential Protected areas still used for biodiversity conservation
The Crimean Peninsula	Existing security concerns Inadequate level of own energy, water, food Multinational region with intensified social tension Recreational economic specialization Significant natural diversity	Increased aridity Rising temperatures Decline in rainfall Increase in extreme events Sea level rise Seasonal floods	Land degradation and losses of biodiversity, losses in cultural and natural heritage Water insecurity, additional pressure and competition over scarce natural resources	High/High	Weak Lack of consolidation of the society Energy, water, food supply dependence

7. CONCLUSIONS AND RECOMMENDATIONS

According to current climate research covering the Eastern Europe region, the climate conditions here have changed over the last 2-3 decades and more changes are projected for the coming years. Temperature has increased everywhere, with greater increases during the winter periods leading to milder winters and less snow cover. Precipitation is varying seasonally within the norms, but anomalies in some areas bring flash floods, heavy rains and storms. The number, frequency and magnitude of extreme weather events with significant economic losses and consequences for human health and livelihoods have increased altogether.

Rising temperatures and disruptions in the hydrological cycle caused by variations in precipitation patterns are likely to affect the agriculture and water resources of Eastern Europe, and the increase in droughts and floods – already in evidence – will make matters worse.

Agriculture is an important economic sector in all three countries of Eastern Europe, and is the one most likely to be affected by climate change. Agriculture will experience both positive and negative impacts: as the warming trend continues, countries can expect improved growing conditions and the potential to introduce new crops that require warmer conditions; the shifting of natural zones will introduce new agriculture zones; but floods, droughts, storms, hail and early spring frosts are likely to increase agricultural losses too. Accelerating and more widespread desertification will affect arable lands, and farming risks in some places will increase. Soil erosion, degradation and salinization will decrease the areas of effective agriculture. Southern and south-western parts of Belarus, including Polesie, almost all territory of the Republic of Moldova, southern and south-eastern parts of Ukraine, including the northern Crimean Peninsula and other steppes, will likely be impacted.

Water resources are already under pressure and the issue will be raised due to climate change. An increase in average run-off for all major rivers of the region is projected in the near future, but water use will increase as well. Catastrophic floods, mud slides, bank erosion, flooding of settlements will be likely observed in the basins of the Zapadnaya Dvina, Zahidnyy Bug, Neman, Pripyat (Belarus); Dniester, Prut, Reut (the Republic of Moldova); Dniester, Prut, Pripyat, Danube, Tisza (Ukraine).

The overuse and inefficient and irrational management of water resources can lead to water deficits, especially in urban and industrial areas, such as Navapolatsk, Polatsk, Mahilyov, Minsk, Vitebsk, Orsha, Malazhyechna, Lida, Hrodna, Baranovichy, Brest, Homyel, Zhlobin (Belarus), Chisinau (the Republic of Moldova); major cities, Donbas and south-eastern industrial area (Ukraine). The quality of drinking water may decline. The storage of water can be a matter of dispute both within and between countries (for instance, the transboundary Dniester River).

The Eastern European countries stand to lose some of their rich biological diversity (forests, fauna, flora), and natural ecological corridors may be compromised. Countries may experience the loss of rare species, the displacement of natural boundaries and reductions in the value and productivity of forests. Areas under risks are western and southern areas, Polesie (Belarus); river basins (the Republic of Moldova); the steppe-forest zone, the Carpathians, Polesie, the Danube delta, the Crimean Peninsula (Ukraine). More frequent forest fires will bring both economic losses and increased health risks (when originating in the areas contaminated by Chornobyl fallout, for example).

The energy sector remains one of the major GHG emitter in three countries and requires additional attention in coming decades, including implementation of such measures as diversification of energy resources and adaptation to new challenges. The economies of the region are so energy-intensive and dependent on imported energy that the development of domestic energy sources is essential to the economic development that can help the countries maintain stability. Energy independence is one of the targets for national security in Ukraine. In the light of recent negotiations on climate change prevention, as well as green economy development, countries of Eastern Europe announced their plans on energy efficiency, development of low-carbon economies / technologies, applying energy-saving technologies, as well as an active development of renewable energy resources (energy of sun, wind, water). The forerunners of such changes will become major cities and industrial zones (both in terms of production and energy supply), among those are Minsk, Svetlogorsk, Belozersk (Belarus), Chisinau, Balti, Dubasari, Costesti (the Republic of Moldova), Donbas, Chervonograd, the Carpathians (Ukraine).

