Ministry of the Environment
Republic of Poland

# Polish National Strategy for Adaptation to Climate Change (NAS 2020)

*with the perspective by 2030*

MINISTRY
OF THE ENVIRONMENT

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**The document has been drawn up by the Ministry of Environment basing on analyses carried out by an Institute of Environmental Protection – National Research Institute within the framework of the project entitled "Development and implementation of the Polish National Strategy for Adaptation to Climate Change – KLIMADA", implemented on behalf of ME in the years 2011-2013 from the funds of the National Fund for Environmental Protection and Water Management.**

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# Chapter 1. Introduction

## *1.1. Background and objective of the document, global and EU conditions*

The effects of climate change, especially the rise of temperature, frequency and intensity of extreme phenomena, taking place in the last few decades, tend to deepen and therefore they have become a matter of interest to governments and the international community. The results of scientific research clearly indicate that phenomena caused by climate change are a threat to the social and economic development of many countries in the world, including Poland. Therefore, efforts to adapt to the effects of climate change should be taken in parallel with actions carried out by Poland with regard to limiting greenhouse gas emissions. A properly chosen range of actions reducing the country's vulnerability to climate change will be an important factor stimulating an increase in effectiveness and innovation of Polish economy. The *"Polish National Strategy for Adaptation to Climate Change by 2020 with the perspective by 2030"* (SPA 2020) has been prepared with a view to ensure the conditions of stable socio-economic development in the face of risks posed by climate change but also with a view to use the positive impact which adaptation actions may have not only on the state of the Polish environment but also on the economic growth.

Adaptation actions involve significant costs. In a global perspective, the largest costs will be incurred by developing countries where necessary expenditure may amount up to USD 100 billion a year[1]. Forecasts in Europe invoked by the European Environment Agency predict spending of several billion EUR a year in the short term and tens of billions in the long term. Despite the differences in available estimates of costs at the global, EU and individual country level, the authors of analyses agree that the possible discontinuance of adaptation actions will result in even greater losses[2].

The main aim of adaptation actions taken by both public and private entities, such as the implementation of policies, investments in infrastructure and technologies as well as changes in behaviour, is to avoid risks and make use of opportunities. Climate change should be seen as a potential risk which should be taken into account when creating for example regulatory mechanisms and investment plans, just like it is the case of macroeconomic or geopolitical risks.

In the light of the above conditions, the Polish government began work on SPA 2020 in order to avoid costs resulting from the adaptation inactions and to reduce social and economic risks associated with climate change.

It should be stressed that in the forum of the *United Nations Framework Convention on Climate Change* (UNFCCC), the governments of more than 190 countries debate on reducing emission of greenhouse gases as well as on adaptation[3] to adverse impacts of climate change, recognizing that these actions should be carried out in parallel. The need to develop and elaborate appropriate and integrated

[1] Pursuant to the data from the European Environment Agency (EEA).
[2] Pursuant to the *EU Strategy on adaptation to climate change* – Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions COM (2013) 216.
[3] Adaptation in human systems is a process of adjusting to existing or expected climate change and its effects in order to mitigate damages or use favourable opportunities. In natural systems, it is a process of adjusting to existing and expected climate change and its effects; human intervention may facilitate this adjustment (of natural systems) to expected climate change (according to IPCC, 2012: *Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation).*

adaptation plans results from Article 4 of the above Convention and the decisions of *Conference of the Parties to the Convention* such as *Cancun Adaptation Framework* and "*Nairobi work programme on impacts, vulnerability and adaptation to climate change*" of 2006. The programme has been adopted in the Convention's forum and provides for, *inter alia*, the need for countries to assess the possible adverse impacts of climate change on various fields of life and to create a strategy to respond to those impacts.

The European Commission, aiming at implementing the *Nairobi Programme*, published on 1 April 2009 "*The White Paper: Adapting to climate change: Towards a European framework for action*", COM (2009) 147, which defined the scope of EU's activity for the years 2009-2012, *inter alia*, with regard to the preparation of the EU strategy on adaptation to climate change, which was finally published by the EC in April 2013 (COM (2013) 216). Adaptation will also be integrated with the EU key policies and will be an essential element of the EU foreign policy. The White Paper is of strategic nature and channels the preparation for the more effective response to the impacts of climate change at the EU and Member States level. The implementation system for the objectives based on the EU adaptation strategy will respect the principle of subsidiarity and support for major EU priorities in the field of sustainable development. The main objectives formulated at the EU level are: strengthening the evidence base relating to climate change, including adaptation into the key EU policies, adaptation financing as well as exchange of knowledge and good practices.
On 19th of May 2010, the Polish government has taken its stance on the White Book issue, recognizing the need to develop a strategy of adaptation for sectors and regions vulnerable to climate change. SPA 2020 is a part of a broader research project named KLIMADA, which covers the period up to 2070. SPA2020 is based to a great extent on conclusions obtained under the KLIMADA project. The decision on the indication of the period 2020 for SPA as a government document and acceleration of preparatory work results from the fact that it is necessary to prepare a set of adaptation actions by 2020 for sectors and areas vulnerable to climate change, with reference to national integrated development strategies, in order to improve the resilience of the economy and society to climate change and to reduce related losses.

The development of SPA2020 matches with the efforts to achieve the overarching objective of the White Paper and the EU strategy of adaptation to climate change, i.e. improvement of the resilience of the Member States to existing and expected climate change, including the better preparation for extreme climate and weather phenomena and reduction of related socio-economic costs.

