State Ltd. “Latvian Environment, Geology and Meteorology Centre”

CLIMATE CHANGE SCENARIOS FOR LATVIA

Report summary

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Riga, 2017

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Project “Development of Proposal for National Adaptation Strategy, Including Identification of Scientific Data, Measures for Adapting to Changing Climate, Impact and Cost Evaluation”, supported by the 2009-2014 European Economic Area Financial Mechanism

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INTRODUCTION

The report summary describes the results and key conclusions of the report "Development of Climate Change Scenarios for Latvia". The summary characterizes various climate variables during the past (period from 1961-2010) and future (projections up to 2100) climate change. The analysis of the past climate change is based on the data of all those LEGMC meteorological observation stations, that take the measurements of the respective climate variables. For the future time periods (2011-2040, 2041-2070 and 2071-2100) the climate variable changes are projected in accordance with two greenhouse gas (GHG) emission scenarios – RCP4.5 and RCP8.5. The RCP scenarios (*Representative Concentration Pathways*) provide insight into the influence of human activities on climate, such as the amount of man-made GHG emissions, land use type, distribution of forests, mitigation measures aimed at the reduction of aerosol particle concentrations and climate change in general. RCP4.5 scenario projects moderate, while the RCP8.5 scenario – significant climate change. The study results provide information on the risks posed by climate change and facilitates their understanding and assessment, thus contributing to the effectiveness of climate change adaptation measures in different areas of economy.

PAST AND PROJECTED CLIMATE CHANGE

This chapter discusses the past trends of change in climate variables and indices, and the corresponding changes according to specific future climate change scenarios.

Air temperature

The annual-mean air temperature in Latvia during the period from 1961-2010 was from +4.9ºC in Vidzeme and Alūksne upland area to +7.1ºC in the Southwest regions of the country, thus clearly indicating the impact of the continentality, distance from the Baltic Sea and the impact of positive terrain surface on air temperature values. During the discussed period of time, the annual-mean air temperature values have increased by 0.7ºC, the most radical increase being in the annual minimum of the mean air temperature – by an average of 1.7ºC. Spatially, the most radical mean air temperature changes have been observed in the Eastern regions of Latvia, especially in the upland areas. As a result of the previous climate change, also the minimum and maximum air temperatures have increased, of which the most radical increase has been observed in the annual minimum air temperature – in Latvia by an average of 1.9ºC. Similarly to the mean air temperature, also the minimum air temperature values have increased most significantly in the Eastern uplands, where so far the lowest values of these variables had been observed. Over the past 50 years, the maximum air temperatures have also increased – the annual maximum temperature in Latvia has

increased by 0.7ºC, while the minimum value of the maximum air temperature has increased as much as by 1.4ºC. As far as spatial changes in the maximum air temperature are concerned, Rīga and its surroundings have witnessed the most radical changes, which is largely attributed to the urban "heat island" effect. The most radical effect of the previous climate change has been on the increase of the minimum values of the minimum, mean and maximum air temperature, and the most significant changes have occurred in winter and spring seasons, while in summer the air temperature changes are mainly due to the impact of the increase in minimum air temperatures.

The most significant change has been observed in the values of climate indices characteristic of winter season. The number of frost days in the period from 1961 to 2010 ranges from 96 days in the coastal area of the Baltic Sea to 155 days in Alūksne and Vidzeme upland areas, and during this period the average number of such days in Latvia has decreased by 9 days per year, in some locations even by as much as 10-16 days per year. Also, the average number of ice days in Latvia has decreased on average by 9 days per year, in some locations – by an average of 5-11 days per year. As the ice days are more typical to conditions of persistent cold than frost days, their number is smaller - from an average of 37 to 80 days per year. Changes are also observed in the climate index values characterizing extreme hot weather conditions. In Latvia the number of summer days is in average from 4 to 26 days a year, and as a result of the past climate change their number has increased by an average of 1-5 days per year. The most significant increase in the number of summer days has been observed is the Southern areas of the country, where there is also the

largest number of summer days. Historically, Latvia has always had a small number of tropical nights - in average from 0.1 to 0.7 nights a year, so no valid conclusions about the trends of change in the number of such nights can be made, however, an increase in the frequency of such nights has been observed during the last couple of decades. The general increase in air temperatures has also affected the length of the growing season - since 1961 by an average of 2 additional days per year and in Ventspils by even up to 10 additional days per year. During the discussed period, a typical growing season in Latvia has been from 184 to 200 days a year, in the Southwestern districts - up to 208 days per year.

