LATVIAN NATIONAL PLAN FOR ADAPTATION TO CLIMATE CHANGE UNTIL 2030

Ministry of Environmental Protection and Regional Development

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CONTENT

INTRODUCTION

The most rapid changes in climate parameters in the history of instrumental meteorological observations have been registered during the last decades. It is forecast that in the 21st century temperature will rise more rapidly than previously in the event of all assessed greenhouse gas (hereinafter – GHG) emission scenarios[1]. This will affect both the society as a whole and various industries and sectors of national economy.

Climate change, which is currently characterised by the increase in mean air temperature, high and low air temperature extremes, a rise in sea level, increase in the frequency of extreme precipitation, etc. in all regions of the world, is directly related to the human impact. Current climate change has resulted in increased concentration of GHG emissions in the atmosphere. In addition, if the concentration of GHG emissions in the atmosphere keeps increasing, this will lead to further increase in global air temperature and climate change. In turn, this will cause long-lasting changes in all areas of the climate system and increase the probability of the occurrence of various severe and irreversible impacts on humans and ecosystems.

As part of the United Nations (hereinafter – the UN) Framework Convention on Climate Change (hereinafter – the Convention), the Parties to the Convention, including Latvia, have agreed under the Paris Agreement of the Convention to limit the global average temperature increase to not more than 2°C above pre-industrial levels and to aim to limit the increase to 1.5°C, since this would significantly reduce risks and the impacts of climate change. Current actions to reduce GHG concentration in the atmosphere and to limit increase in global average air temperature are not sufficiently effective and therefore the global mean temperature continues to rise. Consequently, countries should adopt measures to improve their ability to adapt and build resilience to climate change and its consequences, and also benefit from the opportunities it presents.

Latvian National Plan for Adaptation to Climate Change until 2030 (hereinafter – the Plan) has been designed as a national-level long-term (for the period until 2030) development planning document. The Plan has been drawn up by taking into account Cabinet Order No. 210 of 7 May 2019, On the Government Action Plan for the Implementation of the Declaration on Activities Intended by the Cabinet Headed by Arturs Krišjānis Kariņš[2], and also in order to implement the provisions laid down in the Environmental Policy Guidelines 2014–2020[3], legislation of the European Union (hereinafter – the EU)[4] and the Paris Agreement[5]. The Paris Agreement stipulates that all Parties must be involved in climate change adaptation and implementation of the measures for adaptation to climate change. The development of the Plan is also requested by the EU Strategy on Adaptation to Climate Change[6]. The goal and objectives

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[1] IPCC Fifth Assessment Report (AR5), available online: https://www.ipcc.ch/report/ar5/

[2] Cabinet Order No. 210 of 7 May 2019, On the Government Action Plan for the Implementation of the Declaration on Activities Intended by the Cabinet Headed by Arturs Krišjānis Kariņš, available online: https://likumi.lv/ta/id/306691-par-valdibas-ricibas-planu-deklaracijas-par-artura-krisjana-karina-vadita-ministru-kabineta-iecereto-darbibu-istenosanai

[3] Environmental Policy Guidelines 2014–2020 approved by Cabinet Order No. 130 of 26 March 2014, available online: http://www.varam.gov.lv/lat/pol/ppd/vide/?doc=17913

[4] Regulation (EU) No. 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC, available online: https://eur-lex.europa.eu/legal-content/LV/TXT/?uri=CELEX:32013R0525

[5] Paris Agreement of the United Nations Framework Convention on Climate Change, available online: https://eur-lex.europa.eu/legal-content/LV/TXT/?uri=CELEX:22016A1019(01)

[6] EU Strategy on Adaptation to Climate Change, available online: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013DC0216&from=EN

of the Plan are closely linked to the UN 17 Sustainable Development Goals until 2030 and also the UN Sendai Framework for Disaster Risk Reduction 2015–2030.

Since the necessity of the Plan is stipulated internationally by the Paris Agreement and Regulation (EU) No. 525/2013 of the European Parliament and of the Council, the respective development planning document has been drawn up in compliance with Paragraph 6 of Cabinet Regulation No. 737, Regulations Regarding Development and Impact Assessment of Development Planning Documents, thus developing the Plan, to the extent possible, in compliance with the conditions laid down in the Cabinet Regulation with regard to the type of the policy planning document – the plan, while at the same time drafting it as a long-term planning document (for the period until 2030).

The Plan describes the climate change observed so far in Latvia and identifies adaptation solutions for various risks and opportunities related thereto. The measures are based on studies regarding the assessment of risks and vulnerability and identification of adaptation measures in six areas: landscape planning and tourism, biodiversity and ecosystem services, civil protection and disaster management, building and infrastructure planning, health and welfare, agriculture and forestry developed within the framework of the pre-defined project "Development of Proposals for National Adaptation Strategy, including Identification of Scientific Data, Measures for Adapting to Changing Climate, Impact and Cost Evaluation" of the European Economic Area (hereinafter – the EEA) Financial Mechanism 2009–2014 Programme "National Climate Policy". The selected areas cover all most vulnerable sectors which are exposed to climate change the most.

TERMS, CONCEPTS, ACRONYMS AND ABBREVIATIONS

TERMS AND CONCEPTS

Eutrophication	An overabundance of nutrients, for example, nitrogen and phosphorus, in water. Eutrophication is one of the main reasons for water quality deterioration. Algal blooms and a decrease in the oxygen content of the water are the most significant negative effects of eutrophication.
Ecosystem services	Material and non-material benefits provided by ecosystems that help ensure living conditions suitable for humans. For example, ecosystem services include food supply, water provision, flood regulation function, soil erosion and disease outbreak reduction function, and also non-material values.
Extreme weather	A natural phenomenon that is rare both at a particular place and time of year. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10^{th} or 90^{th} percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense.
Phenology	The sub-sector of biology which studies cyclic natural phenomena caused by the change of seasons and meteorological conditions.
Hydrograph	Chronological graphical representation of water flow rates. Usually, a hydrograph is prepared for a calendar year. For special purposes, hydrographs are prepared for a day or a few days if the aim is to analyse the flow rate fluctuations during the day. Likewise, graphical representation of a hydrograph is possible for several subsequent years in order to analyse long-term changes of flow rates. Measurement unit used in the graphical representation: cubic metres per second or litres per second.
Cost-benefit analysis	A systematic approach to economic analysis, assessing the strengths and weaknesses of various measures and their alternatives, in order to achieve significant benefits with more limited resources (investments). Costs and also benefits are monetarised.
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. Vulnerability (↑) = F [(exposure) (↑); (sensitivity) (↑); (adaptive capacity) (↓)]

Vulnerability assessment	A process that, according to priority, arranges climate change risks, focusing on the extent of harm thereof. Vulnerability assessment is a crucial indicator for the comparison of the impact of unfavourable impacts and damages. For example, heat waves are more affected by certain groups of population and the magnitude of these effects is characterised by vulnerability.
Cost-effectiveness	An indicator in the economic analysis depicting the relative cost and benefit ratio (actions).
Resilience	The capacity of a system and its elements to predict, perceive, adapt or recover from the consequences of catastrophic events in a timely and effective manner, including preservation, restoration or even improvement of the situation for basic structures and provision of functions.
Sensitivity	A measure of characteristics used to characterise the irritation response of the global climate system.
Heat waves	The number of days per year when the maximum daily air temperature of at least six successive days exceeds the maximum daily temperature of the reference period 90^{th} percentile values.
Disaster	The occurrence that has caused human casualties and poses a threat to human life or health, has caused harm or a threat to humans, the environment or property, and also has caused or causes significant material and financial losses and exceeds the daily capacity of the competent State and local government authorities to eliminate the disastrous effects caused by such occurrence.
Disaster management	Management and coordination of a set of preventive, response, remedial measures and also restoration measures taken to ensure the fulfilment of the civil protection tasks.
Climate extreme / Extreme climate events	Extreme weather lasting for a longer period of time, for example, a season, especially if during such period, for example, such precipitation level occurs which is regarded as extreme. Extreme weather is a natural phenomenon that is rare both at a particular place and time of year.
Climate change	Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use.

Effects of climate change	Indications of climate change, for example, changes in precipitation patterns, air temperature changes, changes in extreme weather conditions, etc.
Climate change risk	Risk of consequences caused by climate change. The risk of climate change characterises the probability of a threat (for example, flood or drought) and the severity of potential consequences caused thereby (injuries, damages, destruction of habitats, etc.).
Climate change scenarios	The climate change scenarios described in the Plan refer to projections on climate variables for the period up to 2100 in the territory of Latvia included in the report "Climate Change Scenarios for Latvia" prepared by the Latvian Environment, Geology and Meteorology Centre (LEGMC), based on the conditions forecast in the Representative Concentration Pathways scenarios of the IPCC Fifth Assessment Report (RCP 4.5 and RCP 8.5).
Climate indices	Any properties or phenomena of the atmosphere which together define the climate of a certain place (temperature, humidity, precipitation, etc.).
Climate system	A system where the main formation factors whereof are the energy flows that the Earth receives from the Sun. Climate forms in the lower atmosphere where the solar energy is dispersed and absorbed on the Earth, therefore interaction and processes between the atmosphere, hydrosphere, cryosphere, lithosphere and biosphere are significant in the formation of the climate system.
Climate reference period	A period of time used to assess the extent of climate change, to characterise climate variability, and also to compare the changes observed among various countries of the world in respect of the defined standard or reference climatic conditions. In order to assess the extent of long-term climate change, a reference period of 30 years is used in accordance with the World Meteorological Organisation standard (from 1 January 1961 to 31 December 1990).
Climate	Synthesis of weather conditions in a certain territory characterised by long-term statistics of meteorological elements of the respective territory (average values, dispersion, probability of extreme values, etc.).
Weather	Atmospheric condition at a specific moment in time, characterised by various meteorological parameters.

Precipitation	Any form of water particle (whether liquid or solid) that falls from the atmosphere and reaches the ground. Liquid forms of precipitation include rain, melted snow, snow, hail, drizzle, and also rarer forms of precipitation, for example, grains of snow and ice, needle ice and sleet.
Exposure	The impact of climate change upon society, infrastructure, natural systems and ecosystem services, cultural objects at a certain time and place.
Groundwater	All water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.
Adaptation to climate change	Adjustment to actual or expected climate change and its effects. The aim of adaptation in anthropogenic systems is to reduce or prevent harm or to benefit from favourable opportunities.
Adaptive capacity	The ability of a system, institution, human or any organism to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.
ppm (parts-per-million)	A measurement unit of gas concentration, volume ratio of one type of gas against other types of gas. 1 ppm = 0.0001% of the specific gas molecules in the air.

RCP (Representative Concentration Pathways) scenarios	The Representative Concentration Pathways scenarios represent various GHG emissions and concentration scenarios for the 21st century which also include aerosol and atmospheric pollutant emissions, and also the types of land cover and land use. Basically, 4 baseline scenarios are distinguished – RCP 2.6; RCP 4.5; RCP 6.0; and RCP 8.5. The Representative Concentration Pathways scenarios are used to simulate climate projections. Climate scenarios are generated by combining climate projections with additional information, for example, the existing climate. In turn, differences between the existing climate and climate scenarios are the corresponding climate change scenarios. RCP 2.6; RCP 4.5; RCP 6.0; and RCP 8.5 describe various versions for increase in radiation balance in the period from 1750 to 2100 and anthropogenic effects on the respective version of the total radiation increase. Among these four scenarios, there is one scenario for reducing emissions: RCP 2.6, two stabilisation scenarios – RCP 4.5 and RCP 6.0, and also one high-level emissions scenario – RCP 8.5. In the RCP 2.6 scenario increase in the radiation balance is forecast approximately until 2050 (3.0 W/m^2), followed by its reduction to 2.6 W/m^2 in 2100, while in 2300, the radiation balance of such scenario conforms to the present day. The forecast in the RCP 4.5 and RCP 6.0 scenarios is that the radiation balance will increase to the forecast level of each scenario (4.5 W/m^2 RCP 4.5 scenarios around 2100 and 6.0 W/m^2 RCP 6.0 scenarios around 2150) and afterwards will remain unchanged. However, in the RCP 8.5 scenario, the radiation balance increases until 2200 when it becomes stable at 12.0 W/m^2.
Risk identification	The process of risk detection, recognition and description is a screening measure and is regarded as a preparatory stage for the next stage of risk analysis.
Risk assessment	A multi-step process which includes risk identification, risk analysis and risk assessment.
Risk	A combination of the consequences of an occurrence (hazard) and the likelihood / probability thereof.
Greenhouse gases (GHG)	Greenhouse gases (GHG) are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit infrared radiation. Greenhouse gases consist of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6) nitrogen trifluoride (NF_3) hydrofluorocarbons (HFC) and perfluorocarbons (PFC).
Greenhouse gas (GHG) emissions	Discharge of greenhouse gases (GHG) into the atmosphere as a result of natural or anthropogenic processes.
Heavy precipitation index	Number of days per year when daily precipitation amount is above 10 mm.

Tropical nights	Number of days per year when daily minimum air temperature is above +20°C.
Water stock	One of the variables of water balance equation for a river basin characterising the amount of water accumulated within the catchment basin when evapotranspiration and run-off are deducted from precipitation in the calculations of water balance. Measurement unit: millimetres.
Vegetation period	The number of days per year between periods when the average daily air temperature of at least six successive days during the first and last year is +5°C.
Surface water	All inland waters and marine coastal waters.
Green infrastructure	A strategically planned network of natural or partially natural territories that can provide numerous and diverse ecosystem services. It may also include green spaces or blue spaces (if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. Green infrastructure covers both rural areas and urban areas. Adaptive capacity characteristic to nature is applied when using green infrastructure to reduce climate change.

ACRONYMS AND ABBREVIATIONS

UN	United Nations
AR5	Fifth Global Climate Assessment Report (AR5 – Fifth Assessment Report, 2014) developed by the Intergovernmental Panel on Climate Change (IPCC)
JSC	Joint stock company
Climate–ADAPT	European Climate Adaptation Platform, portal
NCA	Nature Conservation Agency
EEA NFM	European Economic Area and Norwegian Financial Mechanism
EC	European Commission
EU	European Union
HPP	Hydroelectric power plant
SPNT	Specially protected nature territory
GDP	Gross Domestic Product
IPCC	Intergovernmental Panel on Climate Change
Convention	UN Framework Convention on Climate Change
RSS	Rural Support Service
RDP	Rural Development Programme

UAA	Utilised Agricultural Area
LRATC	Latvian Rural Advisory and Training Centre
UL	University of Latvia
LSF	Joint stock company "Latvian State Forests"
LEGMC	State limited liability company "Latvian Environment, Geology and Meteorology Centre"
DGFRS	Development Guidelines for Forestry and Related Sectors for 2015–2020
NDP2020	National Development Plan of Latvia for 2014–2020
SEMS	State Emergency Medical Service
OECD	Organisation for Economic Co-operation and Development
Paris Agreement	Paris Agreement of the UN Framework Convention on Climate Change
Plan	Latvian National Plan for Adaptation to Climate Change until 2030
RCP	Representative Concentration Pathways, explained in further detail in section "Terms and Concepts".
CVD	Cardiovascular diseases or diseases of the circulatory system
GHG	Greenhouse gas
CHP	Combined Heat and Power plant
SPPS	State Plant Protection Service
MEPRD	Ministry of Environmental Protection and Regional Development
SFS	State Forest Service
NRP	National Research Programme
EPG2020	Environmental Policy Guidelines 2014–2020
SLLC	State Limited liability company
WG2	Intergovernmental Panel on Climate Change Working Group II which assesses climate change impacts, vulnerability and adaptation
WMO	World Meteorological Organisation

I. SUMMARY OF THE PLAN

Observations of climatic parameters in the world over a period of 100 years confirm the climate change. As it is globally, also in Latvia changes in climatic conditions have been identified during the baseline period both in terms of changes in the average values of meteorological parameters and changes in extreme values thereof. Over the last 50 years (in the period from 1961 to 2010), a steady rise in air temperature – both in terms of the mean and maximum and minimum air temperature values – has been observed in Latvia, similarly to elsewhere in the world. Mean air temperature values have increased by 0.7°C (1981–2010 compared to 1961–1990), while the annual minimum air temperature has increased by 1.9°C, but the maximum annual air temperature in Latvia on average has increased by 0.7°C. When analysing changes in air temperature values in the future, it can be concluded that the mean air temperature in Latvia will continue to rise.

Increase in total atmospheric precipitation is also observed in the territory of Latvia. The number of days with heavy and very heavy precipitation has increased accordingly by two and one days since 1961. It is forecast that the amount of precipitation and also the number of days with heavy and very heavy precipitation will increase in the future as well. By the end of the 21st century, the total amount of annual precipitation is expected to increase by 10–21% (approximately 80–100 mm). Throughout the seasons, the highest increase in the amount of precipitation is expected in winter and spring.

Analysis of previous climatic conditions and also the future climate change scenarios clearly demonstrates that trends in climate change will continue throughout the entire period of this century. Moreover, the most significant changes will affect the extreme values of climate parameters – weather conditions not characteristic to and extreme for Latvia will be a more frequent reality in the future. Changes in climate parameters and indices have an impact not only on natural capital (species, habitats, ecosystems) over time, but also on health, well-being, safety and economic activities of the population. Such risks as changes of seasons, including changes of the vegetation period, increased fire hazard, proliferation of pests and pathogens, tree diseases, expulsion of local species, entering of new species, spread of diseases of the respiratory system, spread of infectious diseases, heat strokes, flood caused by precipitation, wind surges, occurrence of disturbances in electricity supply, increased run-off, hydropower variations, reduction of frost, black frost, drying of soil, eutrophication, damages to infrastructures, overheating of equipment, decreased run-off during summer are anticipated as the most essential risks caused by climate change in Latvia.

In order to limit climate change, different action policies include objectives and measures for reducing greenhouse gas (GHG) emissions at international, European Union (EU) and national level. It is possible to curb climate change and its adverse effects in a long-term by reducing GHG emissions. The more countries succeed in implementing measures to reduce GHG emissions in a broader and more timely manner, the lesser will be the negative impact of climate change that requires adaptation.

Certain measures for adaptation to climate change in order to reduce climate change risks and to benefit from the possibilities of climate change are included in the existing action policies; however, a comprehensive, coordinated policy and implementation of additional measures are necessary to improve climate resilience of Latvia, while promoting the development and competitiveness of Latvia.

The Plan has been prepared by taking into account the experience of different European countries in terms of adaptation to climate change risk management and planning of adaptation to climate change. In Latvia, the Plan builds on the cycle for ensuring adaptation to climate

change (Figure 1) that provides for the assessment of climate impacts, vulnerability and risks; adaptation planning; implementation of adaptation measures; monitoring and evaluation.

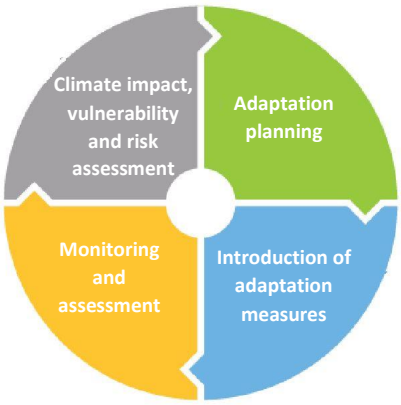

Figure 1. Cycle for ensuring adaptation to climate change

The development of the Plan is based on the analysis of the current climate change in Latvia and climate change scenarios for the period until 2100 and also the assessment of climate change impacts and risks carried out in Latvia in 6 (six) areas: building and infrastructure planning, civil protection and disaster management, health and welfare, biodiversity and ecosystem services, agriculture and forestry, tourism and landscape planning. The Plan defines the main goal of adaptation to climate change and 6 (six) strategic objectives, 14 (fourteen) action directions and 89 (eighty-nine) measures.