### *1.2. SPA synthesis*

SPA 2020 indicates the objectives and directions of adaptation actions to be taken in the most vulnerable sectors and areas within the period by 2020: water management, agriculture, forestry, biodiversity and protected areas, health, energy, building industry, transport, mountain areas, coastal zone, spatial development and urban areas. The vulnerability of those sectors has been identified on the basis of climate change scenarios adopted for SPA. The objectives, action lines and specific actions that correspond to strategy documents, have been proposed, in particular the National Development Strategy 2020 and other development strategies that are complementary in the context of adaptation. Current and future climate change impacts has been taken into account and analyzed,

including climate change scenarios for Poland by 2030[4] which showed that in this period the greatest threat to the economy and society will be extreme weather events (torrential rains, floods, flooding, landslides, heat waves, droughts, hurricanes, landslips, etc.), which result from climate change. These phenomena will take place with the increasing frequency and intensity and on a greater scale.
The implementation system of a strategic plan has been proposed, by identifying responsible entities and indicators for monitoring and evaluation of the achievement of the objectives. Also, both costs of losses incurred as a result of extreme weather and climate events in Poland in the period 2001-2011 and costs of adaptation inactions at the intervals by 2020 and 2030 have been estimated. The framework for financing the implementation of actions in the perspective of 2020 has been indicated and the opportunities created by EU funds for the years 2014-2020 were taken into account. It should be stressed that registered losses attributed to climate change and occurring in 2001-2010, amounted to ca. PLN 54 billion. A probable consequence of future inaction may result in losses estimated at around PLN 86 billion by 2020 and additionally PLN 119 billion in the years 2021-2030.

While formulating SPA, it has been decided that the document should include various groups of adaptation actions, covering both technical projects (e.g. the construction of the necessary flood and coast protection infrastructure) and regulatory changes (e.g. changes in the spatial planning system limiting a possibility of building in areas at risk of flood, flooding and landslides, more flexible procedures for rapid response to natural disasters), the implementation of monitoring systems related to individual areas and wide dissemination of knowledge on the necessary shifts in economic behaviours. The following general principles have been taken into account:

- It is required to reduce the vulnerability to the risk associated with climate change, *inter alia*, by taking this aspect into account at the investment planning stage.
- It is necessary to develop rapid response plans in the event of climate disasters (floods, droughts, heat waves), so that public institutions were prepared to provide immediate help to victims.
- It is required to determine priority actions in terms of the cost-effectiveness In the first place, it is required to be prepared to address threats to health and life of humans and permanent loss and damages (e.g. in the form of lost cultural property, rare ecosystems).

### *1.3. Reference to the perspective 2070*

As indicated above, SPA 2020 is the first step towards defining a long-term vision of adaptation to the adverse effects of climate change. Guidelines regarding adaptation by 2070 will be developed by Ministry of Environment and publicly available = after the adoption of SPA 2020. Planning of long term actions is necessary, *inter alia*, due to the fact that – as climate change scenarios show - intensity and frequency of extreme climate and weather events will change significantly over the nearest decades in comparison with the current situation. This is crucial for enhancing the resilience of the economy and ensuring its competitiveness in the conditions of climatic stress with an upward trend till the end of this century.

[4] Climate change scenarios cover the period 2001-2030: for the purposes of the SPA 2020 project, scenarios for two decades 2001-2010 and 2021-2030 have been drawn up.

# Chapter 2. Diagnosis

## *2.1. General characteristics of climate in Poland*

The Polish climate is characterized by a great variability of weather and significant changes in the course of the seasons in consecutive years. The annual average air temperature values range from 5°C to nearly 9°C. The warmest area is the south-western part of Poland, while the coldest – the north-eastern part of the country and mountain areas (Figure 1). The average annual temperature amplitudes differs from 19°C at the coast to 23°C in the eastern fringes of the country. A distinctive feature of the climate diversity is the number of cold days (max. temp. below 0°C), occurring from November to March (mostly in January), increasing from the west (less than 20 days a year on the lower Odra river and along the coast) to the north-east (to more than 50 days in the Suwałki Lakeland) and in the mountains to 192 on Śnieżka and 146 on Kasprowy Wierch. The lowest temperature in Poland was recorded in Siedlce -41°C (1940) and in the Żywiec Valley -40,6°C (1929). The number of days with frost (min. temp. below 0°C), which may occur from early autumn to late spring, ranges from 80 (at the seaside) to more than 120 in the north-eastern areas, in the mountains it exceeds 200 days a year.