Similar trends in changes of air temperature variables and indices can be observed also in the global climate model projections for future periods. According to the scenarios, it is expected that by the end of the century the annual-mean air temperature will increase by an average of 3.5ºC in RCP 4.5 scenario and by 5.5ºC in RCP 8.5 scenario. Although spatially the average air temperature rise in Latvia will be relatively even, the most pronounced changes are expected in the Eastern regions. A similar increase by 3.6ºC to 5.7ºC, in some locations in the Northern part of Vidzeme even by 6.8ºC, is expected also in the annual maximum air temperature values, so if the most pessimistic scenario is realized, at the end of the century the average maximum air temperature in Latvia could reach even +35°C. However, by 2100 the most significant increase will be observed in the minimum air temperature values. If the annual-mean minimum air temperature rises similarly to the mean and maximum air temperature values, i.e. by 3.6ºC to 5.6ºC, then the annual minimum air

temperature will increase by an average of 9.3ºC to 13.5ºC; according to the RCP 8.5 scenario in Vidzeme upland, a 16ºC increase is projected. Also seasonally, until the end of the 21st century the climate change trends, characteristic of current climate change, will be observed – the most radical increase in air temperatures will take place during winter and spring seasons. The mean air temperature in the winter season will be higher than in 1961-1990 by about 4.4ºC to 7.8ºC. If the significant climate change scenario is realized, a significant mean air temperature increase is projected also in the summer season (by 4.8ºC to 5.2ºC).

It is expected, that by 2100 the increase of air temperatures will affect the duration of the growing season – the scenarios project an extension of the growing season by 27 to 49 days, or by about 1 to 2 months; in the Kurzeme coastal areas even by as much as 30 to 67 days per year. Consequently, due to the fact, that the most rapid air temperature rise will be experienced during the winter season, it is expected that the number of frost days and ice days will reduce significantly. The number of frost days will reduce by an average of 52 to 81 days per year and according to RCP 8.5 scenario in the most part of Latvia the reduction is projected at over 80 days per year. By 2100 the number of ice days will decrease by 32 to 46 days, in some locations in the Eastern regions by as much as 50 to 54 days per year. It is important to note, that already in the near future certain models project a number of ice days within the range from 0 to 10. The number of summer days is expected to increase by an average of 31-53 days a year, in some locations - even by more than 60 days, and the number of tropical nights, which has been very small so far, will increase by 4

to 14 nights a year; in the coastline area of the Baltic Sea and the Southern part of the Gulf of Riga - even by about 18-28 nights a year.

Precipitation

Over the past 50 years, the annual total amount of precipitation in Latvia has been from an average of 576 mm in Dobele to 757 mm in Rucava. The largest amount of precipitation has been observed in the Western area of Kurzeme and Vidzeme uplands, which is attributable to the topography of the area and the distance to the Baltic Sea and the Gulf of Riga. The past climate change has resulted in the increase of the amount of precipitation in Latvia by an average of 6%, or about 39 mm. Seasonal amount of precipitation is affected by the atmospheric circulation conditions in different seasons. The least amount of precipitation is observed during the spring season when the activity of the cyclones that were dominant during the autumn and winter seasons has ended, but the convective processes typical for the summer season have not yet begun. The highest amount of convective precipitation is observed during the summer season. Similarly to changes in the air temperature, the most significant increase in the amount of precipitation has been observed during the winter season; an increase is observed also during the spring and summer seasons, while in the autumn season there has been even a slight reduction in the amount of precipitation.

Since 1961, the intensity of precipitation has increased - at the end of the discussed period a simple daily intensity index values being by an average of 0.1-0.6 mm/day higher than at the beginning of the period, consequently there is an increase in the number of heavy and

very heavy precipitation days, by 2 and 1 day respectively. Within the discussed period, the average number of days with heavy precipitation is 15 days a year, whereas the number of very heavy precipitation days is 3. On average, the annual maximum diurnal precipitation amount in Latvia is 31 to 38.5 mm, while the highest five day precipitation amount – from 44 to 85 mm. Spatially, with certain exceptions, the distribution of the values of these indices is similar to the distribution of the annual total amount of precipitation.

By the end of the century, an increase of the total annual precipitation by 13 to 16% (about 80-100 mm) according to RCP4.5 and RCP 8.5 scenarios respectively is projected. Seasonally, the most significant increase in the amount of precipitation is expected during the winter and spring seasons. According to the moderate climate change scenario, in winter the amount of precipitation will increase by 24-37%, while the significant climate change scenario projects an increase by 35-51%. In general, both scenarios project an increase of precipitation in all future periods of time and seasons, with the exception of the summer seasons of 2071-2100, during which, according to the RCP 8.5 scenario, the amount of precipitation in some locations may decrease; these projections, however, are uncertain.

The scenarios project also an increase of the intensity of precipitation – by about 0.1-1 mm / day according to the RCP4.5 scenario, and by 0.5 to 1.3 mm / day according to the RCP 8.5 scenario; the highest precipitation intensity increase is expected in the coastal area of the Baltic Sea and in Vidzeme. Over the period from 2071 to 2100, the number of days with heavy precipitation will increase by an average of 3 to 5 days, in some locations – even by up

to 7.8 days. According to the moderate climate change scenario, the number of days with very heavy precipitation will increase by 0.1 to 2.3 days, but a significant climate change scenario projects an increase of 0.8 to 3.3 days. The maximum amount of one and five days precipitation will also increase – in RCP4.5 scenario by 3 and 9 mm respectively, or by about 6 and 12 mm in RCP8.5 scenario; the projections of these two indices, however, are characterized by inter-model uncertainty.