The principal objective of the Plan is to reduce the vulnerabilities of the population, national economy, infrastructure, buildings and nature of Latvia to climate change impacts and to promote the use of opportunities derived from climate change. Five strategic objectives have been set for the achievement of the Plan:

1. *Human life, health and welfare, regardless of gender, age and social background, are protected from the adverse effects of climate change;*
2. *National economy has the capacity to adapt to the adverse effects of climate change and seize the opportunities derived from climate change;*
3. *Infrastructure and buildings are climate-resilient and planned according to possible climate risks;*
4. *Nature, cultural and historical values of Latvia have been preserved and the negative impact of climate change thereupon has been reduced;*
5. *Information based on scientific argumentation is provided, including monitoring and projections that promote integration of the aspects of adaptation to climate change in sectoral policy and territorial development planning documents, and also public awareness.*

Implementation of the Plan requires a wide-ranging involvement of authorities by implementing adaptation measures listed in Annex 1 to the Plan. However, most adaptation measures are largely related to measures already in progress (for example, civil protection, flood protection measures, compliance with building climatology and other building standards, etc.) and the Plan ensures the necessary vision on the adjustment of customary measures to the new climatic conditions and also, where necessary, introduces effective planning, coordination, monitoring, etc. It is planned to introduce the measures and tasks for the implementation of the

Plan by using both State and local government budget funding, attracting financial resources of the EU and other sources, and also private capital.

II. CHARACTERISATION OF THE CURRENT SITUATION

2.1. Characterisation of Climate Change in Latvia

The main indicators characterising climate change are air temperature (and indicators related thereto), the amount of atmospheric precipitation, sea level, wind speed, extreme weather and climate events (extremes). Chapter 2.1 describes historical observations and future scenarios with regard to indicators characterising climate change (climatic parameters).

Historical observations on changes in indicators characterising climate change are used both for the analysis of past events and forecast of climate change. The current analysis of climate change trends in Latvia has been carried out using the data of all meteorological observation stations of the Latvian Environment, Geology and Meteorology Centre (LEGMC) in the period from 1961 to 2010. In turn, changes in climatic parameters for future periods until 2100 are forecast by taking into account historical observations and using the calculations of 28 global numerical climate models according to GHG emissions scenarios outlined in the Fifth Global Climate Assessment Report (AR5) developed by the Intergovernmental Panel on Climate Change (IPCC) (RCP 4.5 and RCP 8.5). [7]

The RCP 4.5 scenario provides for the reduction of GHG emissions from the middle of this century and, under the circumstances of this scenario until the end of the 21st century, air temperature in Latvia will rise by more than 3°C above the average value in the period from 1971 to 2000. According to the IPCC Fifth Assessment Report, the RCP 4.5 scenario provides that the global average air temperature will rise by 1.1°C up to 2.6°C by the end of the 21st century. However, in the event no climate change mitigation measures described in the climate change scenario RCP 8.5 are implemented globally, the air temperature in Latvia will rise by up to 5°C, whereas globally – by 2.6°C up to 4.8°C.

LEGMC has established a monitoring system for climate change indicators and adaptation to climate change indicators which ensures the possibility to regularly monitor the progress of climate change in Latvia. Regular monitoring of climate parameters and indices is carried out within the framework of the system (if necessary, new indicators are developed), ensuring the update of climate change scenarios according to the latest IPCC scientific models / scenarios. LEGMC provides support to maintain the monitoring system for climate change indicators. A detailed description of the monitoring system for climate change and adaptation to climate change is included in Annex 2 to the Plan.

Table 1 features a general summary of the previous values of the climatic parameters and current changes described in the sub-sections of this Chapter and also the expected changes in the future taking into account various climate change scenarios[8].

[7] *Klimata pārmaiņu scenāriji Latvijai* [Climate Change Scenarios for Latvia], report, LEGMC, Riga, 2017. Available online: http://www2.meteo.lv/klimatariks/zinojums.pdf
[8] Ibid.

Table 1 Current and future changes in climate parameters compared to long-term average values of climate parameters in the past[9]

Climate parameter		Current climatic value (1961–1990)	Current changes (1981–2010 compared to 1961–1990)	Changes in the future (2071–2100 compared to 1961–1990)	
				RCP 4.5	RCP 8.5
Maximum air temperature	Annual maximum value	+29.3ºC	↑ +0.7ºC	↑ +3.6ºC	↑ +5.7ºC
	Annual meanl value	+9.5ºC	↑ +0.7ºC	↑ +3.4ºC	↑ +5.4ºC
	Annual minimum value	-14.4ºC	↑ +1.4ºC	↑ +6.5ºC	↑ +9.5ºC
Mean air temperature	Annual maximum value	+22.4ºC	↑ +0.7ºC	↑ +3.2ºC	↑ +5.4ºC
	Annual mean value	+5.7ºC	↑ +0.7ºC	↑ +3.5ºC	↑ +5.5ºC
	Annual minimum value	-18.6ºC	↑ +1.7ºC	↑ +7.5ºC	↑ +11ºC
Minimum air temperature	Annual maximum value	+17.6ºC	↑ +0.8ºC	↑ +3.1ºC	↑ +5.6ºC
	Annual mean value	+2ºC	↑ +0.7ºC	↑ +3.6ºC	↑ +5.6ºC
	Annual minimum value	-24.1ºC	↑ +1.9ºC	↑ +9.3ºC	↑ +13.5ºC
Summer days		15 days	↑ +3 days	↑ +31 days	↑ +53 days
Tropical nights		0 days	↕ 0 days	↑ +4 days	↑ +14 days
Growing season length		195 days	↑ +2 days	↑ +27 days	↑ +49 days
Frost days		134 days	↓ -9 days	↓ -52 days	↓ -81 days
Ice days		62 days	↓ -9 days	↓ -32 days	↓ -46 days
Precipitation totals		651 mm	↑ +6%	↑ +13%	↑ +16%
Highest 1-day precipitation amount		33 mm	↑ +1 mm	↑ +3 mm	↑ +6 mm
Highest 5-day precipitation amount		58 mm	↑ +2 mm	↑ +9 mm	↑ +12 mm
Heavy precipitation days		15 days	↑ +2 days	↑ +3 days	↑ +5 days
Very heavy precipitation days		3 days	↑ +1 days	↑ +1 days	↑ +2 days
Simple daily intensity index		5.1 mm/day	↕ 0 mm/day	↕ 0 mm/day	↑ +1 mm/day
Annual mean wind speed		3.6 m/s	↓ -8%	↓ -7%	↓ -3%
Stormy days		1 day	↓ -1 day	↕ 0 days	↕ 0 days

[9] *Klimata pārmaiņu scenāriji Latvijai* [Climate Change Scenarios for Latvia], report, LEGMC, Riga, 2017 Available online: http://www2.meteo.lv/klimatariks/zinojums.pdf

Climate parameter	Current climatic value (1961–1990)	Current changes (1981–2010 compared to 1961–1990)	Changes in the future (2071–2100 compared to 1961–1990)	
			RCP 4.5	RCP 8.5
Calm days	75 days	↑ +13 days	↑ +24 days	↑ +2 days

Current climate change trends in Latvia have marked significant changes in air temperature values and, similar to the trends observed in many parts of the world, confirm a distinct and stable trend of global warming. In analysing further changes in air temperature values in the context of different climate change scenarios, it could be concluded that the average annual air temperature in Latvia will continue to rise. The analysis of data rows of multiannual observations shows that the maximum duration of continuous drought periods in Latvia reaches 21–25 days, while in some years, even extremely long periods of drought have been observed in the country. Forecasts suggest that the periods of drought and heat in the future will become more frequent. With regard to the amount and intensity of precipitation, current effects of climate change in the territory of Latvia have marked increase in total amount and intensity of atmospheric precipitation and also the increasing number of heavy precipitation cases and it is forecast that such trends in Latvia will continue throughout this century.

Thus, it can be concluded that in the future in Latvia in general:

- air temperature (average, minimum and maximum temperature) will significantly increase;
- the number of summer days will increase significantly and also a significant increase in the number of tropical nights is expected;
- the number of frost days and days without thaws will decrease, the amount of snow and ice formation and durability will also decrease;
- the total amount of precipitation (rain) will increase significantly, the number of days with heavy and very heavy precipitation will also increase;
- the average wind speed will decrease slightly and the number of no wind days will increase; however, significant changes in the number of storm days are not forecast, yet differences in the regions of Latvia are forecast.
- The periods of heat and drought and the frequency thereof will increase during which surface water and groundwater levels may decrease.

2.1.1. Air temperature

Air temperature is a meteorological parameter used to characterise global climate change processes. Sub-chapter 2.1.1 discusses the observations related to air temperature and the anticipated changes.

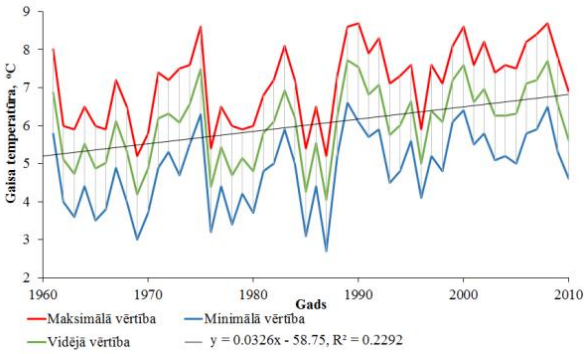

Figure 2. Changes in the average annual air temperature in Latvia in the period from 1961 to 2010[10]

Figure 3. Changes in the average annual air temperature under the circumstances of the RCP 8.5 climate change scenario (changes in 2071–2100 compared to values of 1961–1990)[11]

The values of the mean air temperature in Latvia from 1960 to 2010 have increased by 0.7°C with the highest average annual air temperature rise by 1.7°C on average (Figure 2). Due to the current climate change, the minimum and maximum air temperature has also increased. Over the last 50 years, the minimum annual air temperature in Latvia has increased by 1.9°C, while the maximum air temperature values have increased on average by 0.7°C. According to LEGMC data, the year 2018 (along with 2000 and 2008) was the third warmest year in observed history with the average air temperature therein +7.6°C (1.9°C above the climate reference period (1961–1990)).

It is forecast that in Latvia the annual mean air temperature will increase by 5.2°C – 5.5°C by the end of the century (Figure 3). At the end of the century, the average annual maximum air temperature in Latvia could reach +35°C. However, most importantly, until 2100 the minimum air temperature will increase on average by 9.3°C up to 13.5°C. The most extreme increase in air temperature values will be observed in winter and spring as the average air temperature in winter is expected to increase by 4.4°C up to 7.8°C compared to 1961–1990. Significant increase in mean air temperature is forecast also in summer (by 4.8°C up to 5.1°C).[12]

[10] *Klimata pārmaiņu scenāriji Latvijai* [Climate Change Scenarios for Latvia], report, LEGMC, Riga, 2017. Available online: http://www2.meteo.lv/klimatariks/zinojums.pdf
[11] Ibid.
[12] Ibid.

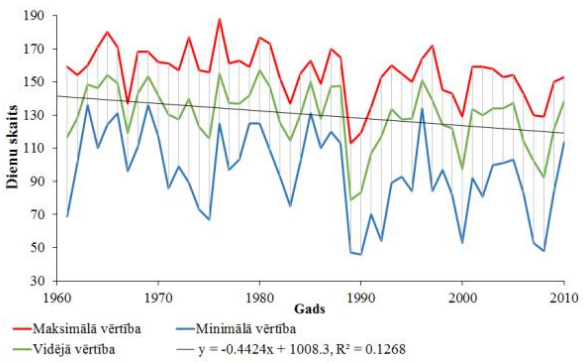

Figure 4. Number of frost days in Latvia in the period from 1961 to 2010[13]

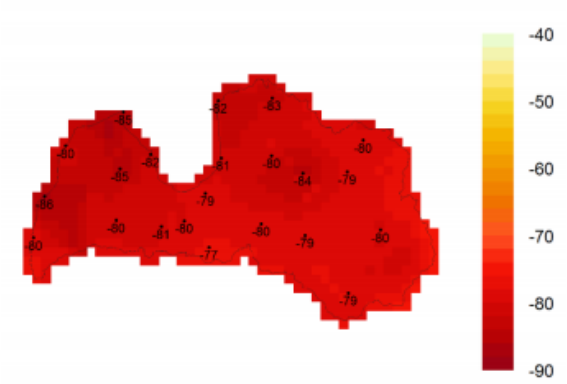

Figure 5. Changes in the number of frost days under the circumstances of the RCP 8.5 (to the right) climate change scenario (changes in 2071–2100 compared to values of 1961–1990)[14]

The number of frost days between 1960 and 2010 was 96–155 days, and during the period, the number of days in Latvia decreased on average by 9 days per year (Figure 4). On average, the number of ice days in Latvia has decreased by 9 days per year, whereas in certain places – on average by 5–11 days per year. Taking into account the increase in the air temperature during winter, it is expected that until 2100 the number of frost days will decrease on average from 52 to 81 days per year, whereas the number of ice days will decrease from 32 to 46 days (Figure 5).

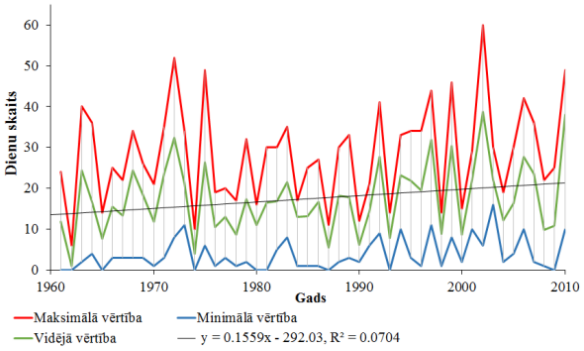

Figure 6. Number of summer days in Latvia in the period from 1961 to 2010

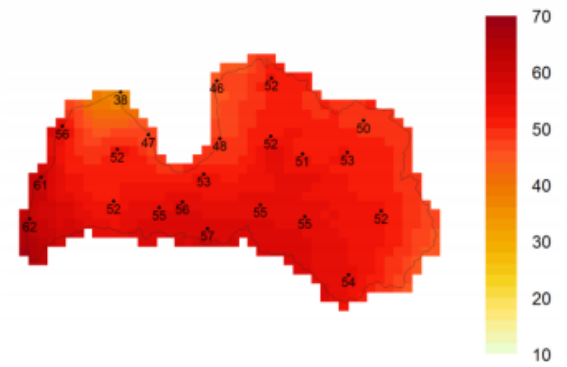

Figure 7. Changes in the number of summer days under the circumstances of the RCP 8.5 climate change scenario (changes in 2071–2100 compared to values of 1961–1990)[15]

The number of summer days in Latvia on average varies from 4 to 26 days per year and the number thereof has increased by 1–5 days per year due to previous climate change (Figure 6). Historically, there have been a few tropical nights in Latvia – on average 0.1 to 0.7 nights per

[13] *Klimata pārmaiņu scenāriji Latvijai* [Climate Change Scenarios for Latvia], report, LEGMC, Riga, 2017. Available online:
http://www2.meteo.lv/klimatariks/zinojums.pdf
[14] Ibid.
[15] Ibid.

year; therefore, it is impossible to draw strong conclusions about trends with regard to changes in the number of tropical nights; however, increase in the frequency of such nights can be observed over the last decades. The number of summer days in the future will increase on average by 31–53 days per year and the number of tropical nights, which so far were a few, will increase by 4 to 14 nights per year (Figure 7).

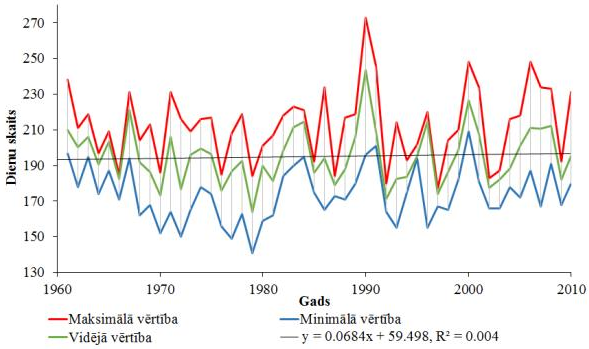

Figure 8. Changes in the duration of the vegetation period in Latvia during the period from 1961 to 2010[16]

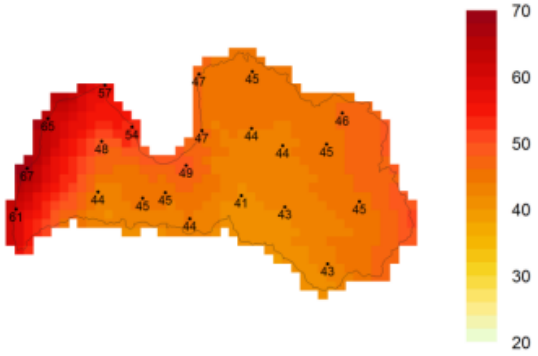

Figure 9. Changes in the duration of the vegetation period under the circumstances of the RCP 8.5 climate change scenario (changes in 2071–2100 compared to values of 1961–1990)[17]

Due to increase in the overall air temperature, the duration of the vegetation period has changed as well – on average 2 days per year since 1961, in Latvia mostly there were 184 to 208 days per year (Figure 8). Although the duration of the growing season is closely related to changes in air temperature, the current increase in air temperature observed in Latvia has not caused an increase in the duration of the growing season that would be statistically significant. Ventspils is the only meteorological observation station where a statistically significant increase in the duration of the growing season is observed – compared to the climate reference period, the duration of the growing season now is 10 days longer. It is expected that by 2100, the increase in air temperature will prolong the vegetation period – by 27 to 49 days or approximately by 1 to 2 months (Figure 9), including regional differences, namely, more significant increase in the duration of the vegetation period is expected particularly in the coastal area in Kurzeme.

2.1.2. Atmospheric Precipitation

Atmospheric precipitation is a climate variability parameter used to characterise global climate change processes. The observations related to atmospheric precipitation and the forecast changes are discussed in more detail in Sub-chapter 2.1.2. In Latvia, the total amount of precipitation in the period from 1961 to 2010 on average was from 576 mm to 757 mm. Due to the current climate change impacts, the amount of precipitation in Latvia has increased by 6% or by approximately 39 mm (Figure 10). So far, the amount of precipitation has increased the

[16] *Klimata pārmaiņu scenāriji Latvijai* [Climate Change Scenarios for Latvia], report, LEGMC, Riga, 2017. Available online:
http://www2.meteo.lv/klimatariks/zinojums.pdf
[17] Ibid.

most in winter, but an increase is also observed in spring and summer, while in autumn there is even a slight decrease in the amount of precipitation.

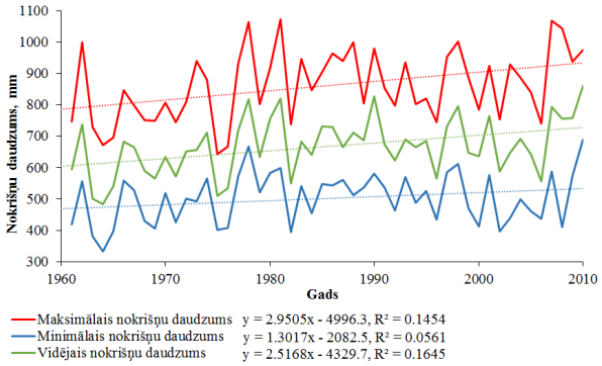

Figure 10. Changes in the total amount of atmospheric precipitation in Latvia in the period from 1961 to 2010

Figure 11. Changes in the total annual atmospheric precipitation under the circumstances of the RCP 8.5 climate change scenario (changes in 2071–2100 compared to values of 1961–1990)[18]

Taking into account that precipitation intensity has increased since 1961, the number of days with heavy and very heavy precipitation has increased, respectively by two days and one day. During the studied period of time (1961–2010), the number of days with heavy precipitation on average reaches 15 days per year, while the number of days with very heavy precipitation – 3 days. In analysing the baseline period (1961–2010), it can be observed that the maximum daily amount of precipitation in the territory of Latvia on average every year is 31–38.5 mm, whereas the maximum amount of precipitation for a period of five days – from 44 to 85 mm. According to forecasts, until 2100 precipitation intensity will increase by 0.1–1 mm per day or 0.5–1.3 mm per day (respectively in the RCP 4.5 and RCP 8.5 scenarios). The number of days with heavy precipitation will increase on average by 3 to 5 days per year, whereas the number of days with very heavy precipitation will increase by 0.1–2.3 days per year and in the case of severe climate change scenario – by 0.8–3.3 days per year.

By the end of the 21st century, the total amount of annual precipitation is expected to increase by 10–21% (approximately 80–100 mm), respectively under the circumstances of the RCP 4.5 and RCP 8.5 scenarios (Figure 11). Throughout the seasons, the highest increase in the amount of precipitation is expected in winter and spring. Under the circumstances of moderate climate change scenario, the amount of precipitation will increase by 24–37% during winter, while in the case of severe climate change scenario it is expected to increase by 35–51%. Overall, increase in precipitation is forecast in all future periods and seasons, except for summer in the period from 2071 to 2100 when the amount of precipitation may also decrease in some places.