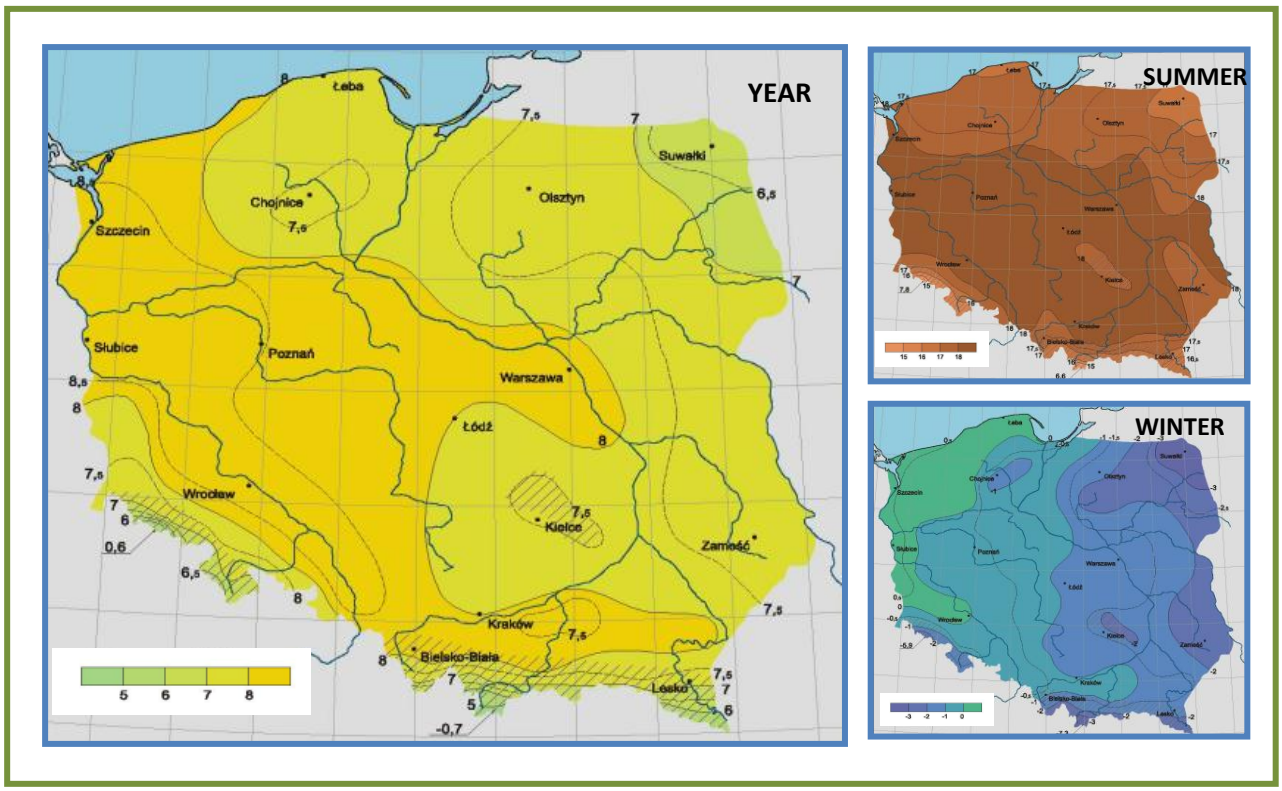


Figure 1. Average air temperature in °C in Poland (1971-2000)

*Source: Atlas of Climate in Poland 2005*

Variations in temperature affect the length of the vegetation period and the active plant growth period measured by the number of days with the daily average temperatures of more than 5°C and 10°C, respectively. The vegetation period in Poland lasts on average 214 days, ranging from 199 to 234 days with the northeast-southwest temperature gradient.

Basing on the course of the average daily air temperature there are six seasons in Poland: early spring (0-5°C), spring (5-15°C), summer (above 15°C), autumn (5-15°C), early winter (0-5°C), winter (below 0°C). The length of the seasons is diversified regionally: summer lasts from 60-70 days in the northern part of Poland to 100 days in the south-east, central, western and south-western part, winter — from 10-40

days at the seaside and in the west to 3-4 months in the north-east and in the Tatra Mountains even up to 6 months.

Precipitation is highly dependent on the land relief. The average sum of atmospheric precipitation is almost 600 mm but rainfall varies from less than 500 mm in the central part of Poland to almost 800 mm at the coast and more than 1000 mm in the Tatra Mountains (Figure 2). The highest amounts of precipitation fall on summer months, when they are 2-3 times higher than in winter and in the Carpathian Mountains they are even up to 4 times higher. Torrential rains (precipitation of >2 mm/min) take place between April and September with the highest frequency in July, often associated with storms.

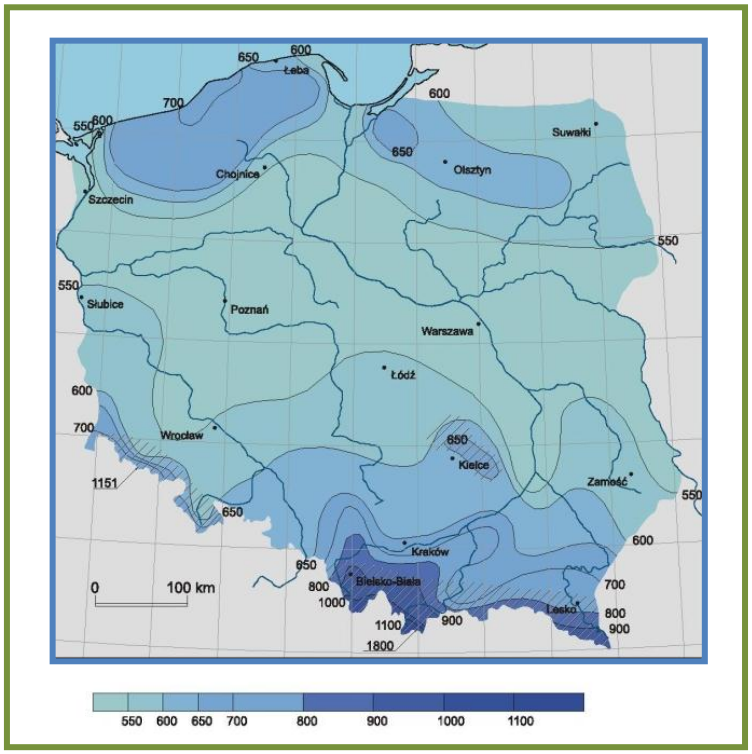


Figure 2. Average annual amounts of precipitation [mm] in Poland (1971-2000)

*Source: Expert opinion by IMGW for the KLIMADA project*

Snowfall composes from 15 to 20% of the annual amount of precipitation. Snowfall takes place from November to April and in the mountains as early as in September. In the Tatra Mountains, it may occur occasionally also in summer months. The number of days with snow cover increases from the west and south-west to north-east of the country from 30-60 to 80-90 days and more than 200 days high in the mountains.

### *2.2. Climate change in Poland during the years 1971 – 2011*

The last two decades of the 20$^{th}$ century and the first decade of the 21$^{st}$ century are the warmest in the history of instrumental observations in Poland. A rise in the air temperature is observed during all seasons. However, the growth is definitely stronger in winter and weaker in summer. There is a noticeable rise in extreme temperatures since 1981.

In the multiannual period 1971-2000 the amount of precipitation has not changed significantly. However, in that period they were characterized by the considerable variability year by year

– the occurrence of more and less humid periods at short intervals. Also downward trends in amounts of precipitation were observed in the area of North-Eastern Poland (starting from Warsaw) and in the area of the Central Odra River Valley. In the rest of the country these trends were upward.

The main factors affecting climatic conditions are extreme events, which present escalation noticeably changes the climate dynamics characteristics in Poland. Thermal phenomena which are adverse and bothersome to the population, environment and economy include the occurrence, especially since the 90s, of severe heat waves (sequences of days with the maximum daily air temperature ≥ 30°C holding for at least 3 days) and hot days (with the maximum temperature of ≥30°C), most common in the south-western part of Poland, least common at the coast and in the mountains, where the longest sequences of hot days last ≥ 17 days (Nowy Sącz, Opole, Racibórz).