Humans – the main and richest resource for prevention and adaptation activities, as well as the main contributor to global warming – will be negatively affected by climate change. Deterioration of people's health due to infections, cardiovascular diseases and heat stress is likely to get worse. Livelihoods of people will be disrupted by extreme events. Poverty may remain at the same level or increase. Existing social problems and new ones caused by climate change will strengthen some of the existing social tensions, and may bring new tensions and impact on national security.

Some of the heavy, energy-intensive industries developed in the Soviet era are located in densely populated areas that are environmentally and socially stressed. These industries are crucial to the existing economies, and provide employment in places with few alternatives. Restructuring these industries and diversifying the economies require significant financial resources, and the countries may not be able to respond effectively and in time to the challenges of climate change. While adequately addressing global threats, new global negotiations and requirements for a greener economy may thus bring new challenges to economies and their capacity to modernize and optimize their facilities.

The capacity to respond to climate challenges also depends on political and economic stability. Overall improved geopolitical stability is necessary for the region to be able to mobilize resources to address climate threats that are not necessarily at the top of the countries' political agendas. Conflicts, active or protracted, are expected to worsen the situation.

All issues listed above will and already do create new challenges for all sectors, and impact on the livelihoods and security of people. Acceleration in any part of the water-agriculture-energy nexus will have direct or indirect impacts on other sectors and finally will affect security – be it food or water, energy, human health or insecurity within hotspots.

There are numerous ways that Eastern European countries can act together with the international community to better understand, monitor, mitigate and adapt to the security aspects of risks related to climate change. The table below summarizes the current regional priorities as identified with stakeholders in the regional consultation meeting. The priorities coincide with the general priorities of the Environment and Security Initiative vis-à-vis climate-related issues, which can guide some of the specific interventions.

Table 2: Climate change and security issues and recommendations in Eastern Europe

Hotspot	Security implications and risks related to climate change	Recommendations	Target group
Regional/transboundary hotspots			
Urban areas	Livelihood insecurity Human health insecurity, including health risks in areas in proximity to Chornobyl Economic insecurity Damage to infrastructure	**General** • Adapt leading sectors (in this region) to climate change to avoid economic losses and to increase the resilience to climate change • Identify and monitor urban environmental threats, and assess the costs of non-action • Review and update technical documents, regulations and permits for buildings and construction in light of climate change • Take projected climate change conditions into consideration in urban development plans • Promote and provide state and private insurance schemes for climate-related risks • Provide training and capacity-building for decision makers and staff in local administrations and other relevant authorities on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security and adaptation measures • Establish and expand urban green spaces that will help people deal with heatwaves **Industry** • Restore and renovate infrastructure and industrial facilities • Renovate and modernize industrial facilities and processes in light of low-carbon economy developments **Water management** • Further strengthen monitoring and maintenance of centralized water supply and sewer systems to ensure rational water use, and sufficient water quality to protect public health • Conduct strict monitoring of water and food quality, especially after extreme events that could destroy or interrupt the supply systems **Energy** • Diversify, control and optimize energy use, and promote energy-efficiency and low-carbon processes	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society
The Carpathian Mountains	Land degradation and losses in cultural and natural heritage, as well as biodiversity disruptions and possible losses Livelihood insecurity Biodiversity disruptions and possible losses Damage to infrastructure Economic insecurity, due to decreasing tourist attractiveness	**General** • Promote green tourism and maintain local culture while strengthening adaptive capacity • Develop and implement comprehensive public awareness campaigns on potential climate change and security implications and adaptation measures • Develop modelling, mapping, monitoring and forecasting of hydrometeorological and hazardous events to support preparedness and to provide a system of timely early warning • Protect and increase the area of forests for flood prevention and mitigation • Continue efforts to conserve biological diversity and maintain ecological corridors to increase ecological resilience, and apply ecosystems-based approaches to respond to climate change and security implications • Adopt and implement the provisions of the EU Water and Flood Directives and the Directive on Habitat • Adapt leading sectors to climate change to avoid economic losses and increase the resilience to climate change • Promote and provide state and private insurance for climate-related risks **Industry** • Review and update technical documents, regulations and permits for buildings and construction in light of climate change • Ensure inventory and monitor active and dormant industrial facilities, and create protected zones around them **Water management** • Assess the regulatory frameworks for small hydropower stations in light of the impacts on water resources, biodiversity and tourism • Conduct water availability forecasts for the Carpathian rivers for effective water management and planning	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society