2.1.3. Wind Speed

[18] *Klimata pārmaiņu scenāriji Latvijai* [Climate Change Scenarios for Latvia], report, LEGMC, Riga, 2017. Available online:
http://www2.meteo.lv/klimatariks/zinojums.pdf

Wind speed is one of the climate variability parameters, therefore observations related to wind speed and projected changes are described in this Sub-chapter.

According to observations, the average wind speed curve in Latvia is downward in the baseline period (1961–2010); however, at the beginning and end of the period, some peaks are observed in the maximum average wind speed values which are related to the frequency and activity of the observed storms. The trend of the decrease of wind speed has been observed in the greater part of the territory of Latvia: only three (Ventspils, Kolka, Alūksne) of 22 meteorological observation stations included in the LEGMC study did not detect significant changes in wind speed.

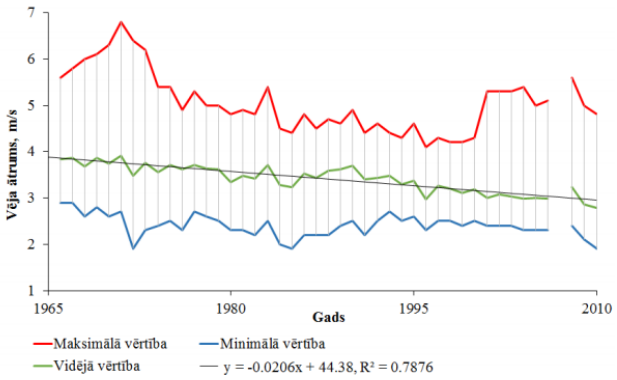

Figure 12. Average wind speed changes in Latvia in the period from 1961 to 2010[19]

Figure 13. Average wind speed changes under the circumstances of the RCP 8.5 climate change scenario (changes in 2071–2100 compared to values of 1961–1990)[20]

In the period from 1966 to 2010, the average wind speed in Latvia was 2.6–4.8 m/s. The wind is characterised by a gradient towards marine areas – land, but the average annual wind speed values are closely related to the storm activity in autumn and winter. Since 1966, the average wind speed in Latvia has decreased by 8% (Figure 12). As a result of the decreasing average wind speed, the number of calm days has increased by 13 days on average. In Latvia, the number of calm days from year to year varies from 53 to 127 days and so far the highest number of calm days was recorded in 2010, while the lower number of calm days – in 1977. The analysis of long-term changes in the number of calm days reveals that in the baseline period the number of calm days in the greater part of the territory of the country has increased considerably, but at the same time, insignificant decrease in the number of calm days has been observed at meteorological observation stations in Kolka and Dobele.

In turn, stormy days in Latvia are observed quite rarely – from 0 to 1 day per year in the greater part of the territory, and during the previous period, the number of such days in Latvia has decreased by one day on average.

In the future, according to the RCP 4.5 climate change scenario, the annual average wind speed in Latvia will decrease by 5%, while the average wind speed in the RCP 8.5 climate change scenario will remain unchanged. Territorially, in the RCP 4.5 climate change scenario the average wind speed will decrease by 4–13%, while there is a minor change in wind speed in the RCP 8.5 scenario, not exceeding 0–6% (Figure 13). Such differences in the estimates of climate change scenarios are related to the high uncertainty in calculating wind speed

[19] *Klimata pārmaiņu scenāriji Latvijai* [Climate Change Scenarios for Latvia], report, LEGMC, Riga, 2017. Available online: http://www2.meteo.lv/klimatariks/zinojums.pdf
[20] Ibid.

parameters in climate models included in the global climate model ensemble which on an annual basis also shows significant differences between the calculations of individual model ensemble.

An important wind speed parameter is the gusts of wind speed which is significantly higher than the average wind speed. Strong winds cause the largest damages during storms. Taking into account that today anemometer measurements are the main data source on wind speed and direction over land, there is a high uncertainty in the analysis of long-term change trends.

Observations show that the strength of maximum wind gusts nowadays, compared to the values of the nearest period of the climate reference period (1966–1995), generally have slightly decreased; however, these differences exceed 1 m/s only at the meteorological observation stations of Liepāja, Daugavpils, Bauska and Alūksne. At the same time, maximum wind gusts at Ainaži and Riga meteorological observation stations nowadays have become by 0.8–1.1 m/s stronger than in the reference period. The analysis of the trends of long-term changes rejects the presence of significant changes in maximum wind gusts in the greater part of the country; however, it confirms considerable to very significant decrease in the strength of wind gusts in the southernmost regions of the country – Liepāja, Bauska and Daugavpils. Meanwhile increase in the strength of wind gusts, which might be related to changes in storm trajectories in the reference period, has been observed at observation stations in Ainaži and Riga.

2.1.4. Water Level of the Sea and Rivers

In the period from 1901 to 2015, the sea level has globally increased by 13–20 cm, i.e. on average 1.2–1.7 mm/year, varying by decades. The global mean sea level increased most rapidly in 2016 (3.4 mm/year)[21]. Future forecasts regarding changes in the sea level entail a high degree of uncertainty. The sea level continues to rise also in 2018 when, according to WMO (World Meteorological Organisation) data, the global mean sea level was by 3.7 mm higher than in 2017, thus becoming the highest in the history of observations. Future forecasts regarding changes in the sea level entail a high degree of uncertainty.

Global climate change is also observed in the Baltic Sea. Changes in temperature, wind and precipitation patterns in the Baltic Sea basin may cause both direct and cascading effects. For example, due to the increase in air temperature, the maximum ice surface area and duration of the ice season have decreased in the Baltic Sea which affects the distribution range of all species whose survival requires ice. Moreover, along with decrease in the ice surface area and duration of the ice season, larger coastal areas are exposed to coastal erosion during intensive storm season (autumn–winter). It is further intensified by rising water levels observed due to climate change impacts.[22]

Climate change significantly affects the hydrological regime of both surface water and groundwater. In winter, river flow rates have increased at a significantly higher rate than in summer when no changes were observed in flow rates during the observation period, except for small rivers where river fragmentation has occurred due to artificial and natural barriers (HPP reservoir barriers, dams, blockage caused by mechanical pollution and beaver dams). In winter, flow rates have increased particularly over the last decades.

[21] Willis, J. K., Kemp, A., Strauss, B. H. (2018) Sea Level Rise, Ocean Portal. Available online: https://ocean.si.edu/through-time/ancient-seas/sea-level-rise

[22] Aigars J., (2018), *Latvijas ekosistēmu dinamika klimata ietekmē* [Ecosystem Dynamics in Latvia under Climate Impacts]. The national research programme EVIDENT, the book on NRP results is available online: http://lhei.lv/attachments/article/572/Latvijas-ekosistemu-dinamika-klimata-ietekme.pdf

In addition, global climate change has also caused long-term and seasonal changes in the run-off of rivers in Latvia, observing significant changes in river hydrographs specifically in winter and spring. Seasonal changes of air temperature and atmospheric precipitation could affect also seasonal spread of hydroelectric power. During the historical period, the largest amount of annual run-off in rivers occurred in spring with the largest flow rate in April, whereas seasonal changes in the overall run-off of rivers are observed in the last decades. There is a clear trend towards increased run-off in January, February and decreased run-off in April, May. Duration of the ice freeze-up period in the largest rivers of Latvia has decreased by 6–15 days[23]. Milder winters and reduced snow and ice cover in the future will affect minimisation of spring flood risk.

Due to drought, heat waves and tropical nights the riverbed will become exposed in small rivers where river fragmentation has occurred, thus stimulating intense decrease or loss of aquatic vegetation and habitats.

As the water level increases, flooding of low coastal territories and adaptation of the bankside profile to the new circumstances will cause the retreat of river banks and formation of new river banks, especially in small rivers with different relief profiles of the opposite banks. Along with the problems caused by erosion, there is the risk of flooding in low territories around the coastal basin rivers. Overall development trends during the last 20 years also indicate to the activation of coastal processes – increase in the length of coastal compartments subject to erosion and increase in the rate of erosion.

Total length of the coastal sections where nowadays the retreat of coastline is observed[24]:

- 0.1–0.5 m/year ~ 120 km;
- 0.6–1.5 m/year ~ 50 km;
- 1.6–3.0 m/year ~ 10 km (Bernātu rags (Cape Bernāti), Jūrkalne, Melnrags, Staldzene, Kolkas rags (Cape Kolka), Gaujas grīva (Mouth of the River Gauja)).

In the future, prevalence of coastal erosion is mainly expected at places where it was observed over the last decade with the increase in the overall length of coastal sections endangered by erosion by 10–20%. It is expected that due to coastal retreat the territory of Latvia will decrease by approximately 10 km^2 until 2060.[25]

However, it should be noted that Latvia lacks updated data on changes in the hydrological regime and forecasts thereof.

2.1.5. Extreme Weather Conditions

In Latvia, just like elsewhere in the world, in the second half of the last century and at the beginning of this century significant changes in extreme climate phenomena have been observed – extreme high temperature during the days and at nights and also days with heavy precipitation have become more frequent, while days of extreme cold are observed increasingly less. Increase

[23]Latkovska I., (2015), *Latvijas upju hidroloģiskā režīma ilgtermiņa un sezonālās izmaiņas* [Long-term and Seasonal Changes in the Hydrological Regime of the Rivers in Latvia]. Riga, UL. https://dspace.lu.lv/dspace/bitstream/handle/7/31011/298-50941-Latkovska_Inese_ip05033.pdf?sequence=1&isAllowed=y

[24] *Vadlīnijas jūras krasta erozijas seku mazināšanai* [Guidelines for Reducing the Consequences of Coastal Erosion], methodological material, Riga, 2014. Available online: http://www.varam.gov.lv/lat/publ/met/?doc=18713

[25]Ibid.

in repeated cases of heat waves (prolonged, continuous period of hot weather) has been also established, causing specific problems particularly in urban territories. According to IPCC forecasts, increase in the recurrence and weather contrasts in terms of extreme weather conditions (including precipitation and wind speed) is expected in the future.[26] Weather contrasts in Latvia is illustrated by, for example, 2018 that was the driest year in the history of observations. Total annual precipitation in Latvia was 472.7 mm (32% below the annual norm – 692.3 mm) which is the lowest amount of annual precipitation in the history of observations in Latvia (since 1924). A new record of summer days (days with the maximum air temperature of >+25°C) was reached at 15 observation stations, whereas a new record of tropical nights (days with the minimum air temperature of +20°C) was recorded in Ainaži, Jelgava and Liepāja. However, a cold wave was observed at the end of February and at the beginning of March which lasted 13 days (from 21 February to 5 March) and was the severest cold wave experienced in the last 5 years. In May, extreme drought hit the territory of Latvia which lasted from 4 May to 20 June. The second heat wave was recorded in the second half of July and the beginning of August, beating a total of 60 maximum air temperature records, including absolute maximum air temperature records in Ainaži (+33.7°C) and Kolka (+32.1°C), and several forest and bog fires were registered. The summer heat continued also in September and for the first time air temperature of +30°C was observed in the second half of September (21 September in Jelgava). In turn, at the end of the month (25 September), the first snow was observed in Ventspils and Jelgava and it is the earliest snow record of these observation stations. This is particularly significant in the case of the observation station in Jelgava because air temperature of +30°C was registered there only 4 days ago. Moreover, 97 maximum air temperature records were exceeded in October. Furthermore, the record of +20°C recorded at the latest in autumn was repeated on 18 October. November became the fourth driest month in the history of observations. December became the only month in 2018 when no air temperature record was exceeded.

Nowadays, the amount of precipitation in the period of five days has increased by 1–10 mm in Latvia in comparison with the reference period. Intense rainfall causes local damages in Latvia every year, flooding populated areas, causing road washout and also damages to infrastructure. For example, on 24 August 2017, the amount of precipitation reached 123.1 mm in Rēzekne which became a new record of the maximum amount of precipitation of this observation station. Whereas, the total amount of precipitation registered in the period from 23 August 2017 to 24 August 2017 at the observation station in Rēzekne was equal to ¼ of the total annual norm (Figure 14). Such intense rainfall had not been recorded in this region since the beginning of meteorological observations. Nevertheless, even more intense rainfall has been experienced in Latvia – on 9 July 1973 in Ventspils when the amount of precipitation reached 160 mm.

[26] *Klimata pārmaiņu scenāriji Latvijai* [Climate Change Scenarios for Latvia], report, LEGMC, Riga, 2017. Available online:
http://www2.meteo.lv/klimatariks/zinojums.pdf

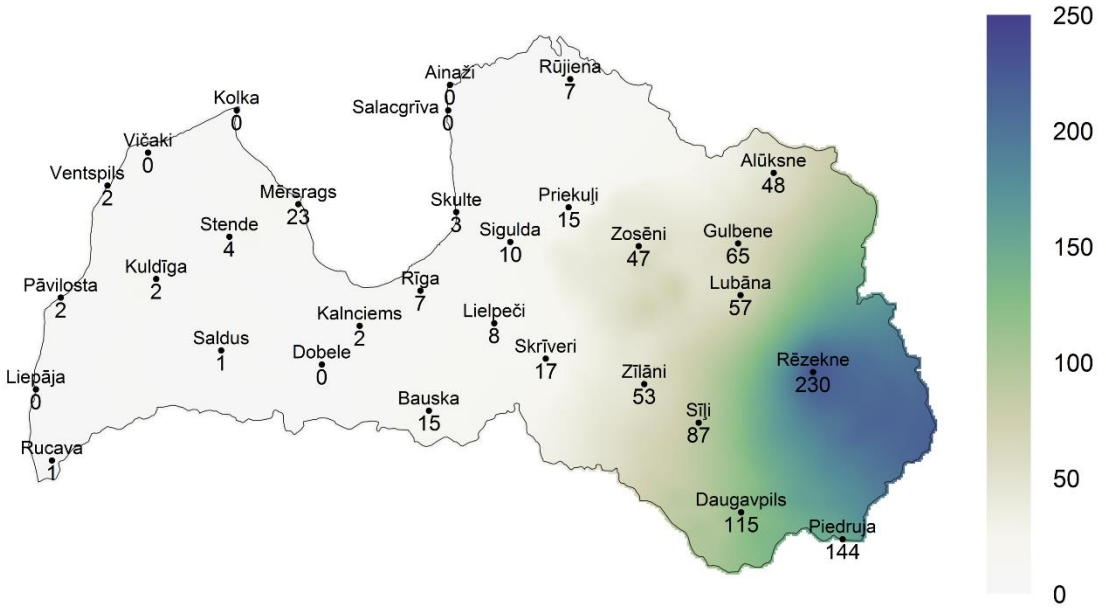

Figure 14. Comparison of the total precipitation recorded at observation stations of LEGMC (23.–24.08.2017) with the monthly norm of August, in per cent (%)

Intense rainfalls initially caused road washout in the lowest areas – rural fields, meadows and also ditches. Gradually the water reached rivers, thus significantly increasing the water level there as well. Flood plains were flooded in the River Aiviekste, River Padedze and River Rēzekne. The water level increased by more than two metres in separate river stretches. Due to rainfalls and flood, huge losses were caused to the farmers of this region – the harvest was destroyed and it was impossible to harvest the produce. The state of emergency was declared in the agriculture sector.

Extreme events do not repeat every year, sometimes only once every decade or even less often, and this circumstance even amplifies their hazard because the population is not prepared for such natural disasters.

2.2. Climate Change Risks and Possible Benefits

This Chapter includes the climate change vulnerability assessment and overview of the related risks in such areas of national economy as landscape planning and tourism, biodiversity and ecosystem services, civil protection and disaster management, building and infrastructure planning, health and welfare, agriculture and forestry. This information is based on the studies conducted within the framework of the pre-defined project "Development of Proposals for National Adaptation Strategy, including Identification of Scientific Data, Measures for Adapting to Changing Climate, Impact and Cost Evaluation" of the European Economic Area (EEA) Financial Mechanism 2009–2014 Programme "National Climate Policy". The selected areas cover all sectors of national economy of Latvia that are exposed to climate change the most. Figure 15 depicts a summary of climate change risks in Latvia.

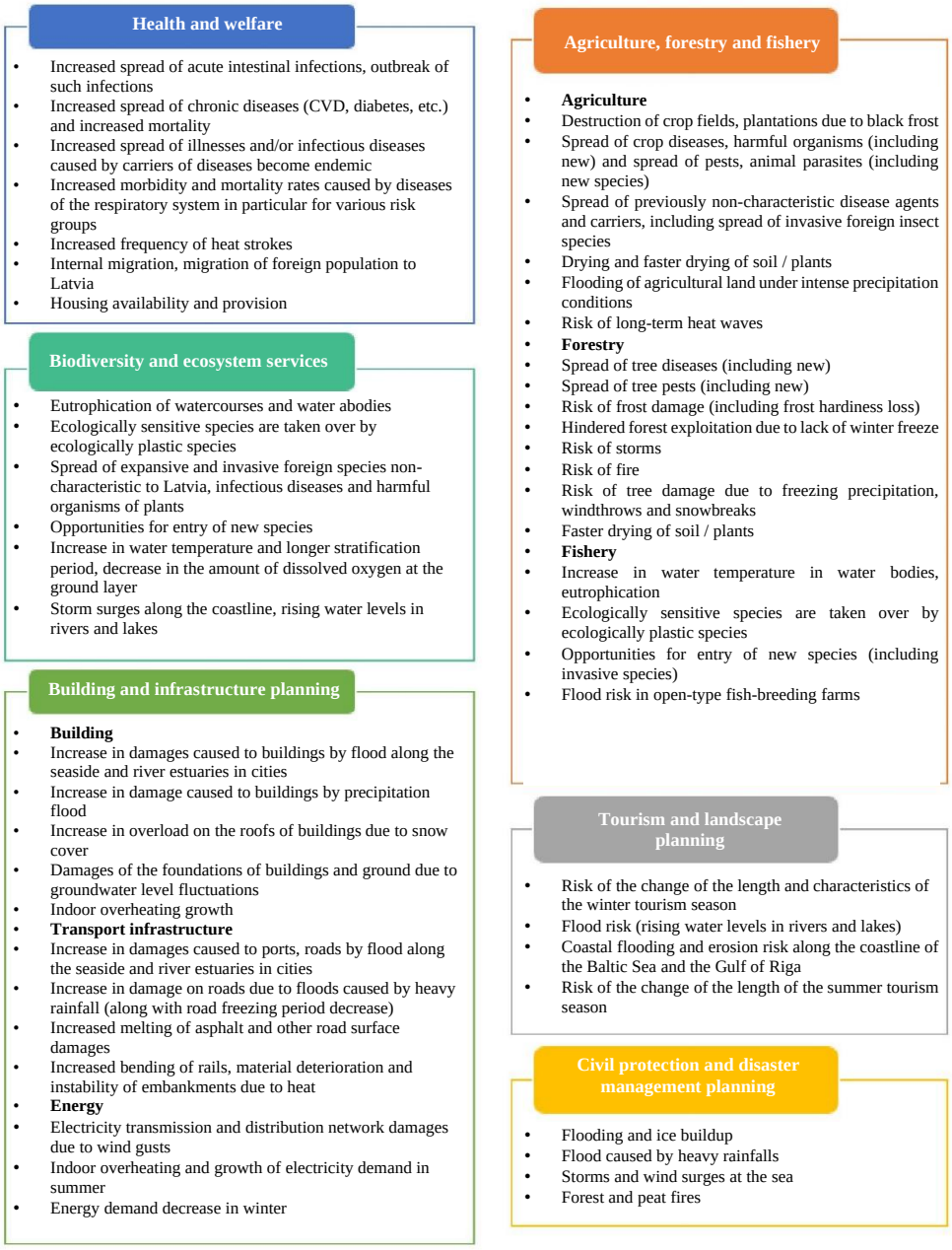

Figure 15. Climate change risks in Latvia

The most significant risks caused by climate change in Latvia with a higher probability of occurrence are as follows:

- changes in seasons, including the growing season;
- fire hazard;
- proliferation of pests and pathogens, tree diseases, expulsion of local species, entering of new species;
- spread of diseases of the respiratory system;
- spread of infectious diseases, heat strokes;
- flood caused by precipitation, wind surges;
- occurrence of disturbances in electricity supply;
- increased run-off, hydropower variations;
- reduction of frost, black frost, drying of soil;
- eutrophication;
- damages to infrastructures, overheating of equipment;
- decreased run-off during summer.