In most areas of Poland there is a downward trend in the number of frosty and very frosty days. Slight increases in the number of frosty days were noticed only in the mountain areas and in the south-western part of Poland. There is slight upward trend in a duration of frosty periods in the greater part of the country. The longest very frosty periods took place in the north-eastern and eastern part of the country (10-20 such episodes within 40 years), in the remaining area several very frosty periods were recorded, exclusive of the coastal areas, where such temperatures have not been recorded.

In most Polish areas the structure of precipitation has changed. *Inter alia*, an increase in the number of days with very intense precipitation (daily precipitation ≥ 50 mm) has been observed, especially in the southern regions. The longest precipitation sequences in the period 1961-2000 ranged, on average, from 11 to more than 40 days. An upward trend in the number of days with precipitation ≥ 50 mm was marked with blue dots in the picture, which size indicates the degree of the escalation of changes. A downward trend was marked in red while the absence of any trend was marked in green. Downpours with the intensity exceeding 5 mm/min., of the seasonal probability (V-IX) ≥ 10% occur most often in the entire Subcarpathian region, the Świętokrzyskie Mountains, longitudinally situated area from Opole and Częstochowa to Olsztyn, western part of Roztocze and cover a part of the Nysa Kłodzka River basin (in the period 1966-1985).

An analysis of the duration of precipitation-free periods (number of days without precipitation or with precipitation below 1 mm) indicates that during the last 12 years (1991-2002) the rainless period tends to extend even by 5 days/decade in entire eastern Poland (from the Wisła River to the east). This is a region was most frequently affected by drought (including hydrological drought) in the period of 1991-2002. The periodic occurrence of droughts is a characteristic feature of the Polish climate. In the 20$^{th}$ century they have already happened 24 times and since the beginning of the 21$^{st}$ century, i.e. in the years 2001-2011, droughts have taken place 9 times at different times of the year.

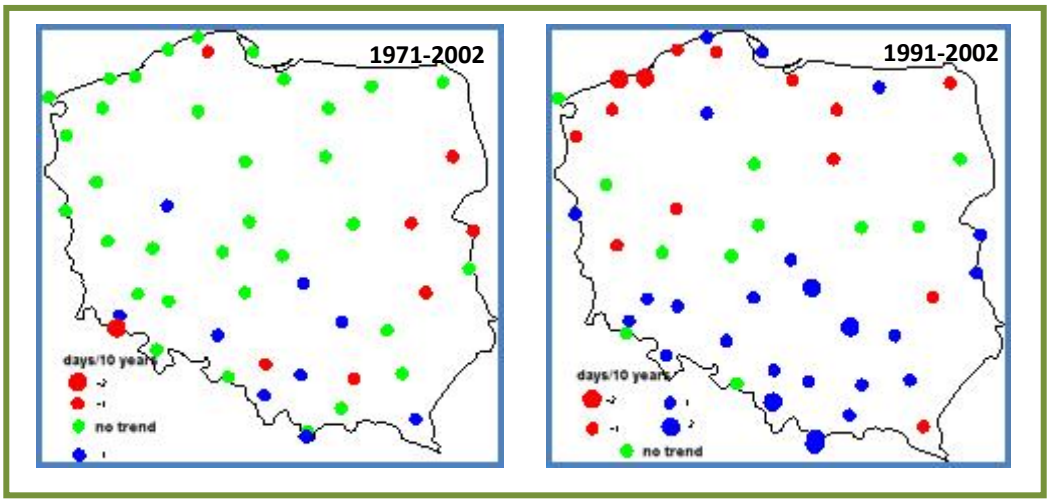


Figure 3. Trends of the number of days with precipitation ≥50 mm

*Source: Expert opinion by IMGW for the KLIMADA project*

During the cool season (X-IV) may be distinguished intensified wind speeds gusting to ≥ 17 m/s which are a significant threat, in the summer (VI-VII) hurricane wind speeds appear. There is to be observed an increasing occurrence of very high speed winds lasting several hours or even several days. The most vulnerable areas to the occurrence of maximum wind speeds are: central and eastern part of the Słowińskie Coast from Koszalin to Rozewie and Hel and a broad, latitudinal belt of northern Poland to Suwałki Region, Silesian Beskids, Żywiec Beskids, Silesian Foothills and Podhale and Dynowskie Foothills, central part of Poland with Mazowsze and the eastern part of Wielkopolska. Squalls and whirlwinds (when wind speeds in the vortex from 50 to 100 m/s) appear from June to August most often in the region of Małopolska Upland and Lublin Upland, stretching with a broad belt towards the south-west – north-east through the area of the Kutno Upland, Mazowsze to Suwałki Region. Such winds occur on average 6 times a year while in the last three years (2008-2010) the frequency increased to 7-20 a year (Figure 4).


Figure 4. Occurrence of whirlwinds in Poland in the period 1998 – 2010

*Source: „Impact of climate change on the environment, economy and society" IMGW*

### 2.3. Analysis of losses and costs of removing damages caused by extreme weather and climate events in the years 2001-2011

The impact of extreme weather and climate events[5] on people, their property and the environment causes direct damages. Such damages may involve loss of health and life of humans, destruction of the technical infrastructure, loss of farm animals and harvest or destruction of ecosystems. Indirect damages are in turn a result of long-term consequences of extreme weather and climate events and cover a much larger area than the affected by the phenomena. They arise, *inter alia*, as a result of company profit loss caused by transport problems, reduced production involving the decreased competitiveness of selected industries or reduced demand in the market affected by damages.

An analysis of losses and damage costs has been drawn up on the basis of data collected from departments, regional offices, other institutions and of expert opinions made for the purposes of the KLIMADA project. The analysis showed that extreme events causing the greatest damages in Poland are associated mainly with floods.