Wind speed

During the period of reference mean wind speed has been 2.6-4.8m/s, and it was characteristic with clear gradient from sea territories to land; also annual average wind speed values are closely related to autumn and winter period storm activity. Since 1966 average wind speed in Latvia has decreased by 8%; however extremes of the maximum mean wind speed values may be observed both at the start and the end of the period. Under the impact of decrease in mean wind speed the number of calm days has increased for about 13 days. The number of such days in Latvia is on average from 53 days at the Baltic Sea coast up to 127 days per year in eastern provinces. Meanwhile stormy days in Latvia are observed very rarely: from 0-1 day per year in most parts of the territory up to 6.9 and 7.9 days on the average in Liepāja and Ventspils; up to recently, the number of such days on the average in Latvia has decreased by 1 day.

In the future the most radical decrease of mean wind speed (4-13%) can be expected in a moderate climate change scenario while in the significant climate change scenario a decrease of 0-6% is

projected. Climate model projections, however, show uncertainty, and in both scenario conditions some models project increase in mean wind speed, too. Under the impact of further decrease in mean wind speed, most climate models project decrease in the number of calm days in Latvia on the average for 2-24 days in RCP 8.5 and RCP 4.5 scenarios, respectively. Meanwhile, only small changes in the mean number of stormy days are projected for Latvia.

CONCLUSIONS

Under the impact of recent climate change one may observe a uniform increase of air temperature, expressed in mean, minimum and maximum air temperature values. Most changes has been observed in winter and spring seasons. Under the impact of general air temperature increase the length of growing season and the number of summer days and tropical nights has increased while the number of frost days and ice days has decreased. Upon analysing climate model projections for future periods, a further temperature increase is clearly seen. Under its impact the length of growing season and the number of summer days and tropical nights will continue growing, and the number of frost days and ice days will be falling.

In the period from 1961 to 2010 one may observe an increase in precipitation, especially in winter and spring seasons. Also precipitation intensity has increased, which in turn has increased both the intensity and frequency of extreme precipitation events. Up to 2100 a further increase in precipitation amount is expected, and it will be more determined by the projected precipitation intensity increase. Under the impact of projected changes the most significant precipitation increase is expected in winter season in which, along with temperature increase, comparing to recent period, one may expect larger percent of rain precipitation.

In the long-term period, average wind speed curve is trending slightly downwards and, although climate model projections show

uncertainty, they mostly confirm continuation of this type of mean wind speed change tendency up to the end of the 21st century.

Analysis of recent climate and future climate change scenarios shows graphic climate change tendencies. Most significant changes are related to extreme values of climate variables, indicating that in the future Latvia will more often face weather conditions uncharacteristic and extreme for its territory. Therefore, in order to prevent risks related to climate change and their possible consequences, it is essential to develop and introduce research result-based adaptation actions in all economy industries. Nonetheless important is to ensure a timely transition of Latvian economy to low carbon development thus lessening greenhouse gas emissions and at the same time, preserving and increasing carbon dioxide sequestration.

Table 2.1

Previous and future changes in climate variables in relation to long-term mean climate variable values in the past

Climate variable		Previous climatological value (1961-1990)	Previous changes (1981-2010 in relation to 1961-1990)	Future changes (2071-2100 in relation to 1961-1990)	
				RCP4.5	RCP8.5
Maximum temperature	Annual maximum value	+29.3ºC	↑ +0.7 ºC	↑ +3.6ºC	↑ +5.7ºC
	Annual-mean value	+9.5ºC	↑ +0.7 ºC	↑ +3.4ºC	↑ +5.4ºC
	Annual minimum value	-14.4ºC	↑ +1.4 ºC	↑ +6.5ºC	↑ +9.5ºC
Mean temperature	Annual maximum value	+22.4ºC	↑ +0.7 ºC	↑ +3.2ºC	↑ +5.4ºC
	Annual-mean value	+5.7ºC	↑ +0.7 ºC	↑ +3.5ºC	↑ +5.5ºC
	Annual minimum value	-18.6ºC	↑ +1.7 ºC	↑ +7.5ºC	↑ +11ºC
Minimum temperature	Annual maximum value	+17.6ºC	↑ +0.8 ºC	↑ +3.1ºC	↑ +5.6ºC
	Annual-mean value	+2ºC	↑ +0.7 ºC	↑ +3.6ºC	↑ +5.6ºC
	Annual minimum value	-24.1ºC	↑ +1.9 ºC	↑ +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

Climate variable	Previous climatological value (1961-1990)	Previous changes (1981-2010 in relation to 1961-1990)	Future changes (2071-2100 in relation to 1961-1990)	
			RCP4.5	RCP8.5
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 day	↑ +1 day	↑ +2 days
Simple daily intensity index	5.1 mm/per day	↕ 0 mm/per day	↕ 0 mm/per day	↑ +1 mm/per day
Annual-mean wind speed	3.6 m/s	↓ -8%	↓ -7%	↓ -3%
Stormy days	1 day	↓ -1 day	↕ 0 days	↕ 0 days
Calm days	75 days	↑ +13 days	↑ +24 days	↑ +2 days

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Climate change analysis tool

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