Sub-chapters 2.2.1–2.2.6 discuss the risks of climate change in such six areas as building and infrastructure planning, civil protection and disaster management, health and welfare, biodiversity and ecosystem services, agriculture and forestry, landscape planning and tourism. Sub-chapter 2.2.7. describes the possible benefits from climate change.

2.2.1. Building and Infrastructure Planning

There are several effects of climate change (including extremes) in the field of building and infrastructure planning (including transport infrastructure) in Latvia:

- increase in the annual mean air temperature, increase in the frequency and duration of heat waves, extension of meteorological summer, increase in the maximum value of day-to-day temperature;
- decrease in the number of frost days and ice days;
- increase in the amount of precipitation and the maximum amount of overnight precipitation, increase in the number of days with very heavy precipitation, increase in the maximum amount of precipitation of a five-day period, increase in abundant snowfalls;
- rise in the average sea water levels in the long-term and coastal erosion, and also groundwater level fluctuations affected by changes in precipitation and sea water level, and changes in the river run-off.

Climate change affects all building and infrastructure objects – buildings, water supply and sewerage infrastructure, land amelioration, transport, communications and energy networks and the functioning thereof, where the largest impact is attributed to extreme weather caused by climate change (storms, flood, large amount of precipitation, heat waves).

In total, 14 risks related to climate change have been identified in the field of building and infrastructure planning in Latvia (see Table 2).[27]

[27] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana būvniecības un infrastruktūras jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Building and Infrastructure Planning], final report, association *Zaļā brīvība* [Green Freedom], 2017. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

Table 2. Climate change risks and potential consequences in building and infrastructure planning

Risk	Potential consequences
Increase in damages caused to buildings by flood along the seaside and river estuaries in cities	Damages to buildings along the seaside (due to coastal erosion and flood); damages to buildings along river estuaries; necessity of building repairs or irreparable damage; write-off of the building; decrease in the value of buildings and increase in insurance pricing; decrease in safety and comfort.
Increase in damage caused to buildings by precipitation flood	Damages to buildings with insufficient sewerage capacity, damages to buildings in the areas of flood of watercourses and water bodies; necessity of building repairs or irreparable damage; write-off of the building; decrease in the value of buildings and increase in insurance pricing; decrease in safety and comfort.
Increase in overload on the roofs of buildings due to heavy snowfalls in short-duration periods	Damages to building structures (increased formation of micro-cracks of buildings, moisture damage); collapse of roofs; increase in mould; threat to life and property.
Damages of the foundations of buildings and ground due to groundwater level fluctuations	Threat to the durability and stability of buildings and foundations thereof (old buildings are exposed to the highest threat, as durability and waterproofing of the foundations, if any, are significantly depreciated), causes micro-cracks in the long-term and increases moisture penetration into the building structures.
Increase in damages caused to roads by flood along the seaside and river estuaries in cities	Damages to roads along the seaside (due to coastal erosion and flood); damages to roads along river estuaries; necessity of road repairs, cleaning or closure thereof.
Increase in damage on roads due to floods caused by heavy rainfall (along with road freezing period decrease)	Damages to roads in cities with insufficient sewerage capacity, flooding of tunnels; damages to roads outside cities (mainly gravel road subsidence or washout, embankment instability, landslide formation); necessity for road renovation and cleaning; environmental pollution; decrease in safety and comfort; road closure.
Accelerated melting of asphalt and other road surface damages	Damages to roads; deterioration of traffic safety.
Increased bending of rails, material deterioration and instability of embankments due to heat	Damages to railway infrastructure; economic losses due to speed limit; overheating of engines; restrictions on freight and passenger transport.
Increase in damage caused by flooding at ports	Damages to port infrastructure; damages to goods; economic losses.
Indoor overheating and growth of electricity demand in summer	Growth of demand for indoor cooling systems; installation of indoor cooling and ventilation systems; deterioration of human health and welfare; decrease in labour productivity; increase in extraordinary costs; investment growth to the public; growth of electric energy consumption and costs in summer.

Risk	Potential consequences
Electricity transmission and distribution network damages due to increase in strength of maximum wind gusts in certain regions of Latvia	Damages to energy networks; disruptions in energy supply; welfare and economic losses.
Electricity transmission and distribution network damages due to heavy rainfall and flood	Damages to energy networks; disruptions in energy supply; welfare and economic losses.
Threat to coastal overpass structures due to rise in sea water level / increased tidal change / storms	Damages to CHP; decrease in freight and passenger transport tidal change at ports; disruptions in energy supply.

Risks caused by climate change in the field of building and infrastructure planning with a rather high or high probability of occurrence in Latvia and with the most negative consequences are as follows:

- increase in damages caused to buildings by flood along the seaside and river estuaries in cities;
- increase in electricity demand in summer;
- Energy demand decrease in winter and indoor overheating in summer;
- distribution network damages due increased wind gusts in certain regions of Latvia;
- increase in damage on roads due to floods caused by heavy rainfall (along with road freezing period

  decrease and increase in precipitation during that period).

Other risks have rather moderate consequences; however, at the same time there is also a very high probability of occurrence thereof.

The results of economic calculations[28] suggest that, for instance, the annual increase of losses arising from damages to buildings caused by high tide in all towns alongside the sea coast in Latvia in the time period from 2040 to 2070 might be EUR 1.5 million per year, but in the time period from 2070 to 2100 it might reach EUR 3 million per year.

In turn, the impact of increase in flood caused by rain and melting of snow under exposure to climate change on buildings in Latvia may cause annual economic losses in the amount of EUR 40–50 thousand (in the time period from 2020 to 2040) and around EUR 160–210 thousand in the time period from 2070 to 2100. Due to the increase of overload caused by snow accumulation on roofs the projected economic danger in the nearest future (until 2040) is around EUR 90 thousand per year, but at the end of the century (in the time period from 2071 to 2100) it will be around EUR 300–700 thousand per year. It is to be taken into account that damages to building structures may also occur due to intense precipitation and rapid changes in air temperature, for example, in cases when a thick snow cover is formed rapidly which is followed by the return to an above-zero temperature thus increasing the weight of snow load several times, causing overload caused by snow accumulation on roofs. High moisture may cause the risk of mould formation. For buildings of wooden structures, it is necessary to take into consideration the expected distribution of insects, including invasive foreign insect species.

[28] The assessment is based on flood risk management plans for Riga and Ventspils and the relevant studies.

The social and economic impact calculations have been carried out for railway infrastructure hazards related to rail bending. As a result, it is necessary to reduce the permitted rain movement speed that overall has a significant economic impact. Upon evaluating the days of delay occurring due to the degradation of tracks, the annual late losses in the time period from 2040 to 2070 will be around EUR 0.2 million with an increase of EUR 0.1 million, but in the time period from 2070 to 2100 – EUR 0.4 million and EUR 0.3 million accordingly.[29]

2.2.2. Civil Protection and Disaster Management Planning

Extreme weather and climate events characterised by explicit inter-annual and spatial variability are of great relevance in the field of civil protection and disaster management. Furthermore, climate projections in Latvia also show that weather conditions not characteristic to and extreme for Latvia will be a more frequent reality in the future. Extreme events caused by climate change in the field of civil protection and disaster management affect the following:

- human health, safety and life – extreme events caused by climate change could result in victims and fatalities, people could be relocated to safer, risk-free territories, there could be obstacles to the provision of aid to victims (risks causing severe or catastrophic effects);
- significant traffic accidents, infrastructure damages, industrial accidents, etc.

In Latvia, the following effects and extremes of climate change are crucial for civil protection and disaster management planning:

- increase in the number of summer days, tropical nights, duration and frequency of heat waves, continuous increase in the frequency and duration of drought periods;
- maximum wind gust increase;
- increase in the number of days with very heavy precipitation, the maximum amount of overnight precipitation and decrease in the amount of annual precipitation in the form of snow;
- changes (increase) of the sea water level and changes in the amount of precipitation, the consequent change of the run-off of rivers from the current peak in spring to intense run-off in autumn and drought in summer without intense spring flood maximum.

Four risks which could arise as a result of climate change have been identified in the field of civil protection and disaster management planning (see Table 3).

Table 3. Climate change risks and potential consequences in the field of civil protection and disaster management planning

Risk	Potential consequences
Spring flood and flood caused by a buildup of the ice	Casualties, fatalities or relocation of people to safe territories as a result of the occurrence of direct and underlying risks (industrial accidents and infrastructure damages). Occurrence of material losses; formation of restrictions in the provision of assistance (high numbers of casualties, damaged infrastructure, limited access to hospitals). Reduced probability of the occurrence spring floods and the consequences thereof, therefore, possible losses may decrease as well. Consequences depend significantly upon whether the populated areas are flooded.

[29] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana civilās aizsardzības un ārkārtas palīdzības jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Civil Protection and Emergency Assistance], final report, *Procesu analīzes un izpētes centrs* [Centre of Processes Analysis and Research], 2017. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

Risk	Potential consequences
Storms and wind surges at the sea	Casualties, fatalities or relocation of people to safe territories as a result of the occurrence of direct and underlying risks (severe transport accidents, industrial accidents and infrastructure damages). Occurrence of material losses; formation of restrictions in the provision of assistance (high numbers of casualties, damaged infrastructure, limited access to hospitals). Such risk is of particular relevance in the coastal area and river estuaries. In case of very severe storms, the hazard caused has significant effects across Latvia.
Heavy rainfall and flood caused by such rainfall	Casualties, fatalities or relocation of people to safe territories as a result of the occurrence of direct and underlying risks (severe transport accidents, industrial accidents and infrastructure damages). Occurrence of material losses (including costs related to the time spent by transport users, costs related to liquidation of the consequences, insurance costs); formation of restrictions in the provision of assistance (high numbers of casualties, damaged infrastructure, limited access to hospitals). The consequences of floods depend on the location of the flood zones in populated areas.
Forest and peat bog fires	Casualties, fatalities or relocation of people to safe territories as a result of the occurrence of direct and underlying risks (severe transport accidents, industrial accidents and infrastructure damages). Occurrence of material losses (including losses due to forest fires, fire fighting and forest restoration costs); formation of restrictions in the provision of assistance (high numbers of casualties, damaged infrastructure, limited access to hospitals). The risk depends both on weather and the type of land use – primary, forest density.

Risks caused by climate change in the field of civil protection and disaster management with a rather high or high probability of occurrence in Latvia and with the most negative consequences are as follows:

- forest and peat fire – a risk with moderate consequences that will increase in the future and with a very high probability;
- storms and wind surges at the sea – a risk with severe consequences that might increase in the future and with a moderate probability. The analysis of the trends of long-term changes shows considerable to very significant trends in reduction of the number of storm days which have been particularly evident in the greater part of the country; however, increase in the frequency of recurrence of projected extreme events in different periods (IPCC, 2014) must be taken into account;
- heavy rainfall and flood caused by such rainfall – a risk with rather minor consequences that will increase in the future and with a high probability of occurrence;
- spring flood and flood caused by a buildup of the ice – a risk with rather minor consequences and a moderate probability of occurrence; however, it is forecast that both the probability of occurrence and consequences of this risk will decrease in the future.

It is forecast that, for example, the amount of losses caused by the risk of spring flood and flood caused by a buildup of the ice in the context of climate change will decrease by approximately 50%, i.e. from EUR 6.49 million in the current situation to EUR 3.10 million in 2100. The amount of losses caused by the risk of forest and peat bog fires in the future, compared to the current situation, will slightly increase from EUR 1.22 million to EUR 1.39 million in 2100. In

Latvia, it is estimated that the total amount of losses resulting from the loss of productive time by traffic participants due to the risk of heavy rainfall and flood caused by such rainfall constitutes EUR 31,571 thousand, the amount of losses related to the liquidation of consequences thereof equals to EUR 8.85 thousand, the remuneration paid by insurers amounts to EUR 39,420 thousand, but the total amount of losses caused by the risk is EUR 79.84 thousand. Calculations show that the amount of losses related to the risk will increase in 2100, and in 2100, the risk of heavy rainfall and flood caused by such rainfall will account for losses in the amount of EUR 121.56 thousand due to the loss of productive time by traffic participants, whereas the liquidation of consequences will cause losses in the amount of EUR 12.75 thousand, the remuneration paid by insurers will be EUR 56.78 thousand, thus, in total such risk is estimated to cause losses in the amount of EUR 191.10 thousand. In the future, the risk of storms and wind surges at the sea in relative terms will cause the largest amount of losses. Calculations show that in the current situation the risk could cause losses in the amount of EUR 3.15 million (EUR 2.2 million – the amount of losses caused by storms, EUR 944.67 thousand – the amount of losses caused by wind surges). During the period up to 2100, the total amount of losses caused by the risk could reach EUR 15.59 million, including significantly increasing the amount of losses caused by wind surges – to EUR 6.86 million, and the amount of losses caused by storms – to EUR 8.73 million.[30]

2.2.3. Health and Welfare

In Latvia, groups of socially disadvantaged persons (families with small children, elderly people, people with chronic diseases (including physical and mental health disorders), people with disabilities, poor and low-income population, persons residing far from the centres of economically active regions, etc.) will be affected by climate change the most. Without the necessary support and assistance (availability of medical aid and other emergency services), which is affected by poor material conditions, inappropriate or inaccessible infrastructure and information, the social and economic situation of these groups of the population may deteriorate significantly that in general could lead to greater social inequality in the country.

In case of extreme weather conditions, significant losses to health (a severe illness or death case) may also affect the social and economic stability of households which do not belong to the group subject to poverty and social exclusion. The productivity of the economically active household members, possibilities to get involved in the labour market and, hence, to earn income in order to ensure household needs could be affected both by the significant health problems of the working household members and the need to take care of unemployed family members (children, elderly family members) with significant health problems caused by the negative effects of climate change.[31]

The effects of climate change (including extremes) which are relevant in the field of health and welfare in Latvia are as follows:

[30] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana civilās aizsardzības un ārkārtas palīdzības jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Civil Protection and Emergency Assistance], final report, *Procesu analīzes un izpētes centrs* [Centre of Processes Analysis and Research], 2017. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

[31] Losses related to incapacity for work due to disability have been calculated in the draft Plan on the basis of the years lost due to disability according to the final report *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana veselības un labklājības jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Health and Welfare].

- increased mean air temperature that could result in longer spring / summer / autumn periods and shorter winter periods;[32]
- increased total amount of annual precipitation, increased frequency of heavy rainfalls, increased water temperature in rivers, lakes and other water bodies;
- increased frequency and duration of heat waves.

Several risks have been identified in the field of health and welfare, whereas the risks listed below have been analysed in depth and are considered to be of significant relevance in Latvia (see Table 4).

Table 4. Climate change risks and potential consequences in the field of health and welfare

Risk	Potential consequences
Increased spread of acute intestinal infections, outbreak of such infections	Increased number of people affected; increased number of inpatients and outpatients. Increased healthcare costs and costs related to productivity loss; increased social sector expenses.
Increased spread of chronic diseases (cardiovascular diseases (hereinafter – CVD), diabetes) and increased mortality	The number of people affected is increasing and also the number of deaths caused by CVD increases (in acute cases, often there is not enough time for hospitalisation), especially at the age of 60 years; the number of inpatients and outpatients with other chronic diseases is increasing; the number of prematurely lost life-years is increasing and the amount of losses due to incapacity for work as a result of disability is increasing, the loss of productivity during the time of sickness and additional hospital expenses will increase in particular due to CVD; increase in the amount of expenses in the social area;
Increased spread of illnesses and/or infectious diseases spread by carriers of diseases become endemic	Increased number of people affected; increased number of inpatients and outpatients; increased healthcare expenses; increased expenses in the social area.
Increased morbidity and mortality rates caused by diseases of the respiratory system in particular for various risk groups (employees whose work is related to long-term stay outside, elderly people, people with chronic diseases)	Increased number of people affected; increased number of inpatients and outpatients. Expected increase in healthcare costs and costs related to productivity loss; increased expenses in the social area.
Increased frequency of heat strokes	Increased number of people affected; increased number of inpatients and outpatients; slight increase in the number of prematurely lost life-years; increased healthcare costs and costs related to productivity loss; increased expenses in the social area.

[32] Meteorological winter is a season when air temperature is stable below 0ºC. LEGMC has started working on clarification of the definition because up to now no definition has been assigned to the notion ‘stable. In other countries and the WMO often use in particular the calendar season (winter – from 1 December to 28/29 February).

Internal migration of the population due to the effects of climate change	Growing urbanisation causing pressures on the environment, infrastructure, healthcare and social care; moreover, large concentrations of people in particular locations cause potentially greater future losses.
Migration of foreign population to Latvia due to the effects of climate change abroad	Migration of the population due to climate and environmental factors; psycho-emotional tension; fertile conditions for conflicts and social tension; increased expenses in the social area.
Housing availability and provision, housing-related losses	More widespread damages to housing caused by extreme weather conditions, affecting social and economic stability of households, labour productivity of economically active household members; groups of the population exposed to the risks of poverty and social exclusion will be facing the difficulty to ensure adaptation of their housing (house / apartment) to the effects of climate change.

Such risks as "increased frequency of heat strokes" and "increased spread of chronic diseases (CVD, diabetes) and increased mortality" are of the highest relevance in terms of the highest risk level and the highest probability of occurrence. In the context of climate change, CVD is expected to have the greatest negative impact in respect of losses to human health.

Economic losses in the period from 2016 to 2100, for example, caused by CVD are estimated on average in the amount of EUR 21.6 million per year and losses due to incapacity for work as a result of disability – on average EUR 4.3 million per year. Due to climate change, CVD is expected to generate also the largest amount of costs for the country. Costs will be caused by productivity loss during the time of sickness (EUR 103 thousand per year) and increase in hospital expenses (EUR 346 thousand per year). All other health risks will pose a lesser threat to human health. A slight impact on the lost life-years is expected in the case of a heat stroke – EUR 26 thousand (discounted) on average per year. The highest expected costs among other risks are forecast to diseases of the respiratory system where the productivity loss is estimated on average in the amount of EUR 24 thousand per year and additional losses in the field of healthcare – on average EUR 62 thousand per year.[33]

2.2.4. Biodiversity and Ecosystem Services

Due to the lack of data, currently it is difficult to assess the impact of climate change on biodiversity in Latvia. It is necessary to carry out in-depth study of the entry of new species into Latvia, to monitor expansive and invasive foreign species, and also species located in Latvia at the border of the natural range thereof. For example, boreal species feel worse and could recede, while nemoral species feel better and their quantity could expand. Likewise, it is important to intensify the monitoring of organisms which are harmful to plants (quarantine organisms) typical in regions with moderately warm climate as this could directly affect biodiversity. Decrease in the biodiversity and ecosystem services as a result of interaction between climate change and anthropogenic causes a threat to preservation and sustainable development of the natural capital of Latvia. In order to obtain detailed and scientifically substantiated information on nature values of Latvia, the amount, types, distribution and quality

[33] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana veselības un labklājības jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Health and Welfare], final report, SIA "Estonian, Latvian & Lithuanian Environment", Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

thereof, identification of distribution and quality of specially protected habitats of EU significance, analysis of the obtained basic information and preparation of preconditions for the preservation of biodiversity and protection of ecosystems are carried out within the framework of the project "Nature Census"[34].

The effects of climate change that might affect biodiversity and ecosystem services in Latvia are as follows:

- increase in air temperature, increase in the minimum air temperature in winter;
- earlier growth phase in spring, longer summer periods;
- increase in water temperature and level and increase in frequency of fluctuations in surface water levels;
- changes in the amount of precipitation (increase in certain seasons and decrease during summer), more likely occurrence of more frequent and longer periods of drought, reduced snow cover;
- increased frequency and contrast of extreme weather conditions.

The study Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Biodiversity and Ecosystem Services provides the following classification of ecosystem services in Latvia: **provisioning** (for example, water, materials (for example, uncultivated wild-growing plants, mushrooms, use thereof), energy (wood, biodiesel, etc.), **regulating** (for example, biological treatment, noise regulation, pathogen control, etc.) and **non-material** (aesthetic and cultural) ecosystem services (for example, recreation, landscape as a cultural and historical value, etc.).

Several risks have been identified in the field of biodiversity and ecosystem services in Latvia, whereas six risks listed below[35] have been analysed in depth and are considered to be of significant relevance in Latvia (see Table 5).