The problem of floods and flooding applies to all sectors of the economy, in particular, to the infrastructure existing in areas exposed to the risk of flooding. Small-scale floods take place every year and cause losses at the average level of 0.08-0.1% of GDP. However, once a few or a dozen

[5] Classifications of flood damages, which have already been developed, were adopted for damages caused by the whole of adverse weather phenomena.

or so years greater flood disasters resulting in above-average losses take place. In the analyzed period these were the floods in the years 2001 and 2010, resulting in damages estimated at approximately 0.5 and 0.9% of GDP, respectively (

Figure 5)

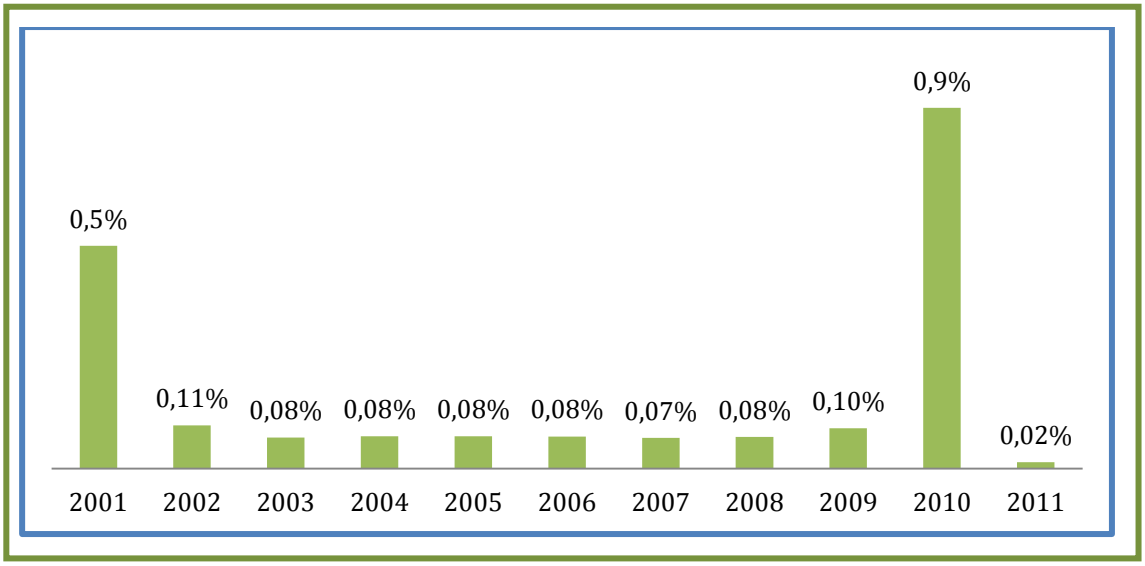


Figure 5. Estimated value of floods and flooding caused losses (in % of GDP)

*Source: Study by E. Siwiec (IOŚ- PIB) and J. Gąska (IBS)*

Apart from floods significant losses in the economy are also caused by droughts, strong winds and hurricanes. A collation of disadvantageous weather and climate events by key vulnerable sectors is shown in table below (

Table 1.).

Table 1. Weather phenomena causing damage to the economy.

| Sector | agriculture, biodiversity, water resources | forestry | health, local communities | infrastructure |
|---|---|---|---|---|
| **Phenomena resulting in damages** | • flood<br>• hurricane<br>• lightning<br>• drought<br>• adverse effects of overwintering<br>• spring frosts<br>• rainstorm<br>• hail | • flood<br>• strong winds<br>• drought<br>• flooding and landslides<br>• cap of snow, intense snowfall<br>• lightning<br>• hail<br>• heat waves | • heat waves<br>• cold waves<br>• extreme events resulting in psychosocial damages, health damage and loss of life<br>• landslides<br>• drought | • flood<br>• flooding<br>• hurricane<br>• lightning<br>• hailstorm<br>• landslides<br>• rime and snowfall<br>• ice build-up |

*Source: Study by E. Siwiec (IOŚ- PIB)*

The highest losses are often caused by the occurrence of a whole range of phenomena. In the infrastructure and forestry, losses may arise as a result of the occurrence of strong winds combined with rain, hail and lightning which consequently may lead to flooding and floods. Similarly the agricultural sector recorded high losses at the time of overlapping of several adverse weather extreme events .
In 2006 there was a significant loss of crops due to strong frosts and sequential droughts (including hydrological ones) and torrential rains. Losses in agriculture were several times higher than losses in that sector caused by floods in 2010. In 2001 the flood in Poland caused losses of about PLN 3.6 billion (at prices of 2010). The highest damages have been reported in the area of the Małopolskie, Podkarpackie and Świętokrzyskie voivodeships. The losses mostly were incurred in the south-eastern part of the country, in the upper basin of the Wisła River, reaching around 64% of total losses in the area of 3 voivodeships. Minimum losses took place in the area of the Kujawsko-Pomorskie, Opolskie and Warmińsko-Mazurskie voivodeships.

The flood that took place in Poland in May and June 2010, affected 14 of 16 voivodeships, both those from the Wisła and Odra Rivers basins. Due to the flood's and damages' size it was decided to estimate losses in a way which would allow the Polish government to apply to the European Commission for funds from the Solidarity Fund. The total value of losses caused by the flood in 2010 was estimated at about PLN 12.5 billion. The voivodeship affected by the highest damages was again the Małopolskie voivodeship. Losses in this voivodeship amounted to more than 30% of total damages in Poland. Losses in the Podkarpackie (17%) and Silesian (14%) voivodeships were estimated significantly lower. In the Zachodniopomorskie and Warmińsko-Mazurskie voivodeships, no significant losses have been recorded.

The total value of direct losses caused by disadvantageous weather and climate events in the country during the years 2001-2011 is estimated at more than PLN 56 billion (Figure 6). Assuming that indirect losses account for about 60% of direct losses[6], it may be assumed that total losses caused by extreme weather events in Poland in the period 2001-2011 amount to about PLN 90 billion.