Hotspot	Security implications and risks related to climate change	Recommendations	Target group
Regional/transboundary hotspots			
Polesie and Chornobyl	Human health insecurity Economic insecurity Water insecurity Land degradation, losses in biodiversity, and natural heritage, including increased fire risks and degradation of forests Growing risks of climate-related disasters in Polesie	**General** • Develop modelling, mapping, monitoring and forecasting of hydrometeorological and hazardous events to support preparedness and to provide a system of timely early warning • Conduct programmes on prevention of forest, agricultural and peat fires in contaminated areas, provide constant monitoring, and strengthen local capacities for responding to fires • Adapt leading sectors to climate change to avoid economic losses and increase resilience • Conserve and restore water bodies and support biological diversity • Monitor invasive species of flora and fauna • Conduct preventive measures and strengthen capacities to prevent peat fires • Promote and provide state and private insurance schemes for climate-related risks • Provide training and capacity-building for decision-makers and staff in local administrations and other relevant authorities on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures **Industry** • Renovate and modernize industrial facilities and processes in light of green and low-carbon economy developments, apply new climate-smart technologies and practices, and promote sustainable development **Health** • Consider appropriate measures within the health care sector with special attention to potential radiation risks and increasing temperatures	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society

Hotspot	Security implications and risks related to climate change	Recommendations	Target group
Regional/transboundary hotspots			
The Tisza River	Economic and livelihood insecurity including losses from flooding Social insecurity (tensions) Human health insecurity, and/or human losses Energy insecurity Land degradation, including additional pressure and competition over scarce natural resources	**General** • Develop modelling, mapping, monitoring and forecasting of hydrometeorological and hazardous events to support preparedness and to provide a system of timely early warning • Adapt leading sectors (in the basin) to climate change to avoid economic losses and increase the resilience to climate change • Adopt and implement the provisions of the EU Water and Flood Directives and the Directive on Habitat • Promote and provide state and private insurance schemes for climate-related risks • Protect and increase the area of forests for flood prevention and mitigation • Provide training and capacity-building for decision-makers and staff of local administrations and other relevant authorities on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures **Water management** • Implement integrated water resources management, and further strengthen transboundary co-operation • Prevent negative industrial impacts on water resources and ecosystems	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society

Hotspot	Security implications and risks related to climate change	Recommendations	Target group
Regional/transboundary hotspots			
The Pripyat River	Human health insecurity Economic and livelihood insecurity Land degradation, losses in biodiversity and natural heritage including increased fire risks	**General** • Adapt leading sectors (in the basin) to climate change to avoid economic losses and increase the resilience to climate chang • Promote and provide state and private insurance schemes for climate-related risks • Control and take preventive measures for forest and peat fires • Prevent negative industrial impacts on water resources and ecosystems • Protect and increase the area of forests for flood prevention and mitigation • Conserve and restore water bodies and support biological diversity • Provide training and capacity-building for decision-makers and staff of local administrations and other relevant authorities on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures **Water management** • Implement integrated water resources management, and further strengthen transboundary co-operation • Develop modelling, mapping, monitoring and forecasting of hydrometeorological and hazardous events to support preparedness and to provide a system of timely early warning **Health** • Consider appropriate measures within the health care sector with special attention to potential radiation risks and increasing temperatures	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society

Hotspot	Security implications and risks related to climate change	Recommendations	Target group
Regional/transboundary hotspots			
The Danube Delta	Economic insecurity and livelihood, including loss of sources of income and increased poverty or diminished wellbeing Water insecurity and additional pressure and competition over scarce natural resources Land degradation, biodiversity disruptions and possible losses, as well as an increase of invasive species, and loss of cultural and natural heritage Social insecurity including increased social tension and conflict	**General** • Increase monitoring and take preventive measures against wild reed fires • Monitor invasive species of flora and fauna • Conserve biological diversity and maintain ecological corridors to increase ecological resilience, and apply an ecosystems based approach in adaptation to climate change • Conserve water bodies to maintain their role for flood prevention • Adapt leading sectors (in the basin) to climate change to avoid economic losses and increase the resilience • Adopt and implement the provisions of the EU Water and Flood Directives and the Directive on Habitat • Plan for the installation of bank fortifications to protect infrastructure against sea level rise • Promote and provide state and private insurance schemes for climate-related risks • Protect and increase the area of forests for flood prevention and mitigation • Provide training and capacity-building for staff and decision makers on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures **Water management** • Implement integrated water resources management, and further strengthen transboundary co-operation • Develop modelling, mapping, monitoring and forecasting of hydrometeorological and hazardous events to support preparedness and to provide a system of timely early warning • Prevent negative industrial impacts on water resources and ecosystems	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, wwcivil society