Table 5. Climate change risks and potential consequences in the field of biodiversity and ecosystem services

Risk	Potential consequences
Eutrophication of watercourses, water bodies	Disappearance of ecologically sensitive and primarily protected species (spread or quality of which rapidly decreases); decrease in the total area of habitats typical of Latvia; decrease in biodiversity.
Increase in water temperature and longer stratification period, decrease in the amount	Disappearance of ecologically sensitive and primarily protected species (spread or quality of which rapidly decreases); decrease in the total area of habitats typical of Latvia; decrease in biodiversity.

[34] The project *Dabas skaitīšana* [Nature Census] or *Priekšnosacījumu izveide labākai bioloģiskās daudzveidības saglabāšanai un ekosistēmu aizsardzībai Latvijā* [Creation of Preconditions for Better Preservation of Biodiversity and Protection of Ecosystems in Latvia], information on the project is available online: https://www.daba.gov.lv/public/lat/projekti/kohezijas_fonds/dabas_skaitisana/

[35] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana bioloģiskās daudzveidības un ekosistēmu pakalpojumu jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Biodiversity and Ecosystem Services], final report, SIA "Estonian, Latvian & Lithuanian Environment", Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

Risk	Potential consequences
of dissolved oxygen at the ground layer	
Spread of expansive and invasive foreign species non-characteristic to Latvia, infectious diseases, harmful organisms of plants	Formation of new pathogenic and ecologically plastic species, taking over of ecologically sensitive species. The regulating ecosystem services, non-material ecosystem services and provisioning ecosystem services, on which also agriculture and forestry depend, are affected. Public health is affected.
Opportunities for entry of new species	The amount of invasive species is increasing, whereas biodiversity is decreasing. The regulating ecosystem services, non-material ecosystem services and provisioning ecosystem services are affected.
Ecologically sensitive species are taken over by ecologically plastic species	Change of species and habitats, including the disappearance of certain species and regression of populations in the territory of Latvia (ecologically plastic species take over ecologically sensitive species); decrease in the total area of habitats and species typical of Latvia; formation of new habitats in the place of disappearing habitats; decrease in biodiversity.
Flood – storm surges along the coastline, rising water levels in rivers and lakes	A certain part of habitats is washed away and destroyed irreversibly, reducing biodiversity.

Within the context of climate change, it is forecast such risks as "pollution and eutrophication of watercourses and water bodies" and "increase in water temperature and longer stratification period, decrease in the amount of dissolved oxygen at the ground layer" are of the highest relevance in terms of the highest risk level and the highest probability of occurrence. Overall, the greatest impact caused by climate change is expected in the fields of provisioning ecosystem services (for example, the use of uncultivated fresh water / marine plants and animals for human consumption) and regulating ecosystem services (for example, maintenance of life cycle, protection of habitats and gene pools).

The impact of climate change on biodiversity and ecosystem services can be described, for example, by a separate element of biodiversity, such as the deer population, dune habitats, herring populations and changes in the values of bird species in the future[36]. Due to several reasons, fluctuations in the size of the deer population is a good climate change indicator.[37] It is forecast that until 2100 the economic value of the deer population[38] will increase, providing the benefit of EUR 158.85 million (compared to the economic value of the deer population in 2014), the total value of the Gulf of Riga herring stock[39] will increase, providing the benefit of EUR 413.48 million (compared to the economic value of the herring stock in 2016), while the

[36] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana bioloģiskās daudzveidības un ekosistēmu pakalpojumu jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Biodiversity and Ecosystem Services], final report, SIA "Estonian, Latvian & Lithuanian Environment", Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

[37] Ibid.

[38] Ibid.

[39] Ibid.

value of coastal dune habitats and the total value of bird species will decrease, respectively causing losses in the amount of EUR 231.69 million and EUR 45.21 million.[40]
Biodiversity and ecosystem services are affected also by landscape simplification (monocultures – continuous forest plantations with one type of species, agricultural land with large continuous crop areas). Ecosystems become less stable, this promotes the spread of invasive or foreign species and pests. The more diverse ecosystem, the more stable it becomes and is capable of adjusting to climate change more quickly and provides a wider range of ecosystem services.

2.2.5. Agriculture, Forestry and Fishery

Since agriculture, forestry and fishery are directly exposed to the impact of weather conditions, it is important to determine the necessary adaptation measures and to develop recommendations for further development of a competitive industry, minimising the risks arising due to climate change and taking advantage of the potential benefits of climate change.

The effects of climate change that might cause risks in the fields of agriculture, forestry and fishery are as follows[41]:

- increase in the mean temperature in winter and decreased duration of meteorological winter, increase in the mean temperature during summer and increased duration of meteorological summer, more frequent and longer periods of drought in summer; increased number of days with extremely high temperature in summer;
- increase in the total amount of annual precipitation, changes in the amount of precipitation during summer months, increase in the probability of sudden and severe thunderstorms in summer;
- greater uncertainty of snow cover thickness, decrease in the number of frozen ground days, formation of air mass contact lanes, creating conditions favourable for freezing precipitation; increased wind speed in separate territories of Latvia.

Several risks have been identified in the field of agriculture, forestry and fishery, whereas the risks listed below have been analysed in depth and are considered to be of significant relevance in Latvia (see Table 6). At the same time, it should be taken into account that, unlike many other sectors, climate change might have a positive impact on agriculture and forestry, for example, a longer vegetation period, better harvests, etc. Potential benefits are described in Sub-chapter 2.2.7.

Table 6. Climate change risks and potential negative consequences in the field of agriculture, forestry and fishery

Risk	Potential negative consequences
Destruction of crop fields / plantations due to black frost	Decrease in the amount of harvest or quality thereof. Affected crops: winter cereals (including wheat, barley, rye, triticale, spelt), winter rape, temporary grasses, fruit trees and berry bushes, ornamental trees and shrubs.

[40] Ibid.
[41] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana lauksaimniecības un mežsaimniecības jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Agriculture and Forestry], final report, Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

Risk	Potential negative consequences
Spread of organisms harmful to crops and woody plants (diseases, pests), spread of parasitic plants (also new species)	Decrease in the amount of harvest or quality thereof; increase in the amount of damaged wood. Affected crops: arable crops, including cereal grain, legumes, industrial crops, energy crops, fodder plants, fruit trees and berry bushes, ornamental trees and shrubs, forest stands.
Spread of zoonotic agents and disease carriers affecting animals in Latvia and spread of zoonotic agents and disease carriers previously non-characteristic to geographical conditions of Latvia, including the spread of invasive foreign insect species	Increased animal morbidity rate and/or occurrence of the endemic nature of infectious diseases of animals, and also expansion of new diseases; increased costs of agricultural produce; risks of antimicrobial resistance and antiparasitic resistance occurrence, prolonged treatment period of animals and increased amount of losses due to non-obtained produce and death of animals.
Flooding of agricultural land under intense precipitation conditions	Decrease in the amount of harvest or quality thereof and also low bearing capacity of soil[42] during harvest; washout of crops, hindered harvesting and soil cultivation due to excessive moisture. Affected crops: arable crops, including cereal grain, legumes, industrial crops, energy crops, fodder plants, fruit trees and berry bushes, ornamental trees and shrubs.
Drying and faster drying of soil / plants	Decrease in the amount of harvest or quality thereof. Affected crops: arable crops, including cereal grain, legumes, industrial crops, energy crops, fodder plants, fruit trees and berry bushes, ornamental trees and shrubs, tree plantations in young stands.
Risk of long-term heat waves	Decrease in the amount of harvest or quality thereof; decrease in productivity and immunity of agricultural animals; risk of fire (especially in forests). Affected crops: arable crops, including cereal grain, legumes, industrial crops, energy crops, fodder plants, fruit trees and berry bushes, ornamental trees and shrubs.
Lack of winter freeze	Hindered forest exploitation.
Freezing precipitation, windthrows and snowbreaks	Wood damage and hindered forest exploitation.
Increase in water temperature in water bodies, eutrophication	Fish suffocation (due to decrease in oxygen level), losses of aquaculture fish products; decrease in certain fish species populations in particular waters or national regions; deterioration of natural reproduction abilities of certain fish species.

[42] *The bearing capacity of soil is one of the indicators of soil quality. It is crucial, for example, in cultivation of agricultural land or forest exploitation. Dry soil has greater bearing capacity, while moisture facilitates soil compaction.*

Risk	Potential negative consequences
Rapid changes in precipitation amount	Flood in open-type fish-breeding farms that may lead to the escape of aquaculture fish, loss of produce and getting of fish into nature, deterioration of the balance of natural ecosystems.

The most significant risks established in the field of agriculture are related to the destruction of crop fields / plantations due to black frost, spread of crop and animal diseases and pests, loss of the harvest or quality thereof due to precipitation during the harvesting period, drying, faster drying of soil and impact caused by long-term heat waves. In turn, the spread of tree diseases and pests, storms and lack of winter freeze hindering forest exploitation are risks of the highest relevance in the field of forestry. Risks are mainly affected by economic impact. Social impact occurs indirectly from the economic situation: the welfare of farm owners decreases along with the decrease in the productivity of particular crops, including the possibilities of farms to employ workers, thus leaving a social and economic impact on the region where the farm is located. The impact of these risks is particularly evident in cases where several farms are affected in one region (for example, the necessity to slaughter animal herds affected by a disease or damages caused by freezing precipitation).

The financial impact in the field of forestry can be estimated only approximately, taking into account the data at the disposal of the SFS on sanitary felling areas over the last 10 years, division of forest stands by tree species and age structure according to the statistical inventory data of the forest and assumptions on the volume of damaged wood or decrease in growth thereof. In carrying out these calculations, it has been established that, for example, direct losses caused by storms to forest owners during the last decade were approximately EUR 164 million, whereas, approximately losses in the amount of EUR 36 million were caused by dendrophagic insects.[43]

2.2.6. Tourism and Landscape Planning

Climate change could impact tourism development in Latvia both as a negative factor and a positive factor. Climate change may change the visual quality, aesthetic, ecological, economic, scientific, historical and recreational value of landscapes which, in turn, may change tourist behaviour and habits and affect the economy of the particular place, region or country.

The effects of climate change that might affect tourism and landscape planning in Latvia are as follows:

- increased annual mean air temperature, increased mean air temperature during winter, increased minimum value of maximum day-to-day temperature, increased mean air temperature in summer months;
- decreased number of frost days, number of ice days, decreased average number of days with a snow cover, decreased average thickness of snow cover in winter months, shorter duration of ice freeze-up period, increased number of summer days, increased number of tropical nights;
- increased growing season length;

[43] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana lauksaimniecības un mežsaimniecības jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Agriculture and Forestry], final report, Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

- increased amount of annual precipitation, constant increase in the duration of precipitation period, increased number of days with heavy and very heavy precipitation, increased maximum amount precipitation over a period of 24 hours;
- maximum wind gust increase along the coastline, increased number of days with the maximum wind speed at the western wind directions along the coastline.

Several risks have been identified in the field of tourism and landscape planning in Latvia[44], whereas the risks listed below have been analysed in depth and are considered to be of significant relevance in Latvia (see Table 7).

Table 7. Climate change risks and potential consequences in the field of tourism and landscape planning

Risk	Potential negative consequences
Risk of the change of the length and characteristics of the winter tourism season	Shorter duration of periods where one may enjoy the winter landscape; fewer winter tourism attractions (activities, events); increased costs of artificial snow; fall in the number of winter tourists; rise in outgoing tourism to regions with winter tourism attractions outside Latvia; losses to Latvian tourism companies.
Flood risk (rising water levels in rivers and lakes)	Degradation or destruction of forestry, agriculture, natural attractions and urban landscape elements; degradation or destruction of natural attractions, cultural and historical values; changes in the visual quality and value of landscapes; degradation or destruction of tourism infrastructure; decline in the flow of tourists or increase in affected territories.
Coastal flooding and erosion risk along the coastline of the Baltic Sea and the Gulf of Riga	Degradation or destruction of landscape elements characterising coastal area (including high-value beaches); degradation or destruction of forestry, agriculture, natural attractions and urban landscape elements; degradation or destruction of natural attractions, cultural and historical values along the coastline; changes in the visual quality and value of the coastal area and coastal landscape; degradation or destruction of tourism infrastructure along the coastline; changes in the quality and value of the coastline and landscape along the coastline; decline in touristic aspirations to visit the risks-affected territories; decline in the flow of tourists or increase in affected territories.
Risk of the change of the length of the summer tourism season	Changes in the heating and conditioning periods at tourist accommodation sites.

The assessment of the possible consequences in the tourism industry and the field of landscape planning in terms of economic losses shows that the highest risk level is related to the change of the length and characteristics of the winter tourism season (losses in the amount of EUR 3.4 million) and flood risk (losses in the amount of EUR 29–52 million) – rising water levels in rivers and lakes. Coastal flooding and erosion risk along the coastline of the Baltic Sea

[44] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana ainavu plānošanas un tūrisma jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Landscape Planning and Tourism], final report, SI "Baltkonsults", Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

and the Gulf of Riga might cause losses in the amount of EUR 15–20 million. At a national level, it is possible to identify several indicative vulnerability areas related to the risk of the change of the length and characteristics of the winter tourism season, flood risk (rising water levels in rivers and lakes) and coastal flooding and erosion risk along the coastline of the Baltic Sea and the Gulf of Riga. The tourism industry of Latvia should also take into account the risk of deterioration of the quality of bathing waters and the risk of river run-off variability.

2.2.7. Possible Benefits from Climate Change

Several possible benefits and opportunities of climate change in Latvia were identified in the risk research studies[45] used in the development of the Plan.

Table 8. Possible benefits of climate change

Area	Possible benefits
Building and infrastructure planning	The increase in the annual mean temperature could reduce the heating costs for the population. Changes in the duration of the growing seasoncould improve the availability of bioenergy sources. Warmer air temperature in winter might reduce ice and snow on roads, thus reducing the costs of road cleaning and repairs.
Agriculture, forestry and fishery	Increase in agricultural productivity and forestry production potential due to longer growing season and frost-free periods. Increase in the annual mean temperature and longer growing season could also provide the opportunity to cultivate new crops. Earlier start of harvest works for certain crops. Longer growing season would provide the opportunity to grow late varieties of crops. Longer periods of fresh fodder availability could potentially reduce the prime cost of dairy and other livestock products and improve their quality in many places.

[45] *Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana ainavu plānošanas un tūrisma jomā* [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Landscape Planning and Tourism], final report, SI "Baltkonsults", Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668
Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana lauksaimniecības un mežsaimniecības jomā [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Agriculture and Forestry], final report, Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668
Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana bioloģiskās daudzveidības un ekosistēmu pakalpojumu jomā [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Biodiversity and Ecosystem Services], final report, SIA "Estonian, Latvian & Lithuanian Environment", Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668
Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana veselības un labklājības jomā [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Health and Welfare], final report, SIA "Estonian, Latvian & Lithuanian Environment", Riga, 2016. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668
Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana civilās aizsardzības un ārkārtas palīdzības jomā [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Civil Protection and Emergency Assistance], final report, *Procesu analīzes un izpētes centrs* [Centre of Processes Analysis and Research], 2017. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668
Risku un ievainojamības novērtējums un pielāgošanās pasākumu identificēšana būvniecības un infrastruktūras jomā [Risk and Vulnerability Assessment and Identification of Adjustment Measures in the Field of Building and Infrastructure Planning], final report, association *Zaļā brīvība* [Green Freedom], 2017. Available online: http://www.varam.gov.lv/lat/publ/petijumi/petijumi_klimata_parmainu_joma/?doc=23668

Area	Possible benefits
Tourism and landscape planning	Longer summer periods could attract more tourists during summer. In economic terms, the forecast of benefit shows that changes in the length of summer tourism season could provide significant benefits.
Biodiversity and ecosystem services	In this area, the benefit would be the possible improvement of the condition for species and habitats located at the border of the natural range and improvement of conditions for the entry of new protected species of EU significance non-typical for Latvia. In case of severe floods, regulated rivers could go back in the previous riverbeds that would improve the quality of the landscape and expand biodiversity; in addition, flooded areas are crucial for migratory birds.
Health and welfare	Shorter winter periods could reduce the scale of influenza epidemics, the spread of bronchitis and pneumonia, etc.
Civil protection and disaster management planning	Reduced the scale and frequency of spring flood and flood caused by ice buildup.

Studies show several possible benefits from climate change to Latvia in all areas described in the Plan. At the same time, all benefits must be considered in the context of potential losses due to climate change. For example, although reduction in heating costs could be the benefit for people, air conditioning will require additional costs. Similarly, for example, tourism sector will benefit from longer summer periods, yet warmer winter temperatures resulting in reduced tourist flows will causes losses.

2.3. Alignment of the Plan to Existing International, EU and Latvia's Policy Planning Documents and Legislation

2.3.1. Alignment to Existing International EU-level Policy Planning Documents and Legislation

The objective of the UN Framework Convention on Climate Change[46] (hereinafter – the Convention) is to stabilise GHG concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Moreover, such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. Countries referred to in Annex I to the Convention, which include also Latvia, have strict requirements for the fulfilment of obligations – they must submit national reports once every four years where they must report on climate change impacts, vulnerability, adaptation measures. The Convention states that Member States must introduce safeguard measures in order to predict and prevent or neutralise the causes of climate change and mitigate its adverse effects. The Convention determines the obligation to report on climate change, stipulating that the Parties to the Convention (Annex I to the Convention) must submit national reports once every four years reporting on climate change impacts, vulnerability, adaptation measures.

The goal of the **Paris Agreement**[47] is as follows:

- holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels;
- to increase the ability to adapt to the adverse impacts of climate change and foster climate resilience;
- to promote development characterised by low GHG emissions, in a manner that does not threaten food production;
- making finance flows consistent with a pathway towards low GHG emissions and climate-resilient development.

Article 7 of the Paris Agreement sets out the global goal and tasks in the field of adaptation and that the Parties to the Paris Agreement, including Latvia, should carry out national planning of climate change adaptation process, prepare an action policy and inform the Convention Secretariat thereof. The Paris Agreement states that starting from 2021, reporting of adaptation to climate change must be carried out once every two years; however, certain reporting requirements are not known yet. According to the decisions adopted at the meeting of the Parties to the Convention, which took place in Katowice, Poland, in December 2018, work on the development of joint reporting formats will be continued in 2019.

In 2015, the UN General Assembly adopted the resolution **Transforming our World: the 2030 Agenda for Sustainable Development** which lays out 17 Sustainable Development Goals and 169 targets[48] which aim to mobilise global efforts to end poverty and ensure sustainable global

[46] Law On the United Nations Framework Convention on Climate Change, available online: https://likumi.lv/ta/id/34198-par-apvienoto-naciju-organizacijas-visparejo-konvenciju-par-klimata-parmainam

[47] Law On the Paris Agreement of the United Nations Framework Convention on Climate Change, available online: https://likumi.lv/ta/id/288575-par-apvienoto-naciju-organizacijas-visparejas-konvencijas-par-klimata-parmainam-parizes-noligumu

[48] UN Sustainable Development Goals, available online: https://www.pkc.gov.lv/lv/valsts-attistibas-planosana/ano-ilgtspejigas-attistibas-merki

development. Goal 13 is "take urgent action to combat climate change and its impacts", including the implementation of measures for adaptation to climate change. Goal 13, sub-paragraph 1 sets out the following task: "strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries". In addition, the tasks related to adaptation to climate change are included in almost all other sustainable development goals, for example: end poverty in all its forms everywhere (Goal 1); end hunger, achieve food security and improved nutrition and promote sustainable agriculture (Goal 2); ensure healthy lives and promote well-being for all at all ages (Goal 3); ensure availability and sustainable management of water and sanitation for all (Goal 6); promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (Goal 8); build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation (Goal 9); make cities and human settlements inclusive, safe, resilient and sustainable (Goal 11); protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (Goal 15).

UN Sendai Framework for Disaster Risk Reduction 2015–2030[49] was adopted on 18 March 2015. The Framework Programme outlines objectives to be achieved over a period of 15 years, for example, to reduce global disaster mortality or to reduce disaster damage to critical infrastructure and to reduce direct disaster economic loss in relation to global gross domestic product (GDP), to increase the availability of early warning systems. The Sendai Framework recommends inclusion of the climate change aspect in the disaster risk management policies, plans, actions and mechanisms. It identifies how to use future climate scenarios in disaster risk studies and the preparation of regional maps, to freely share the current situation, remote observations and future forecasts, and to cooperate in climate variability studies. In order to increase the preparedness for efficient response, periodic review of disaster management policies, plans and programmes is required by including the latest scientific opinions therein.