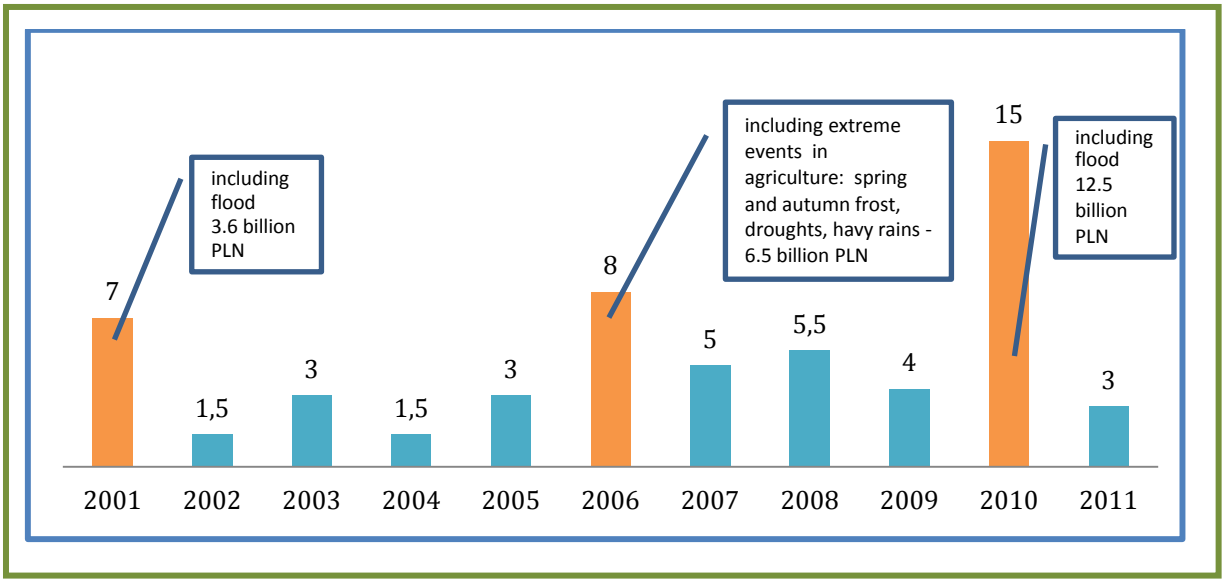


Figure 6. Estimation of losses caused by adverse weather phenomena in Poland (deflated by the investment price index 2010 in billion PLN)

*Source: Study by E. Siwiec (IOŚ- PIB) and J. Gąska (IBS)*

[6] The assumption on indirect flood damages, adopted in the Programme for the protection against flood in the upper Wisła river basin, has been applied to the whole of adverse weather phenomena.

The amount of losses depends on the destructiveness of extreme weather events in a given year, while incurred expenses are characterized by a more regular distribution. This is due to the fact that losses are estimated in the year of an excessive weather and climate phenomena occurrence, while removing the effects of a natural disaster takes many years. When Poland joined the European Union, there was an significant increase in the amount of funds allocated for financing tasks related to disasters effects liquidation, which is also taken into account in the presented estimations. Considering sources of financing, a specification of expenses incurred on removing and preventing the effects of natural disasters has been prepared.

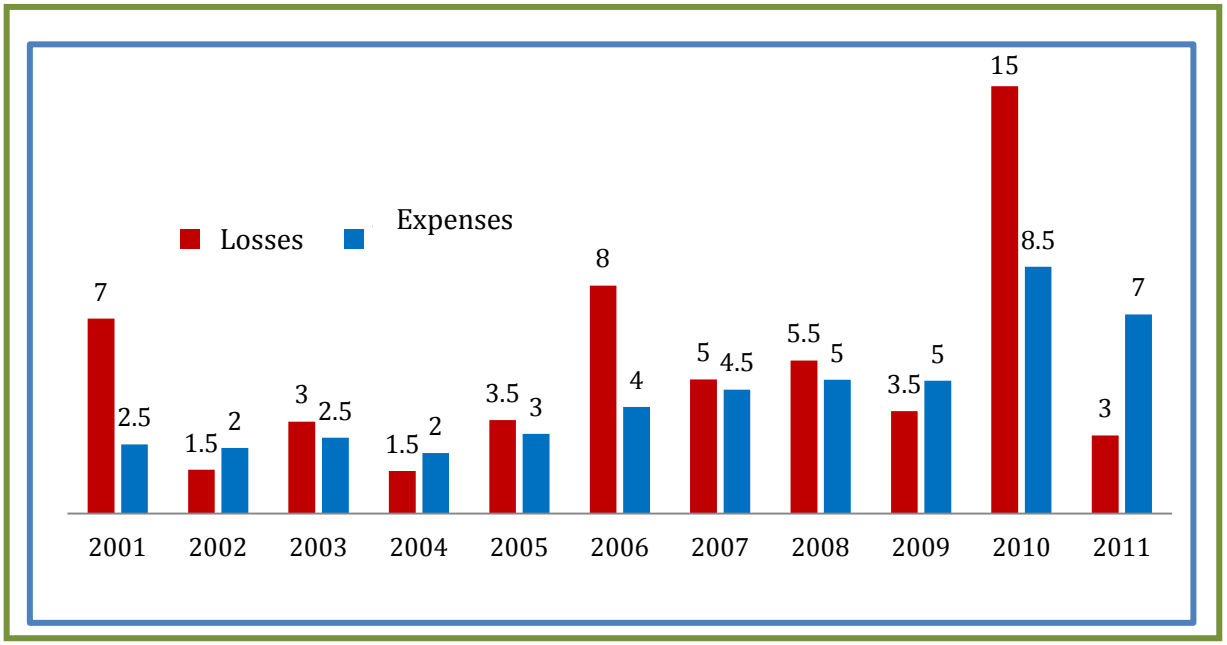


Figure 7. Specification of losses and expenses (deflated by the investment price index 2010 in billion PLN).

*Source: Study by E. Siwiec (IOŚ- PIB) and J. Gąska (IBS)*

A rapid increase in expenses was observed only in 2010 and 2011. It involves both the greater availability of data as well as the country's increased needs due to the flood in 2010. In total, more than PLN 46 billion were spent (deflated by the investment price index of 2010) for liquidation and preventing the effects of natural disasters in the years 2001-2011. Losses estimated at that time are higher by more than PLN 10 billion than expenses incurred (Figure 7). Despite the extensive system of financing tasks related to liquidation of the negative effects of natural disasters, probably over 11 years the state which existed prior to the occurrence of extreme weather events has not been restored.