Hotspot	Security implications and risks related to climate change	Recommendations	Target group
Regional/transboundary hotspots			
The Dniester River	Water insecurity Energy insecurity Social insecurity	**General** • Further strengthen transboundary co-operation through the ratification of the 2012 Dniester Treaty (Treaty between the Government of the Republic of Moldova and the Cabinet of Ministers of Ukraine on Co-operation in the field of Protection and Sustainable Development of the Dniester River Basin) by Ukraine, and establish a river basin commission to implement the Treaty, including the development, adoption and implementation of a joint Dniester River basin management plan • Prepare for the implementation of the Strategic Framework for Adaptation to Climate Change in the Dniester River Basin (endorsed by Moldova and Ukraine in 2015) and proceed with putting the Strategic Framework into action based on its Implementation Plan (2017) • Adapt leading sectors (in the basin) to climate change to avoid economic losses and increase resilience • Promote and provide state and private insurance schemes for climate-related risks • Manage ecosystems to increase the area of forest cover, prevent forest destruction and illegal logging, restore and protect small rivers, prevent soil erosion and create a network of protected natural areas • Provide training and capacity-building for relevant staff and decision makers on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures **Water management** • Develop and extend the network of automated monitoring for providing online monitoring data, including for flood forecasting, preparedness and prevention of possible negative consequences, and provisions for early warning • Forecast and assess water availability, and install an automated system for transboundary management of the cascade of reservoirs to meet the needs of water and near-water ecosystems • Prevent negative industrial impacts on water resources and ecosystems	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture,energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society

Hotspot	Security implications and risks related to climate change	Recommendations	Target group
Regional/transboundary hotspots			
The Neman River	Human health insecurity, and human losses Economic and livelihood insecurity, including economic threats to agriculture Land degradation, biodiversity losses, natural and cultural heritage, including threats to species and forests Water insecurity	**General** • Adapt leading sectors (in the basin) to climate change to avoid economic losses and increase the resilience • Promote and provide state and private insurance schemes for climate-related risks • Protect and increase the area of forests for flood prevention and mitigation • Conserve and restore water bodies and support biological diversity • Monitor invasive species of flora and fauna • Provide training and capacity-building for staff and decision makers on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures **Water management** • Implement integrated water resources management, and further strengthen transboundary co-operation • Develop modelling, mapping, monitoring and forecasting of hydrometeorological and hazardous events to support preparedness and to provide a system of timely early warning • Prevent negative industrial impacts on water resources and ecosystems	Governmental institutions, local authorities, environmental agencies Particularly, ministry of energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society