In order to support the efforts and priorities laid down in the Sendai Framework, the EC adopted the **Action Plan on the Sendai Framework for Disaster Risk Reduction**[50] where, jointly with EU Member States, it undertakes to implement effective policies for disaster prevention and disaster preparedness. For example, the EC has established the Disaster Risk Management Knowledge Centre[51] which allows to reinforce the links between scientific achievements (hazard modelling, forecasting, early warning systems, risk assessment methodologies, disaster loss and damage data storage, etc.) and technologies, and transfer thereof to disaster management policies.

The communication from the EC entitled **EU Adaptation to Climate Change**[52] is the key document that defines climate change policies at EU level and one of the goals of which is to encourage all EU Member States to adopt comprehensive adaptation strategies and to provide funding to support capacity building and step up adaptation action, including to support adaptation to climate change in cities. The goal of the EC is to facilitate adaptation in all key areas vulnerable to the impact of climate change such as agriculture, fishery and cohesion

[49] UN Sendai Framework for Disaster Risk Reduction 2015–2030. Available online: http://www.unisdr.org/we/coordinate/sendai-framework

[50] Commission Staff Working Document "Action Plan on the Sendai Framework for Disaster Risk Reduction 2015–2030. A disaster risk-informed approach for all EU policies", available online: http://ec.europa.eu/transparency/regdoc/rep/10102/2016/EN/10102-2016-205-EN-F1-1.PDF

[51] Disaster Risk Management Knowledge Centre, website, available online: http://drmkc.jrc.ec.europa.eu/

[52] The EU Adaptation Strategy Package "EU Adaptation to Climate Change", available online: https://ec.europa.eu/clima/policies/adaptation/what_en#tab-0-1

policies, ensuring that infrastructure becomes more resilient to the adverse impacts of climate change and to achieve greater resilience to natural disasters. It is emphasised in the communication from the EC that adaptation measures must be implemented at all levels – at local, regional and national level. The EC communication assessment package was released in 2018 which provides an analysis of the implementation of EU adaptation strategy, simultaneously providing forecasts of losses for EU and recommendations for improvements in the context of adaptation in different areas in the future.[53] The accompanying document of the assessment package contains information on the progress of EU Member States, including Latvia, in the field of adaptation.[54] In this stage the EC considers that the current strategy corresponds to its objective, while at the same time admitting that since 2013 adaptation needs have become more intense and more diverse. The EC considers that a range of measures and their results until 2020 must be considered before taking a decision on the possible review of the strategy.

The Baltic Sea Region Climate Change Adaptation Strategy and Action Plan[55] is a document of recommendatory nature to promote actions for adaptation to climate change for the countries of the Baltic Sea region. The Strategy and Action Plan cover the matters of major importance for the urban environment – the intensifying tendency of extreme precipitation and urban planning, and also practical solutions. The use of modern visual materials, which make knowledge of future climate more understandable, is particularly emphasised.

The aim of the **European Landscape Convention[56]** is to promote landscape protection, management and planning, and also to organise European cooperation on landscape issues.

At EU level, reporting on adaptation to climate change is currently determined by **Regulation (EU) 2018/1999 of the European Parliament and of the Council** of 11 December 2018 **on the Governance of the Energy Union and Climate Action**, replacing reporting requirements on adaptation to climate change laid down in Regulation No 525/2013. Pursuant to Article 19 of Regulation No 2018/1999, by 15 March 2021, and every two years thereafter, Member States shall report to the Commission information on their national climate change adaptation planning and strategies, outlining their implemented and planned actions to facilitate adaptation to climate change.

Membership in the WMO provides for reporting on climate parameter observations at the request of the organisation, including information on observations in different periods and cross-sections, and information on observation metadata. There is the obligation to submit annual national reports on precipitation and air temperature observations and any anomalies thereof in comparison with the values of the climate reference period and also information on extreme weather conditions.

Recommendations by the **Organisation for Economic Co-operation and Development** (OECD) include adaptation and inclusion thereof in the development of the action policy[57],

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[53] Report from the Commission to the European Parliament and the Council on the implementation of the EU Strategy on adaptation to climate change. Available online: https://eur-lex.europa.eu/legal-content/LV/TXT/PDF/?uri=CELEX:52018DC0738&from=EN

[54] Commission Staff Working Document, Adaptation preparedness scoreboard Country fiches accompanying the document "Report from the Commission to the European Parliament and the Council on the implementation of the EU Strategy on adaptation to climate change". Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018SC0460&from=EN

[55] The Baltic Sea Region Climate Change Adaptation Strategy and Action Plan, available online: http://www.baltadapt.eu/

[56] European Landscape Convention, available online: https://likumi.lv/ta/lv/starptautiskie-ligumi/id/1265

[57] The OECD recommendations and publications on adaptation to climate change, available online: http://www.oecd.org/env/cc/adaptation.htm

inter alia, considering the role of the private sector, use of the economic analysis, comparison of national adaptation approaches and inclusion thereof in sectoral activities. The OECD helps Member States share their adaptation experience, identify obstacles and inform of the development of action policy solutions. In recent years, there has been a strong focus on economic considerations, including adaptation benefits and costs, discussing more successful adaptation options for cities, agriculture and aquaculture. In the OECD recommendation on climate-resistant infrastructure, it is recommended to design, build and use infrastructure so that it would be climate-resistant. The OECD emphasises the importance of the public partnership approach and green infrastructure solutions that supplement the grey infrastructure.[58] In turn, in the report on adaptation to climate change, the OECD draws attention to the necessity to carry out high-quality monitoring and assessment of climate change and also encourages to integrate adaptation planning aspects into policies.[59]

2.3.2. Alignment to Development Planning Documents of the Republic of Latvia

Latvia has introduced development planning documents that directly affect adaptation to climate change (e.g. Environmental Policy Guidelines 2014–2020) and there are other documents related to adaptation to climate change but without any specific objectives or measures that would promote adaptation to climate change (for example, Sustainable Development Strategy of Latvia until 2030) or the aspects of climate change are not distinguished separately (Latvian Tourism Development Guidelines 2014–2020).

Sustainable Development Strategy of Latvia until 2030[60] (hereinafter – SDSL2030) specifies climate change among the most significant challenges related to global processes that affect national economy and ecosystems, ecosystem services, natural and human capitals. SDSL2030 accents, particularly in respect of climate change risks, coastal erosion and sand accumulation processes taking place along the coast of the Baltic Sea. It is indicated that by promoting sustainable lifestyle, consumption and production models within the context of climate change will allow eliminating not only direct social and economic losses (for example, to reduce the mortality rate due to climate extremes, destroyed harvest in agriculture or wood in forestry), but to increase global competitiveness, labour productivity, promote energy independence, etc. (strategic indicators of SDSL2030).

All three priority areas (growth of the national economy, territories supporting human safety and growth) of the **National Development Plan of Latvia for 2014–2020[61]** are related to the areas described in the Plan. Prevention of risks and vulnerabilities in such areas as civil protection and health is associated with human securitability. Reduction of risks and vulnerabilities in the field of building, agriculture and forestry is directly related to economic growth. Implementation of the measures outlined in the Plan will enhance mitigation of risks and vulnerabilities in regions related to the third priority area "territories supporting growth".

National Development Plan of Latvia 2021–2027 is currently being drafted. Public discussions organised by the Interdepartmental Co-ordination Centre regarding priorities, goals

[58] Climate-resilient infrastructure: Getting the policies right, available online: http://www.oecd.org/environment/cc/policy-perspectives-climate-resilient-infrastructure.pdf
[59] Adapting to the impacts of climate change, Policy perspectives. Available online: http://www.oecd.org/environment/cc/Adapting-to-the-impacts-of-climate-change-2015-Policy-Perspectives-27.10.15%20WEB.pdf
[60] Sustainable Development Strategy of Latvia until 2030, available online: http://www.varam.gov.lv/lat/pol/ppd/?doc=13857
[61] National Development Plan of Latvia for 2014–2020, available online: http://polsis.mk.gov.lv/documents/4247

and investment directions to be included in the National Development Plan of Latvia 2021–2027 were completed on 31 January 2019. It is planned that the National Development Plan of Latvia for 2021–2027 will be submitted for review to the Cabinet in June 2019. It is expected that the National Development Plan of Latvia 2021–2027 will include priorities that will affect the promotion of adaptation to climate change.

Environmental Policy Guidelines 2014–2020[62] (hereinafter – EPG2020) set forth measures to achieve the ultimate goal: to ensure the possibility for inhabitants to live in a clean and well-arranged environment, implementing actions focused on sustainable development, preserving environmental quality and biodiversity, ensuring sustainable use of natural resources, and also public involvement in the decision-making process and awareness of the environmental status. EPG2020 is currently the main document determining the policy on adaptation to climate change in Latvia. EPG2020 defines the following goal for adaptation to climate change: "to promote Latvia's readiness to adapt to climate change and the impacts thereof". EPG2020 lists 10 action directions in order to achieve the defined goals in relation to promoting adaptation to climate change. The action directions include modelling climate scenarios and creating an integrated data system, risk and sensitivity analysis and identification of measures in priority sectors, integration of measures of adaptation to climate change into public health policy, etc. Almost all of the 10 action directions of EPG2020 in relation to the promotion of adaptation to climate change have already been implemented.

Environmental Monitoring Programme 2015–2020[63] includes five parts: (1) air and climate change monitoring programme (inter alia, it includes systematic acquisition and accumulation of primary meteorological and climate information); (2) water monitoring programme (the frequency of monitoring the chemical condition of groundwater has been increased for assessing the impacts of climate variability, whereas the marine environment monitoring programme provides measures for the prevention of shortcomings in the preservation of the climate impact dynamics data and development of hydrological models; (3) land monitoring programme (for example, monitoring of the land cover, monitoring of the soil radioactivity, monitoring of current geological processes); (4) biodiversity monitoring programme (background monitoring, for example, provision of information on trends in the change of population levels of species and habitat areas); and (5) forest monitoring programme. The objective of the implementation of the environmental monitoring is to obtain data and information on the state of the environment and nature, including on the observed impacts of climate change in order to ensure timely response.

National Long-term Thematic Plan for the Development of Public Infrastructure of the Baltic Sea Coast[64] (hereinafter – the Coastal Plan) defines the following main goal: the coast of Latvia is an economically active and multi-functional space where preservation of natural and cultural heritage and adaptation to climate change are ensured with high-quality infrastructure and where good administration is being implemented. Coastal planning solutions are agreements between coastal municipalities, State institutions and non-governmental organisations in order to attract investments to places where they will promote preservation and development of natural and cultural heritage. The conditions included in Coastal Plan stipulate that construction works along the coastline are planned and performed in compliance with long-

[62] Environmental Policy Guidelines 2014–2020, available online: http://www.varam.gov.lv/lat/pol/ppd/vide/?doc=17913

[63] Environmental Monitoring Programme 2015–2020, available online: https://meteo.lv/lapas/noverojumi/vides-monitoringa-pamatnostadnes-un-programma/vides-monitoringa-programma-2015-2020-gadam/vides-monitoringa-programma-2015-2020-gadam?id=2002&nid=968

[64] National Long-term Thematic Plan for the Development of Public Infrastructure of the Baltic Sea Coast, available online: http://www.varam.gov.lv/lat/darbibas_veidi/tap/lv/?doc=18794

term forecasts regarding the impact of climate change, coastal erosion processes and landscape values.

Regional Policy Guidelines 2013–2019[65] (hereinafter – the Regional Guidelines) lay down the following long-term development goals: 1) to create equal living and working conditions for all inhabitants, regardless of the place of residence, promoting entrepreneurship in regions, developing qualitative transport and electronic communications infrastructure and public services, and 2) to strengthen the international competitiveness of Latvia and its regions, increasing the international role of Riga as the metropolis of Northern Europe and other countries. The Regional Guidelines specify the support direction for the coast of the Baltic Sea – infrastructure for the reduction of coastal erosion and flooding risk. Coastal development resources are spatially limited; moreover, climate change (sea level rise, intensity of wind surges and seashore washout) along the coastline are much more explicit than inland; therefore, economic activities along the coastline must be balanced with preservation of natural and cultural heritage. One of the crucial support directions is development of coastal public infrastructure promoting entrepreneurship, reducing the impact of seasonality, preserving coastal values and promoting adaptation to climate change.

In the **Latvian Tourism Development Guidelines 2014–2020**, coastline has been identified as one of the most competitive territories for the export of Latvian tourism. Taking into account future climate scenarios, when southern European countries will be exposed to excessively high temperatures and drought, it is forecast that the number of tourists in the Baltic States and Latvia might increase significantly during summer.

Long-term Strategy for the Renovation of Buildings 2014–2020 states that the renovation of multi-apartment buildings and improvement of energy efficiency are one of the goals of the national housing and energy policy of Latvia. There is about one million dwelling units in Latvia and 69% of those buildings are located in multi-apartment buildings. Most of these buildings have been built before the restoration of national independence and are characterised by high depreciation of construction structures and engineering systems, and also low thermal stability. Energy consumed in the sector of buildings (multi-apartment buildings and public buildings) accounts for up to 40% of the State energy balance. The strategy lays down cost-effective renovation approaches depending on the type of buildings and climatic zone, and also the necessary political measures to promote cost-effective and complete renovation of buildings, including gradual deep renovation.

Landscape Policy Guidelines 2013–2019[66] state that climate is one of the most crucial natural factors in the development of landscapes of Latvia. The goal of the Latvian landscape policy is to develop multi-functional and qualitative landscapes that improve the quality of life of people across Latvia, promote the economic activity and recognition of places, regions and the country, and also ensure biodiversity. In turn, the priority task of the landscape policy is improvement of landscape management, determining competences of the authorities involved in landscape management and integrating the landscape policy in planning the development of the territory, particularly discussing both natural and cultural heritage.

[65] Regional Policy Guidelines 2013–2019, available online: http://www.varam.gov.lv/lat/pol/ppd/?doc=20773

[66] Landscape Policy Guidelines 2013–2019, available online: http://polsis.mk.gov.lv/documents/4427

In accordance with Regulation No. 2018/1999[67], the **initial draft National Energy and Climate Plan of Latvia** was developed in 2018 and submitted to the European Commission on 28 December 2018. Pursuant to the conditions laid down in Regulation No. 2018/1999, the final version of the National Energy and Climate (ENCP) Plan must be submitted to the EC by 31 December 2019. In the field of climate policy, the ENCP will cover measures for the reduction of GHG emissions not only in energy sector, but also in transport, agriculture, industrial processes, waste management, forestry and other sectors. The ENCP lays down actions to be implemented in Latvia in order to achieve the goals approved by the EU for Latvia for the period from 2021 to 2030 and also the annual goals for reducing GHG emissions and carbon dioxide removals. In addition, the ENCP must also ensure further advancement of the national economy of Latvia and the public towards low carbon economy, i.e. further reduction of GHG emissions and carbon dioxide removals in the long-term perspective. The ENCP does not intend to describe in detail matters related to adaptation to climate change; however, there is a reference to the Plan. Specific adaptation measures are set out in the Plan for adaptation. The implementation of adaptation to climate change policies in Latvia are also governed by the legislative acts of various industries. The most important legislative acts related to adaptation to climate change are as follows: Spatial Development Planning Law, Tourism Law, Protection Zone Law, Construction Law, Civil Protection and Disaster Management Law, National Security Law.

3. Goals of Adaptation to Climate Change and Action Directions

3.1. Principal Objective of the Plan

Reduce the vulnerabilities of the population, national economy, infrastructure, buildings and nature of Latvia to climate change impacts and to promote the use of opportunities derived from climate change.

The principal objective of the Plan covers four important focal elements or centres:

– human;

– national economy;

– infrastructure and buildings;

– nature.

Together they create the framework for the implementation of the Plan in two directions:

1) reduction of the adverse effects, risks and vulnerabilities of climate change;

2) seizing the opportunities provided by climate change.

3.2. Targets and Action Directions of the Plan

[67] Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, available online: https://eur-lex.europa.eu/legal-content/LV/TXT/?uri=CELEX:32018R1999

Five strategic objectives have been set forth for the achievement of the principal objective of the Plan which determine the reduction of the adverse effects of climate change on the population, national economy, infrastructure, buildings and nature, and also seizing the opportunities provided by climate change and the necessity of additional knowledge and information in matters related to the impacts of and adaptation to climate change. In total 14 (fourteen) action directions have been defined for each of the five strategic objectives. A plan of priority measures has been developed for each action direction. Measures, authorities involved in the implementation thereof, implementation deadlines, funding sources, and also performance indicator of measures are included in Annex 1.

The first strategic objective is aimed at ensuring health and welfare of the population. Two action directions have been determined for the first strategic objective. Preventive measures are of particular importance for the protection of human health, life and safety.

Strategic objective 1: Human life, health and welfare, regardless of gender, age and social background, are protected from the adverse effects of climate change
The objective is to protect human life, health and welfare, regardless of gender, age and social background, from the adverse effects of climate change. Achievement of the objective is ensured by actions in two areas: human health and welfare, and also in the field of civil protection.
The following action directions are included in the strategic objective: 1.1. Early warning system is responsive, updated on a regular basis and ensures high-resolution modelling for forecasting the impact of extreme weather conditions. 1.2. Comprehensive preventative measures to protect human health and life from the adverse effects of climate change.

The second strategic objective is related to the ability of national economy to adapt to climate change. Three action directions have been determined for the strategic objective. Action areas include both strengthening the climate resilience of the national economy and increasing the ability of certain sectors to adjust to climate change.

Strategic objective 2: National economy has the capacity to adapt to the adverse effects of climate change and seize the opportunities derived from climate change
The objective is aimed at preservation of the resources of national economy and promotion of competitiveness within the context of the adverse effects of climate change and increasing the benefits of opportunities for the national economy of Latvia which derive from climate change (warmer and damper climate, longer vegetation period, etc.).
The following action directions are included in the strategic objective: 2.1. Strengthening of the national economy sectors against the risks and extremes of climate change. 2.2. Protection of resources important for the national economy in forestry, agriculture and fishery sectors from the adverse effects of climate change. 2.3. Ensuring of adaptation of the tourism sector to climate change.

The third strategic objective is aimed at increasing the adaptation ability of infrastructure. Three action directions have been set forth for the strategic objective and they are mainly aimed at increasing the climate resilience of different infrastructure objects.

Strategic objective 3: Infrastructure and buildings are climate-resilient and planned according to possible climate risks
The objective is aimed at ensuring the climate resilience of infrastructure and buildings (buildings and structures) in changing climate conditions, particularly extremes.
The following action directions are included in the strategic objective: 3.1. Use of green infrastructure to minimise the impact of climate risks. 3.2. Ensuring and adaptation of the engineering communication system and infrastructure to climate extremes. 3.3. Adaptation of structures and buildings to the impact and pressure of climate change.

The fourth strategic objective is aimed at preserving nature values. The objective determines three action directions aimed at increasing and protecting adaptive capacities of different natural, cultural and historical values.

Strategic objective 4: Nature, cultural and historical values of Latvia have been preserved and the negative impact of climate change thereupon has been reduced
The objective is aimed at maintaining, to the extent possible, the biodiversity of species and habitats which are endangered by various risks, including invasive foreign species and various pathogens, and preserving or at least preventing the deterioration, to the extent possible, of the condition of ecosystems. The strategic objective also provides for the protection of cultural and historical values and landscape values from the adverse effects of climate change.
The following action directions are included in the strategic objective: 4.1. Reduction of the negative impacts of climate change in ecosystems and preservation and restoration of biodiversity. 4.2. Establishment of a control system for limiting the spread of foreign invasive species, harmful substances and pathogenic organisms. 4.3. Protection of nature (including the coastal area of the Baltic Sea) and values of cultural and historical landscapes from the negative impacts of climate change.

The fifth strategic objective is aimed at promoting research in relation to adaptation to climate change. The strategic objective determines three action directions aimed at strengthening the scientific information base and its integration into various sectoral policies.

Strategic objective 5: Information based on scientific argumentation is provided, including monitoring and projections that promote integration of the aspects of adaptation to climate change in sectoral policy and territorial development planning documents, and also public awareness

This is a horizontal objective which is related to all six areas defined in Latvia and strategic objectives of adaptation to climate change.
The following action directions are included in the strategic objective: 5.1. Development and maintenance of a monitoring, reporting and evaluation system for adaptation to climate change. 5.2. Increasing the scientific and research potential and application thereof in the implementation of an action policies in the field of climate impacts and risk, vulnerabilities and adaptation to climate change. 5.3. Integration of expected climate change forecasts and risk mitigation solutions in territorial development plans and sectoral policies.