# Chapter 3. Climate change scenarios by 2030 and impact on vulnerable sectors and areas

Developed for the KLIMADA project at the Interdisciplinary Centre for Mathematical and Computational Modeling of the Warsaw University, climate change scenarios for Poland describe probable future climatic conditions. They are based on the results of simulations of the atmosphere and ocean hydrodynamic models. Due to the considerable level of uncertainty associated with insufficient knowledge of physical laws governing the atmosphere and the environment as well as due to a whole range of initial assumptions, *inter alia*, on the global economic and demographic development, and thus on scenarios of emissions of greenhouse gases and other pollutants into the atmosphere, they may not be regarded as reliable climate forecasts. For these reasons, climate change scenarios represent the best available approximation of future conditions. As there is no ideal model and there is no one scenario, it is necessary to analyze the results of several most probable models.

In preparing scenarios, the results of regional simulations from the EU's ENSEMBLES project[7] and observation data from the E-OBS gridded dataset have been used[8]. Scenarios have been prepared using a scheme of global changes in greenhouse gas emissions developed by the IPCC SRES A1B, which assumes the rapid global economic development, reaching of the maximum population level in the middle of the century and also takes into account the sustainable use of various energy sources. Simulations carried out for the A1B scenario reflect the image of average changes when compared to extreme scenarios A2 and B1. Due to the policy of adaptation to forthcoming climate change, it is not recommended to apply excessively radical scenarios but rather to rely on a moderate scheme, which justifies the choice of the scenario A1B. The differences resulting from the application of different models are very important and it is necessary to take them into account. The results presented below are based on an analysis of a batch of eight regional simulations using, as the boundary conditions, the results of four different global models. Simulations differ from each other, giving a slightly different picture of future changes.

Climate change may have an impact on social and economic life, both negatively and positively. Taking into account the strategy's objective, the following analysis focuses only on the potential negative effects of such change. Positive change is negligible and does not make up for negative change.

The subject of the analysis were in the first place those sectors of social life and economy, which are mostly affected, or will be affected by the adverse impacts of climate change. A preliminary impact assessment has been carried out with regard to the sectors of the environment, forestry, agriculture, energy, transport and health on the basis of information which was provided by interested departments and pointed out both climate extreme events most affecting the economy and the areas of impact. According to a questionnaire carried out, a number of areas of life are already significantly affected by hazards resulting from changing climatic conditions. A detailed assessment being a basis for this paper has been carried out by the expert groups under the KLIMADA project.

[7] http://www.ensembles-eu.org/
[8] http://eca.knmi.nl/

### *3.1. Analysis of climate change trends in Poland by 2030.*

An analysis has been carried out on the basis of calculated selected items and climate indices. Estimates are based on a batch of climate simulations using regional climate models with various boundary conditions.

For the purposes of this plan, the analysis covered changes in three regions representing various climatic conditions: south-western region (Wrocław), central region (Łódź) and north-eastern region (Suwałki). The values of the climate indicators characterizing changes in extreme conditions are given in the table (Table 2). The values apply to the periods of three decades: 2001-2010, 2011-2020 and 2021-2030 (marked in the table as 2010, 2020 and 2030). City names are used conventionally for the determination of the region. The course of trends in all three regions of Poland is very similar but differs in terms of the size of changes depending on the region.

Table 2. Change in climatic conditions between 2001 and 2030

| Climate indicators | Wrocław | | | Łódź | | | Suwałki | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 - 2010 | 2010 - 2020 | 2020 - 2030 | 2000 - 2010 | 2010 - 2020 | 2020 - 2030 | 2000 - 2010 | 2010 - 2020 | 2020 - 2030 |
| **Average annual temperature** | 9,0 | 9,4 | 9,5 | 8 | 8,7 | 9 | 7,0 | 7,6 | 7,6 |
| **Number of days with temperature <0°C** | 99 | 94 | 94 | 103 | 99 | 99 | 121 | 115 | 115 |
| **Number of days with temperature >25°C** | 39 | 48 | 47 | 35 | 41 | 42 | 24 | 30 | 31 |
| **Number of degree days <17°C** | 3106 | 2984 | 2988 | 3340 | 3205 | 3213 | 3748 | 3581 | 3582 |
| **Length of the vegetation period >5°C (in days)** | 253 | 258 | 262 | 235 | 244 | 246 | 216 | 220 | 221 |
| **Max. daily precipitation (in mm)** | 29 | 30 | 31 | 24 | 24 | 23 | 25 | 24 | 26 |
| **Length of dry periods <1mm (in days)** | 20 | 23 | 21 | 21 | 24 | 23 | 20 | 23 | 23 |
| **Length of wet periods >1mm ( in days)** | 7,3 | 8,0 | 7,5 | 7,0 | 7,0 | 7,2 | 8,0 | 8,0 | 8,1 |
| **Number of days with snow cover** | 67 | 55 | 55 | 83 | 70 | 71 | 104 | 93 | 93 |

Throughout the entire analyzed period, the annual average air temperature shows a gradual increase, however, in the years 2010-2030 this increase is low, it will be slightly higher in case of winter periods. The annual average air temperature is related to many indicators relevant for the economy, in particular such as negative temperature, length of the vegetation period or the number of degree days[9]. In the last two decades, we are dealing with an increase in the number of days with the high temperature and with a systematic decrease in the number of days with the negative temperature (Figure 8 and 9).