Hotspot	Security implications and risks related to climate change	Recommendations	Target group
National hotspots			
Eastern Ukraine	Economic and livelihood insecurity, damage to infrastructure, as well as industrial safety risks Food insecurity Social insecurity including increase in social tensions and migration Water insecurity Land degradation and risks of biodiversity loss, desertification, reduction of agricultural land Human health insecurity	**General** • Support and strengthen monitoring of environmental threats in the region, including economic, political, and migration aspects • Conduct risk analysis and environmental risk assessments, and mitigate the effects of the developments in the Donetsk and Luhansk regions and climate change on natural resources • Implement preventive measures for forest and steppe fires and illegal cutting of forest plantations • Implement measures to improve access to drinking water • Provide training and capacity-building for staff and decision makers on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures **Industry** • Restore and repair infrastructure and industrial complexes in order to allay public health concerns, and increase the potential of the sector, aimed at removing additional climate change stressors (pollution prevention, rehabilitation of farming land and infrastructure, clean-up of industrial sites) • Repair and modernize industrial plants and processes in conformity with the principles of an eco-friendly and low-carbon economy; introduce new sustainable technologies and practices	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society
The Steppe zone of Ukraine	Social insecurity Economic and livelihood insecurity Food insecurity Water insecurity	**General** • Conduct a risk analysis for minimizing the impacts of climate change on natural resources and assess the environmental threats • Restore and renovate infrastructure and industrial facilities in order to avoid security implications related to human health, and to improve the capacity to respond to additional climate change stressors • Adapt leading sectors (in this zone) to climate change to avoid economic losses and increase resilience • Conduct assessments of climate change impacts and develop and implement adaptation measures in the agricultural sector • Promote and provide state and private insurance schemes for climate-related risks • Protect biodiversity to improve climate resilience • Conserve and maintain the unique steppes and desert • Increase capacities to control and prevent forest fires to avoid total desertification and dune development • Provide training and capacity-building for staff and decision makers on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures	Governmental institutions, local authorities, environmental agencies Particularly,ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and water services International organizations and donors Non-governmental organizations, civil society
The Crimean Peninsula	Land degradation and losses of biodiversity, cultural and natural heritage Water insecurity, additional pressure and competition over scarce natural resources	**General** • Develop modelling, mapping, monitoring and forecasting of hydrometeorological and hazardous events to support preparedness and to provide a system of timely early warning • Conduct monitoring and implement adaptive measures for preventing degradation and salinization of land and soil • Build fortifications for banks as preventive measures against sea level rise and bank erosion • Adapt leading sectors to climate change to avoid economic losses and increase resilience • Promote and provide state and private insurance for climate-related risks • Promote proper management and rational use of natural resources • Protect marine and mountain ecosystems to increase their resilience and maintain their biological diversity • Provide training and capacity-building for staff and decision makers on climate change in all related areas • Develop and implement comprehensive public awareness campaigns on climate change and security implications and adaptation measures	Governmental institutions, local authorities, environmental agencies Particularly, ministry of agriculture, energy, industry, health care systems, hydrometeorology, forest and wataer services International organizations and donors Non-governmental organizations, civil society

Note: Some priorities in the table (formulations for some were shortened) are in line with ENVSEC regional priorities and were selected from the Outcome Statement of the ENVSEC's Eastern Europe Regional Consultation Meeting, held in Minsk, Belarus on 8-9 September 2014 based on their assessed medium to high relevance of action on climate-related aspects.

RESOURCES

ON-LINE DATABASES:

United Nations Climate Change Newsroom: http://newsroom.unfccc.int/

International Commission for the Protection of the Danube River (ICPDR): https://www.icpdr.org/main/

UN Environment: http://www.unep.org/

Organization for Security and Co-operation in Europe (OSCE): http://www.osce.org/

Environment and Security Initiative (ENVSEC): http://www.envsec.org/index.php?lang=en

International Relief and Development (IRD): http://ird.si/en/

Conference on Trade and Development of the United Nations Statistics (UNCTAF Statistics): http://unctad.org/en/Pages/Statistics.aspx

Food and Agriculture Organization of the United Nations Statistics (FAOSTAT): http://faostat.fao.org/

Fund for Peace Fragile States Index: http://ffp.statesindex.org/

Human Rights Watch: http://www.hrw.org/publications

International Energy Agency: http://www.iea.org/

Organization for Security and Co-operation in Europe: http://www.osce.org/resources

European Environmental Agency: http://www.eea.com/

United Nations Refugee Agency: http://www.unhcr.org/

World Development Indicators: http://data.worldbank.org/data-catalog/world-development-indicators

World Governance Indicators: http://info.worldbank.org/governance/wgi/index.aspx

WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation: http://www.wssinfo.org

NATIONAL AUTHORITIES:

Ministry of Natural Resources and Environmental Protection of the Republic of Belarus: http://www.minpriroda.gov.by/

Ministry of Environment of the Republic of Moldova: http://mediu.gov.md/

Ministry of Ecology and Natural Resources of Ukraine: http://www.menr.gov.ua/

National Statistical Committee of the Republic of Belarus: http://belstat.gov.by/

National Bureau of Statistics of the Republic of Moldova: http://www.statistica.md/

State Statistics Service of Ukraine: http://www.ukrstat.gov.ua

Ministry of Emergency Situations of the Republic of Belarus: http://mchs.gov.by/

Civil Protection and Emergency Situations Service of the Republic of Moldova: http://www.dse.md

State Emergency Service of Ukraine: http://www.mns.gov.ua

Republican Centre for Hydrometeorology, Control of Radioactive Contamination and Environmental Monitoring (Hydromet): http://hmc.by

State Hydrometeorological Service of the Republic of Moldova: http://www.meteo.md

Ukrainian Hydrometeorological Center: http://www.meteo.gov.ua

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LIST OF VISUALS

GRAPHICS

TABLES

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