3.3. Implementation and Monitoring of the Plan

Adaptation to climate change requires a number of steps which are depicted schematically in Figure 16. It is necessary to identify climate change **indicators** and carry out regular **monitoring** thereof in order to assess climate change, to update forecasts and climate change scenarios. The monitoring system for climate change indicators is described in Annex 2.

Monitoring and assessment of climate change should be carried out on regular basis in order to ensure the relevance of information. The assessment of climate impacts, vulnerabilities and risks is required on the basis of the monitoring of indicators and the forecast climate change. Based on the assessment, the development of adaptation plans is initiated, determining the most significant risks and also measures to be implemented to promote adaptation to climate change. The introduction of adaptation measures is the final phase in the cycle for ensuring adaptation to climate change and this means the implementation of specific measures to promote adaptation to climate change. In order to assess the effectiveness of adaptation measures and the impact thereof on the assessed potential risks in various sectors, monitoring, reporting and analysis of adaptation indicators, and also further assessment must be carried out continuously.

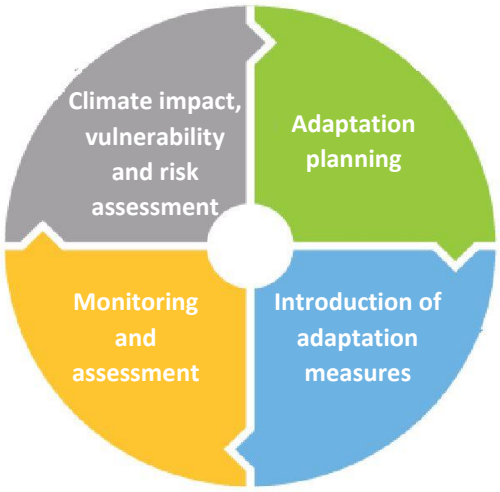

Figure 16. Full Cycle for Ensuring Adaptation to Climate Change

The monitoring of measures (actions) for adaptation to climate change set out in the Plan is carried out alongside the observations of climatic parameters in the monitoring of adaptation to climate change according to the nature of the activity, assessing the progress and effectiveness of the implementation thereof and assessing the preservation of the results of the measure. Monitoring of the implementation of the Plan will be carried out by assessing the achievement of performance indicators. In order to promote the implementation of the objectives outlined in the Plan, there will be regular meetings of the interinstitutional working group for adaptation to climate change established by MEPRD Order No. 1-2/140 of 13 September 2017 and the working group of experts for adaptation to climate change established by MEPRD Order No. 1-2/142 of 13 September 2017.

Reporting on the introduction and implementation of the Plan is planned midway and finally at the end of the activity. The MEPRD will submit to the Cabinet an informative mid-term report on the progress of the implementation of the Plan by 31 December 2026 and by 31 December 2031 – an informative final report on the implementation of the Plan. For the preparation of informative reports on the introduction and implementation of the Plan, all responsible authorities and authorities with a shared responsibility that are involved in the implementation of the Plan will have to provide information respectively by 1 June 2026 and by 1 June 2031.

III. ASSESSMENT OF THE IMPACT ON THE STATE AND LOCAL GOVERNMENT BUDGETS

The measures for adaptation to climate change to a large extent should be implemented within the scope of the functions and obligations of the responsible and involved authorities laid down in laws and regulations (for example, civil protection, flood protection measures, compliance with building climatology and other building standards, etc.) and the Plan ensures the necessary vision on the adjustment of customary measures to the new climatic conditions and also, where necessary, introduces effective planning, coordination, monitoring, etc.
To the extent possible, it is planned to implement the measures and tasks outlined in the Plan within the limits of the allocated State budget funds and by attracting financial means of the EU and other sources and private capital, depending on the nature of the measure. The issue concerning the allocation of additional State budget funds (if any) to responsible authorities involved in the implementation of the Plan shall be assessed during the implementation of the Plan and shall be examined by the Cabinet together with the applications of priority measures submitted by all ministries and central State institutions in the process of preparing and examining the draft annual State budget law and the draft framework of the medium-term budget in accordance with the financial capacities of the State budget.

The required amount of funding for the implementation of the objectives laid down in the Plan and the actions included therein cannot be calculated since this is a long-term (for the period until 2030) development planning document and climate change forecasts show uncertainty; moreover, the policies of many involved sectors are not planned for the period after 2020. The European Commission has published proposals for the EU Multiannual Financial Framework 2021–2027 where it is planned to allocate 25% of the total available funding for climate change activities in different funds. Although the EU Multiannual Financial Framework has not been approved and planned accurately, it is already expected that the financing will be available for climate-related measures, including adaptation to climate change activities.

IV. PUBLIC PARTICIPATION

The draft Plan was published on the website of MEPRD on 30 June 2017[68]. The draft Plan was discussed at the Environmental Consultative Council on 12 December 2017.

The working group of experts for adaptation to climate change was established by MEPRD Order No. 1-2/142 of 13 September 2017, whereas the interinstitutional working group for adaptation to climate change established by MEPRD Order No. 1-2/140 of 13 September 2017 and both working groups were granted the authority to provide proposals for the improvement and introduction of the draft Plan and other policy planning documents related to adaptation to climate change. The draft Plan was repeatedly discussed at the meetings of these working groups and it was also coordinated with their members electronically.

The objectives of the Plan and the proposed solutions have been presented and discussed in various public events.

Minister for Environmental Protection and Regional Development J. Pūce.

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[68] Draft development planning documents:
http://www.varam.gov.lv/lat/lidzd/attistibas_planosanas_dokumentu_projekti/

Annex 1
Latvian National Plan for Adaptation to Climate Change until 2030

Measures for the Implementation of the Action Directions Identified in the Plan

Strategic objective 1: Human life, health and welfare, regardless of gender, age and social background, are protected from the adverse effects of climate change

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
Action direction 1.1: Early warning system is responsive, updated on a regular basis and ensures high-resolution modelling for forecasting the impact of extreme weather conditions						
1	Improve forecasting and early warning systems to warn of extreme weather events.	MEPRD	Ministry of the Interior, LEGMC, State Fire and Rescue Service, local governments	2024	Within the framework of the existing budget, NFM[69]	The measure has been introduced
2	Improve the national early warning system by launching and maintaining the cell broadcast service (i.e. mobile communications network) or another notification solution in order to ensure that the population is promptly informed of natural disasters and also, to the extent possible, of extreme weather events.	Ministry of the Interior	Ministry of Transport	2024	Within the framework of the existing budget and by attracting additional funding sources	The measure has been introduced and is implemented constantly
Action direction 1.2: Comprehensive preventative measures to protect human health and life from the adverse effects of climate change						

[69]Here and hereafter: Norwegian Financial Mechanism 2014–2021 programme "Climate Change Mitigation, Adaptation and Environment".

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
1	Promote accessibility of drinking water in public places for free (stations, bus terminals, bathing sites, parks, stores) and also State and local government institutions.	MEPRD	Local governments, all ministries, State Chancellery	2024	Within the framework of the existing budget and by attracting additional funding sources	The measure has been introduced and is implemented constantly
2	Provide the public with information on the effects of heat on human health and recommendations for protecting health during heat waves.	Ministry of Health	Centre for Disease Prevention and Control, local governments	2021	Within the framework of the existing budget and by attracting additional funding sources	The measure has been introduced and is implemented constantly
3	Ensure additional prevention and awareness-raising measures on the impacts of and adaptation to climate change at educational institutions, social care institutions, and also organise the training of the providers of childcare services and employees at children's camps, library employees.	Ministry of Education and Science, Ministry of Welfare	Local governments, Ministry of Culture, Ministry of Health	2021	Within the framework of the existing budget	The measure has been introduced
4	Conduct studies on correlation between the spread and activity of infectious disease carriers, infection status and population morbidity rates and changes in climate parameters.	Ministry of Health	Food and Veterinary Service, Centre for Disease Prevention and Control	2027	Within the framework of the existing budget and by attracting additional funding sources	Research work has been completed
5	Upon informing the public, provide information on possible changes in infectious disease carriers caused by climate change in Latvia, symptoms of new diseases and preventive measures, particularly in high-risk areas.	Centre for Disease Prevention and Control	Ministry of Health	2024	Within the framework of the existing budget and by attracting	The measure has been introduced and is

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
					additional funding sources	implemented constantly
6	Prepare educational information on climate change, the impact thereof (including risks, potential losses) and adaptation thereto.	MEPRD	LEGMC, State Fire and Rescue Service	2021	Within the framework of the existing budget, NFM	The measure has been introduced
7	Review the legal framework and improve the implementation thereof with regard to the necessity to install and maintain air cooling systems in public spaces, as a priority – in health care institutions, social care and social rehabilitation institutions, kindergartens, trains stations (where relevant).	Ministry of Economics	Ministry of Welfare, Ministry of Transport, Ministry of Health, MEPRD, local governments	2024	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
8	Promote the formation of green spaces in order to create shadow areas in the urban environment.	MEPRD	local governments	2030	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
9	Improve the civil protection training course by including there climate change issues and possible actions to adapt to the adverse effects of climate change.	Ministry of Education and Science	State Fire and Rescue Service, SEMS, general, vocational and higher education institutions	2021	Within the framework of the existing budget, EU funds	The measure has been introduced

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
10	Inform the public, especially chronic disease patients, of preventive healthcare measures before and during heat waves.	Ministry of Health	local governments	2030	Within the framework of the existing budget and by attracting additional funding sources	The measure has been introduced and is implemented constantly
11	Ensure drawing up of recommendations for social care institutions and social workers on preventive healthcare measures during heat waves.	Ministry of Health	Ministry of Welfare, social care institutions of local governments	2030	Within the framework of the existing budget and by attracting additional funding sources	The measure has been introduced and is implemented constantly
12	Perform periodic analyses of the total number of deaths, hospitalised people and people who received emergency medical aid throughout the year, split up over the days, seeking a link to the registered air temperature.	Ministry of Health	Centre for Disease Prevention and Control, RSU, LEGMC	2030	Within the framework of the existing budget and by attracting additional funding sources	The measure has been implemented

Strategic objective 2: National economy has the capacity to adapt to the adverse effects of climate change and seize the opportunities derived from climate change

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
Action direction 2.1: Comprehensive strengthening of the national economy sectors against the risks and extremes of climate change						

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
1	Coordinate the improvement of the legal framework to reinforce the insurance market and expansion of services in order to reduce losses caused by climate change in all potentially affected sectors of national economy.	Ministry of Finance	Ministry of Economics, MEPRD, Ministry of Agriculture	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
2	Organise training for insurance companies on risks related to climate change.	MEPRD	Ministry of Finance, Ministry of Agriculture, Ministry of Economics	2021	NFM	The measure has been introduced
3	Improve the legal framework in order to promote investments, taking into account climate change risks and the necessity for the reduction of GHG emissions and preservation and increase of carbon dioxide removals.	Ministry of Economics	Ministry of Finance, Ministry of Agriculture, MEPRD	2022	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
4	Organise training for the banking sector on green investments (including investments that ensure climate resilience), advantages thereof.	MEPRD	Ministry of Finance	2021	NFM	The measure has been introduced

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
5	Attract financing and assess the possibility of building and maintaining an information system (including integrated information on climate change indexes, satellite data on topography and precipitation, soil maps, mapping of EU protected habitats and distribution of specially protected nature territories, flood zones, provision of ecosystem services, etc.) that would help to take a decision on the type of land use, including taking into account the climate change scenarios of Latvia.	MEPRD	Ministry of Agriculture, SPPS, LEGMC, NCA, Ministry of Education and Science, LRATC	2030	Within the framework of the existing budget, EU funds, attracting additional funding	The measure has been introduced and is implemented constantly
Action direction 2.2: Protection of resources important for the national economy in forestry, agriculture and fishery sectors from the adverse effects of climate change						
Agriculture						
1	Promote in practice the diversity of species and varieties of cultivated crops in order to reduce the risks caused by climate change.	Ministry of Agriculture	LRATC, SPPS, MEPRD, Ministry of Education and Science	2027	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
2	Implement the supervision and monitoring of harmful organisms and develop the supervision and monitoring of zoonotic agents and carriers of animal diseases, taking into account the risks of climate change.	Ministry of Agriculture	SPPS, Food and Veterinary Service and BIOR	2027	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
3	Restore and adapt land amelioration systems, including in populated areas, in order to prevent floods caused by climate change (increase in extreme rainfalls). If necessary, restore the natural sections crossing of watercourses to reduce the consequences of floods and stabilise ecosystems.	Ministry of Agriculture	MEPRD, Immovable Properties of the Ministry of Agriculture, local governments, RSS, NCA	2027	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
4	Ensure that farmers are informed of insurance possibilities and advantages to receive compensation for losses caused by extreme weather events (also due to climate change).	Ministry of Agriculture	LRATC, RSS, MEPRD	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
5	Conduct studies on the role of the variable fauna of insects affected by climate change in the transmission of zoonoses and exotic diseases of animals and the dynamics of the risk of prevalence thereof in Latvia.	Ministry of Agriculture	BIOR	2021	Within the framework of the existing budget, EU funds	Research work has been completed
6	Conduct studies on the carriers of infectious diseases facilitated by climate change and their tendency to spread in order to better understand the epidemiology, emergence, prevalence and burden of infectious diseases, and also to further investigate how resistance develops and spreads, to improve early detection of infectious diseases and resistance development in the field of animal health.	Ministry of Agriculture		2027	Within the framework of the existing budget and by attracting additional funding sources	Research work has been completed

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
7	Conduct studies on the preservation of the existing constructed wetlands[70] and creation of new constructed wetlands, and also promote the creation and maintenance of constructed wetlands, particularly in areas where agricultural land dominates.	MEPRD	Ministry of Agriculture, local governments, NCA	2024	Within the framework of the existing budget, EU funds	Research work has been completed
Forestry						
8	Improve the legal framework in order to promote the breeding of high-quality planting stock for the creation of lower density young stands (restoration of a forest with planting or seeding), thus increasing the resistance of the forest to climate change impacts and increasing its productivity.	Ministry of Agriculture	Forest owners and managers	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
9	Improve the legal framework in order to promote the afforestation of unused, productive agricultural land (ensuring that EU protected habitats are not subject to afforestation) with species compliant with soil and growing type, creating wind-resistant stands.	Ministry of Agriculture	Forest owners and managers, RSS	2025	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
10	Consider the necessity of introducing specific conditions to promote the care for young stands (tree height 4–6 m) in order to ensure stability against various risks caused by climate change.	Ministry of Agriculture	Forest owners and managers, RSS	2025	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly

[70] Constructed wetlands are relatively small wetlands maintained or created artificially in very intensively farmed agricultural land with an aim to reduce landscape fragmentation and to expand the possible biodiversity in the landscape. Such wetlands would serve as relocation islands of various species, especially birds, and also as organic pollutant suppressants. Wetlands have an important role also in the accumulation of rainwater.

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
11	Promote the development of the network of forest roads in order to ensure effective management of forest lands and management of other types of land under unfavourable climate conditions and also prompt response in emergency situations (fire, including peat fire). Create additional forest fire-fighting infrastructure in high-risk areas by carrying out a thorough assessment of the necessity thereof.	Ministry of Agriculture	Forest owners and managers, local governments	2027	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
12	Restore and adapt forest amelioration systems to prevent the negative impacts of climate change as much as possible.	Ministry of Agriculture	Immovable Properties of the Ministry of Agriculture, LSF, forest owners and managers, local governments	2027	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
13	Promote the use of access equipment with lower pressure on soil to protect soil in forests during winters under frost-free conditions.	Ministry of Agriculture	Forest owners and managers	2027	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
14	Develop scientifically valid guidelines for forest management to promote the climate resilience thereof.	Ministry of Agriculture	LSF, SFS, Latvian State Forest Research Institute “Silava”, MEPRD, NCA	2028	Within the framework of the existing budget	The measure has been introduced

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
15	Ensure the harmonisation of measures provided for in the new policy planning document for the forestry sector and the necessity to adapt to climate changes.	Ministry of Agriculture	LSF, SFS, Latvian State Forest Research Institute "Silava"	2022	Within the framework of the existing budget	The measure has been introduced
16	Conduct studies on the impact of risks caused by climate change on ecological, social and economic functions of forests.	Ministry of Agriculture	LSF, SFS, Latvian State Forest Research Institute "Silava"	2024	Within the framework of the existing budget	The measure has been introduced
Fishery						
17	Identify natural water fish species and fish species reared in aquaculture in Latvia that are endangered due to climate change.	Ministry of Agriculture	BIOR	2024	Within the framework of the existing budget	Research work has been completed
18	Review the Guidelines for Artificial Reproduction of Fish Resources and determine therein larger reproduction volumes for natural water species affected by climate change, if necessary.	Ministry of Agriculture	BIOR	2024	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
19	Inform the involved parties of the possible climate risks and possibilities of adaptation in the fishery sector.	Ministry of Agriculture	LRATC	2024	Within the framework of the existing budget, EU funds	The measure has been introduced
20	Elaborate a list of invasive water biological resources species that have entered Latvia as a result of the impacts of climate change.	MEPRD	Ministry of Agriculture, NCA, BIOR	2020	Within the framework of the existing budget	The measure has been introduced
Action direction 2.3: Ensuring of adaptation of the tourism sector to climate change						

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
1	Promote adaptation of cultural monuments and natural monuments of national significance to the impacts of climate change.	Ministry of Culture, MEPRD	National Cultural Heritage Board, NCA	2024	Within the framework of the existing budget EU funds	The measure has been introduced and is implemented constantly
2	Provide educational information to tourism companies on climate, climate change and possibilities of entrepreneurship adaptation.	Ministry of Economics	MEPRD	2020	Within the framework of the existing budget	The measure has been introduced
3	Provide warning and safety measures of coastline visitors at potential mud slide, landslide and flooding risk locations.	MEPRD	NCA, coastal local governments	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
4	Ensure adjustment of tourism infrastructure to changes in sea dunes and bluffs caused by erosion and ensure appropriate access to the beach.	MEPRD	Ministry of Economics, NCA, coastal local governments, Ministry of Agriculture	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
5	Supplement the official tourism portal of Latvia http://www.latvia.travel with information useful for tourists on the climate of Latvia, for example, information on the water level in rivers used for water tourism, more complete information on the climate of Latvia in all seasons.	MEPRD	Ministry of Economics, LEGMC, Latvian Institute	2021	Within the framework of the existing budget	The measure has been introduced

Strategic objective 3: Infrastructure and buildings are climate-resilient and planned according to possible climate risks

No.	Measures	Responsible authority	Authorities involved	Implementation period	Indicative financial source	Performance indicator of the measure
Action direction 3.1: Use of green infrastructure to minimise the impact of climate risks						
1	Identify primarily important places in cities and other densely populated areas where green infrastructure can provide the greatest benefit and promote adaptation to climate change.	MEPRD	Ministry of Economics, local governments	2024	Within the framework of the existing budget, EU funds	The measure has been introduced
2	Upon developing or recovering urban areas, devise and implement solutions of green infrastructure that promote adaptation to climate change.	MEPRD	local governments	Independently.	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
Action direction 3.2: Ensuring and adaptation of the engineering communication system and infrastructure to climate extremes						
1	Assess and plan the necessity for additional capacity for the collection of rainwater in cities, including the performance of maximum precipitation estimates for various probabilities under the impact of climate change in order to protect buildings and structures from rainwater load (foundation wash-out, etc.).	MEPRD	local governments, LEGMC, Ministry of Economics	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
2	Improve rainwater systems and culverts in cities by supplementing them with the elements of green infrastructure, defining the necessary capacity in advance, taking into account climate change, and also promote sustainable water management and use of rainwater in	MEPRD	local governments, Ministry of Economics	2030	Within the framework of the existing budget EU funds	The measure has been introduced and is implemented constantly

No.	Measures	Responsible authority	Authorities involved	Implementation period	Indicative financial source	Performance indicator of the measure
	places where water is not required in the quality of drinking water.					
3	Develop guidelines for the integration of changes in rainwater run-off due to climate change in the planning and design of road construction, and also adaptation of existing road structures.	Ministry of Transport	MEPRD, Ministry of Economics, Latvian State Roads, local governments	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
4	Develop guidelines for ports and berths on adaptation to potential floods from the sea and other hazard caused by climate change according to the latest scenarios of climate change.	Ministry of Transport	MEPRD	2024	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
5	Identify the most sensitive electronic communications infrastructure that requires adaptation to climate change and risks related thereto.	Ministry of Transport	Ministry of Economics	2022	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
6	Ensure adaptation of the current transport (roads, railways, airports, ports) and electronic communications infrastructure to climate change.	Ministry of Transport	Ministry of Economics	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
7	Review laws and regulations governing the field of transport (roads, railways, airports, ports) and electronic communications infrastructure according to climate change forecasts.	Ministry of Economics	Ministry of Transport, MEPRD	2021	Within the framework of the existing budget	The measure has been introduced and is implemented constantly

No.	Measures	Responsible authority	Authorities involved	Implementation period	Indicative financial source	Performance indicator of the measure
8	Restore the values of meteorological and hydrological characteristics included in the design calculations of land amelioration systems and hydrotechnical structures (run-off layers typical for seasons with a certain likelihood of recurrence, drainage modules, annual average run-off layer, etc.).	Ministry of Economics	MEPRD	2025	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
Action direction 3.3: Adaptation of structures and buildings to the impact and pressure of climate change						
1	Promote the use of materials and technologies, including introduction of green infrastructure solutions, in the buildings of the public sector and largest companies that prevent heat accumulation at the buildings in order to reduce the necessity to install and use conditioning systems.	Ministry of Economics	MEPRD	2024	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
2	Clarify the values of precipitation loads in the construction standards for the types of existing buildings in order to improve the accuracy of planning and reduce potential hazard.	Ministry of Economics	MEPRD	2021	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
3	Identify the most sensitive State and local government buildings that require adaptation to climate change and risks related thereto.	Ministry of Economics	MEPRD, LEGMC, local governments	2020	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
4	Develop guidelines for the improvement of existing building structures in order to reduce threats related to climate change, including extremes.	Ministry of Economics	MEPRD	2021	Within the framework of the existing budget	The measure has been introduced

No.	Measures	Responsible authority	Authorities involved	Implementation period	Indicative financial source	Performance indicator of the measure
5	When changing Latvian construction standards, their requirements are to be adjusted to the current climate change scenarios and regulatory framework reducing the risks caused by climate change must be included therein.	Ministry of Economics	MEPRD, LEGMC	2023	Within the framework of the existing budget	The measure has been introduced

Strategic objective 4: Nature, cultural and historical values of Latvia have been preserved and the negative impact of climate change thereupon has been reduced

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
Action direction 4.1: Reduction of the negative impacts of climate change in ecosystems and preservation and restoration of biodiversity of species						
1	Integrate the aspects of adaptation of climate change into all appropriate natural and environmental protection campaigns / projects.	MEPRD	NCA	2030	Within the framework of the existing budget, EU funds, Latvian Environmental Protection Fund	The measure has been introduced and is implemented constantly
3	Integrate climate change impacts, scenarios and adaptation measures into the Habitat Management Guidelines.	MEPRD	NCA, Ministry of Agriculture	2020	Within the framework of the existing budget, EU funds	The measure has been introduced

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
4	Develop a study on climate-sensitive wild species for the survival of which certain micro-climatic conditions are required in Latvia.	MEPRD	NCA, Ministry of Agriculture	2030	Within the framework of the existing budget, EU funds	Research work has been completed
5	In improving laws and regulations which provide for SPNT management, it is necessary to include there the norms regarding compliance with adaptation to climate change, including to maintain habitats and species which are sensitive to climate change and are characteristic to Latvia in an optimal condition.	MEPRD	NCA, Ministry of Agriculture	2024	Within the framework of the existing budget, EU funds	The measure has been introduced
6	Develop a study on the dismantling of mechanical obstacles in rivers (where possible) to increase the current natural flow of rivers in order to reduce the negative impacts of climate change.	MEPRD		2022	Within the framework of the existing budget, EU funds	Research work has been completed
7	Adjust the quality assessment of surface water bodies (including the monitoring of cyanobacteria and chlorophyll) by increasing the monitoring frequency during the summer season, taking into account increase in water temperature due to climate change.	MEPRD	LEGMC	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
8	Develop a study by providing proposals for the implementation of measures to maintain biodiversity at the level of landscapes, taking into account the impacts of climate change.	MEPRD	NCA, Ministry of Agriculture	2030	Within the framework of the existing budget, EU funds	The measure has been introduced
Action direction 4.2: Establishment of a control system for limiting the spread of foreign invasive species, harmful substances and pathogenic organisms						

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
1	Consider climate change impacts when updating the list of invasive species.	MEPRD	NCA, Ministry of Agriculture, SPPS, Food and Veterinary Service	2024	Within the framework of the existing budget	The measure has been introduced and is implemented constantly
2	Improve control and preventive measures for invasive species, taking into account climate change.	MEPRD	NCA, Ministry of Agriculture, SPPS, Food and Veterinary Service	2024	Within the framework of the existing budget and by attracting additional funding sources	The measure has been introduced and is implemented constantly
Action direction 4.3: Protection of nature (including the coastal area of the Baltic Sea) and values of cultural and historical landscapes from the negative impacts of climate change						
1	Integrate the aspects of adaptation to climate change in SPNT nature conservation plans and also national, regional and local development planning documents focused on sustainable use and management of coastal areas.	MEPRD	local governments, NCA	2027	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
2	Promote the implementation of measures for maintaining the stability of the grey infrastructure against risks caused by climate change (flood, flood from the sea, bathing sites of the sea and the Gulf of Riga, inland bathing sites endangered by coastal erosion).	MEPRD	local governments, Latvian Environmental Protection Fund, NCA	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly

No.	Measures	Responsible authority	Authorities involved	Deadlines or period for completion	Indicative financial source	Performance indicator of the measure
3	Assess what measures to reduce the coastal erosion of the Baltic Sea and to reinforce the coastal areas are valid and ensure the implementation of such measures to reinforce the coastal areas where this is of priority importance and valid, taking into account climate change scenarios.	MEPRD	LEGMC, NCA, coastal local governments	2030	Within the framework of the existing budget, EU funds, Latvian Environmental Protection Fund, NFM	The measure has been introduced and is implemented constantly
4	Develop a methodology for the detailed study of landscapes, to conduct research and to determine landscape areas and places that are sensitive to climate change.	MEPRD	local governments, NCA	2024	EU funds, Latvian Environmental Protection Fund	The measure has been introduced and is implemented constantly
5	Develop guidelines for maintaining and preserving landscape territories that are sensitive to climate change.	MEPRD	local governments, NCA	2026	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly

Strategic objective 5: Information based on scientific argumentation is provided, including monitoring and projections that promote integration of the aspects of adaptation to climate change in sectoral policy and territorial development planning documents, and also public awareness

No.	Measures	Responsible authority	Authorities involved	Implementation period	Indicative financial source	Performance indicator of the measure
Action direction 5.1: Development and maintenance of a monitoring, reporting and evaluation system for adaptation to climate change						
1	Improve and maintain the database of climate change analysis and forecasting, ensure public access thereto.	MEPRD	LEGMC	2030	Within the framework of the existing budget, NFM, EU funds	The measure has been introduced and is implemented constantly
2	Create and maintain a single database on losses caused by disasters, including weather conditions facilitated by climate change.	Ministry of the Interior	State Fire and Rescue Service, MEPRD	2030	Within the framework of the existing budget, NFM, EU funds	The measure has been introduced and is implemented constantly
3	Assess the methods for monitoring coastal erosion and develop a permanent monitoring methodology suitable for Latvia.	MEPRD	LEGMC, NCA	2024	Within the framework of the existing budget, NFM, EU funds	The measure has been introduced and is implemented constantly
4	Resume and ensure continuous monitoring, assessment of geological processes of coast areas and modelling of coastal erosion.	MEPRD	LEGMC, NCA	2030	Within the framework of the existing budget, NFM, EU funds	The measure has been introduced and is implemented constantly
5	Assess the existing legal framework, and improve it, if necessary, for cooperation between authorities in order to ensure the operation of the climate change monitoring system, including the collection of data necessary for the operation of the system.	MEPRD	LEGMC	2021	Within the framework of the existing budget	The measure has been introduced and is implemented constantly

No.	Measures	Responsible authority	Authorities involved	Implementation period	Indicative financial source	Performance indicator of the measure
Action direction 5.2: Increasing the scientific and research potential and application thereof in the implementation of an action policies in the field of climate impacts and risk, vulnerabilities and adaptation to climate change						
1	Ensure the implementation of research work that aims at studying the vulnerabilities of the population, national economy, infrastructure, buildings and nature of Latvia to climate change impacts, developing adaptation to climate change solutions and climate-resilient development, and also promoting the use of opportunities derived from climate change.	MEPRD	All ministries, LEGMC	Continuously	Within the framework of the existing budget, NFM, State Regional Development Agency, other EU funds	The measure has been introduced and is implemented constantly
2	Strengthen international cooperation in science and research on climate change impacts, risks and vulnerabilities, adaptation to climate change.	Ministry of Education and Science	MEPRD	Continuously	Within the framework of the existing budget, NRP, EU funds, NFM	The measure has been introduced and is implemented constantly
3	Update and publish future climate change scenarios developed by Latvia, supplementing the scenarios developed so far with indicators that have not been reviewed up to now and updating the data used, taking into account the latest IPCC reports (including action direction 6).	MEPRD	LEGMC	2024	Within the framework of the existing budget, EU funds, NFM	The measure has been introduced and is implemented constantly
Action direction 5.3: Integration of climate change forecasts and risk mitigation solutions in territorial development plans and sectoral policies						
1	Integrate the aspects of climate change, issues related to reducing the impacts thereof and adjustment to climate change in the development and updating of territorial development planning and sectoral policy documents of all levels.	MEPRD	local governments	2025	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly

No.	Measures	Responsible authority	Authorities involved	Implementation period	Indicative financial source	Performance indicator of the measure
2	In developing local government development programmes, ensure the inclusion of detailed actions and necessary measures for adaptation to climate change.	MEPRD	local governments	2025	State and local government budget, LIFE, NFM	The measure has been introduced and is implemented constantly
3	Develop forecasts of floods from the sea for all cities, the administrative territories of which are bordering the sea.	MEPRD	LEGMC, local governments	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
4	Develop or update flood risk management plans for coastal cities of Latvia by previously assessing for which cities such plans are necessary.	MEPRD	LEGMC, local governments	2024	Within the framework of the existing budget, EU funds	The measure has been introduced and is implemented constantly
5	Organise training for local governments on climate change risks and inclusion of their impacts in territorial planning, taking of decisions by local governments.	MEPRD	local governments	2022	Within the framework of the existing budget, NFM	The measure has been introduced and is implemented constantly
6	Ensure that climate-resilient development aspects are taken into account when developing urban spatial plans (street / zone level).	MEPRD	local governments	2027	Within the framework of the existing budget, EU funds	The measure has been introduced
7	Carry out expert training on integrated aspects of climate change mitigation and adaptation to climate change in sectoral and regional policies and activities.	MEPRD	LEGMC, local governments	2024	Within the framework of the	The measure has been introduced

No.	Measures	Responsible authority	Authorities involved	Implementation period	Indicative financial source	Performance indicator of the measure
					existing budget, NFM	

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Annex 2
Latvian National Plan for Adaptation to Climate Change until 2030

Climate Change and Monitoring System for Adaptation to Climate Change

In order to develop the concept and database of the monitoring system, within the period from 2015 until 2017, the Latvian Environment, Geology and Meteorology Centre (LEGMC) carried out the analysis of previous and future climate change observations and developed climate change scenarios in Latvia. The theoretical fundamentals of the monitoring system were based on the analysis approach that provides for examining measures of changing vulnerability, i.e. aggregation and monitoring of vulnerability indicators with a focus on particular indicators which cover the general factors of vulnerability.[71] In turn, experts of national economy sectors, based on the obtained climate data, carried out the analysis of climate change impacts, risk and vulnerability assessment, cost-benefit analysis, and also selected the most important indicators of climate change impact for the relevant field. The indicators of climate change impacts identified by experts, vulnerability assessment of the field and data necessary for its calculation were summarised in a single database that is maintained and supplemented with new data and the monitoring of climate change and sectoral vulnerability is carried out.

The monitoring system consists of two parts (see Figure 1). The first is based on the analysis of climate change, while the second is based on the vulnerability assessment of the sectors:

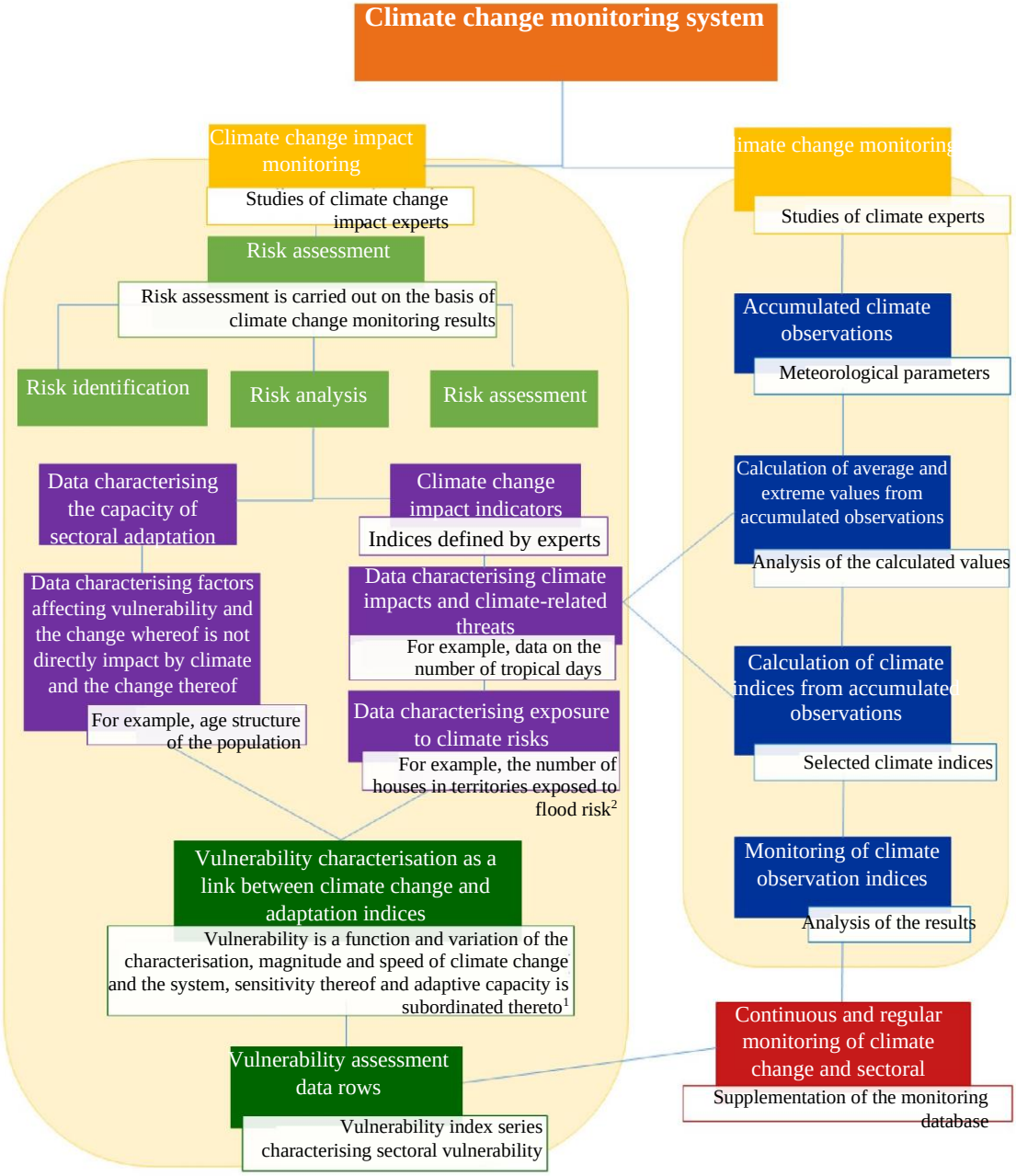
1. **Monitoring of climate change** ensured by LEGMC is performed by summarising and analysing the selected meteorological parameters and climate indices, their variation in time and trends.
2. The **climate change impact monitoring** database includes the selected climate change impact indicators and also the vulnerability of the sector is calculated as the correlation defined by experts or the function between climate change and climate change impact indicators.

In order to ensure further functionality of the monitoring system and database, all data must be qualitative and continuously supplemented. Currently, data of 18 climate change impact indicators, descriptions thereof and vulnerability characterisations received by LEGMC from experts of national economy sectors have been included in the monitoring system database. These indicators (see Table 1) describe various aspects of the relevant field in Latvia for each year or a longer period, yet mostly presenting only the data of the 21st century. Therefore, the vulnerability assessment of the relevant national economy sector is available with the same spatial characterisation and period as climate change impact indicators. The maintenance of the monitoring system database and interactive climate change analysis tool is ensured by LEGMC specialists: climatologists, experts of the monitoring system, data analysts and programmers that maintain and supplement both the monitoring system and database, and also the interactive climate change analysis tool. Such activities as supplementing of indicators used in the monitoring system, introduction of new indicators, and also risk assessment under the supervision of MEPRD are carried out by experts of the respective fields, based on the latest available data characterising the current climate and future climate change scenarios ensured by LEGMC.

[71] OECD, 2015, *National Climate Change Adaptation: Emerging Practices in Monitoring and Evaluation*, OECD Publishing, Paris, pp. 97

Further development and improvement of the system and also revision of the concept additionally requires the development of new methods and analysis of new data. Sustainable development of the monitoring system is crucial to ensure quality and uniformity of the climatic data that is closely related to the coverage of the meteorological monitoring network and available maintenance resources. Moreover, it is important to localise climate change impact indicators and vulnerability assessment from the characteristics of the entire country to the scale of individual regions; however, such detailed analysis requires high-quality relevant spatial scale data. Exchange of experience with foreign specialists both in the field of climate change and adaptation to climate change is crucial for increasing the quality of monitoring.

Figure 1. Climate change monitoring system



[1] European Commission, 2013, *An EU strategy on adaptation to climate change*, Commission staff working document SWD(2013) 132 final, part 2, Brussels, European Commission, 144 p.

[2] *P. Naswa et al., 2015,* Good Practice in Designing and Implementing National Monitoring Systems for Adaptation to Climate Change. *Climate Technology Centre & Network, Denmark, pp. 76*

Table 1. Climate change impact indicators of Latvia

Sector of national economy	Climate change impact indicator
Biodiversity and ecosystem services	1. Foreign vascular plant species
Landscape planning and tourism	1. Changes in the number of persons serviced in tourist accommodations in winter months 2. Turnover index of accommodation and catering enterprises during winter 3. Turnover index of accommodation and catering enterprises in May 4. Turnover index of accommodation and catering companies in September 5. Tendencies of using tourist accommodations in May 6. Tendencies of using tourist accommodations in September
Health and welfare	1. Hospitalisation rate for such diagnoses as sunburn, exposure to heat and sunlight and fever of unknown origin per 100,000 inhabitants 2. General mortality rate in summer months 3. Morbidity rate of Lyme disease per 100,000 inhabitants 4. Changes in the activity of ticks (relative density thereof per 1 kilometre). 5. Number of persons with disabilities where the disability was caused by diseases of the respiratory system
Agriculture and forestry	1. Productivity of winter crops 2. Changes in plant diseases or pests 3. Soybean fields 4. Spread of invasive species (including flora and fauna) 5. Perennial plant productivity (including wood growth per year) 6. The number of animal disease cases related to contagious animal diseases transmitted by insects, including invasive foreign insects 7. Forest areas damaged by diseases and pests (ha) 8. Forest areas damaged by windthrown and snow-thrown wood (ha) 9. Forest areas damaged by excess humidity (ha)
Civil protection, disaster management and emergency assistance planning	1. Average burnout area of one forest fire, ha 2. Proportion of population in the territories exposed to wind surges with various likelihood of repeatability against the total number of population (%) 3. Proportion of population in the territories exposed to spring flood with various likelihood of repeatability against the total number of population (%)

Building and infrastructure planning	1. Decrease in the proportion of dark and gravel road surface and bridges in poor and very poor condition 2. Duration of power failures for one customer per year – disaster component and natural cause component 3. Frequency of power failures for one customer per year – disaster component and natural cause component 4. Losses caused by natural factors to buildings and infrastructure – changes in comparison with the indicator of previous years "a rolling average of the last 5 years" – disaster component and natural cause component

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