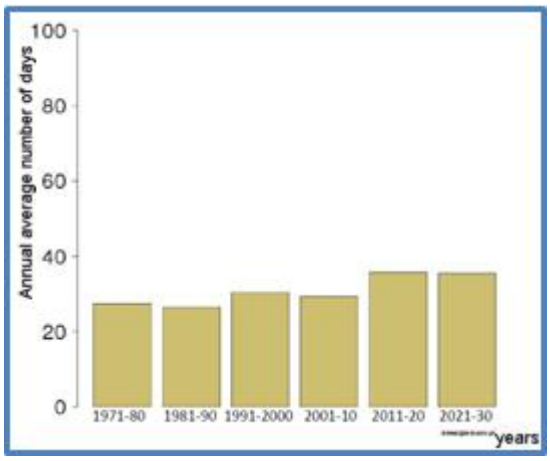


Figure 8. Number of days with the maximum temperature exceeding 25°C in the years 1971-2030

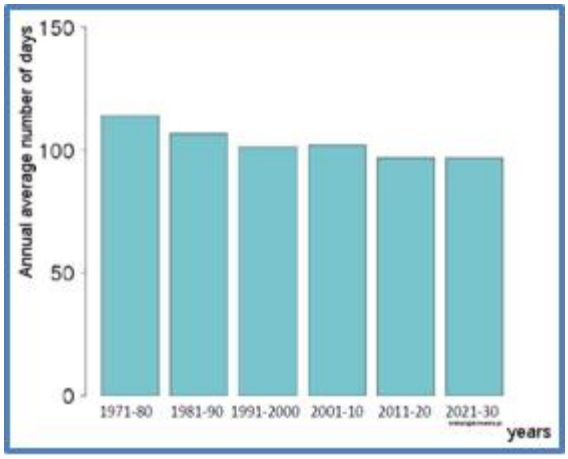


Figure 9. Number of days with the minimum negative temperature below 0°C in the years 1971-2030

The length of the vegetation period is of key importance to plant production. In the period in question, we observe a clear trend consisting in the extension of the period with the temperature higher than 5°C (Figure 10). It is to be expected that this period will extend, on average, by 10-12 days, but in relation to 2010 this increase will be smaller, i.e. about 2-5 days, which will not have a significant impact on plant production.

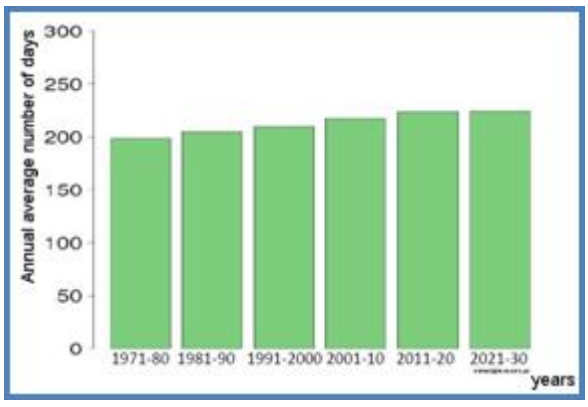


Figure 10. Length of the vegetation period (average daily temperature >5°C) in Poland, in days, in the period 1971-2030

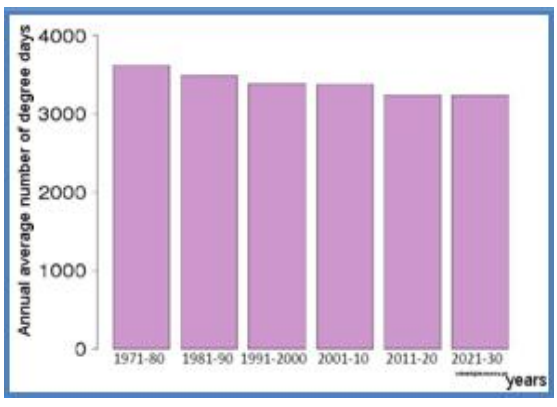


Figure 11. Total degree days for the temperature <17°C in the period 1971-2030

[9] One degree day means a necessity to heat a building for one day so that its internal temperature rises by 1°C.

To estimate demand for thermal energy necessary in the construction industry for heating of buildings, the so-called degree days for the temperature threshold <17°C are used. In the period in question, they show a downward trend (Figure 11) and by 2030, the annual number of degree days will decrease by about 4.5%, which in turn may affect a decrease in demand for electricity and heat and reduction in carbon dioxide emissions.

The second key climate element of fundamental economic importance is precipitation. Unlike the air temperature, the expected total annual amounts of precipitation do not show any clear trend of changes by 2030 (Figure 12). However, we must be prepared for the growing frequency of torrential rains, particularly in the nearest two decades (Figure 13). Such great instability of intense precipitation may contribute to flooding and local violent floods.

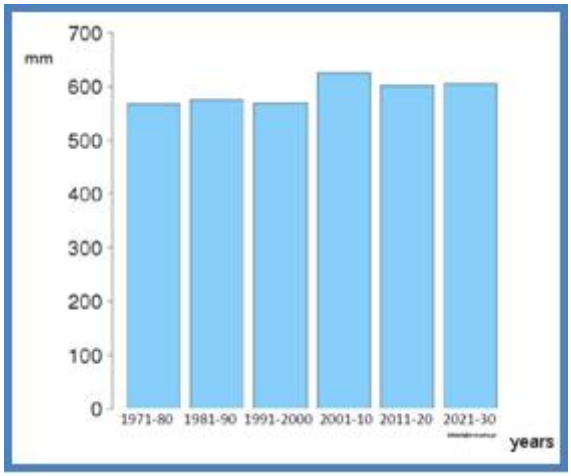


Figure 12. Average 10-year annual amounts of precipitation for Poland in mm

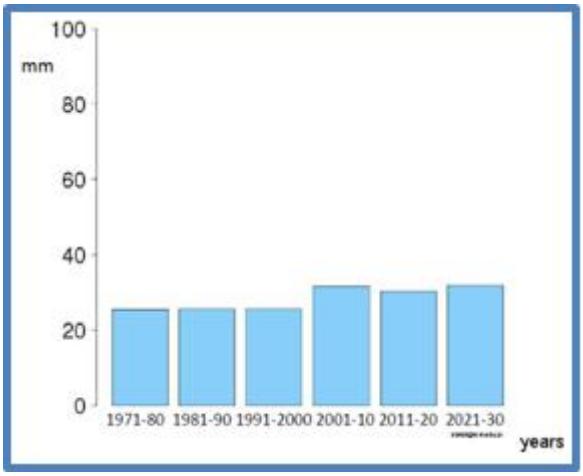


Figure 13. Maximum daily precipitation in mm (average ten-year) in the period 1971-2030

An economically important element, associated directly with precipitation is snow cover, which height and particularly the duration of lingering plays a key role in agriculture and water management. In the years 2010-2030, downward trends in the number of days with snow cover are insignificant and we have to be prepared for large fluctuations between next winter seasons (Figure 14).

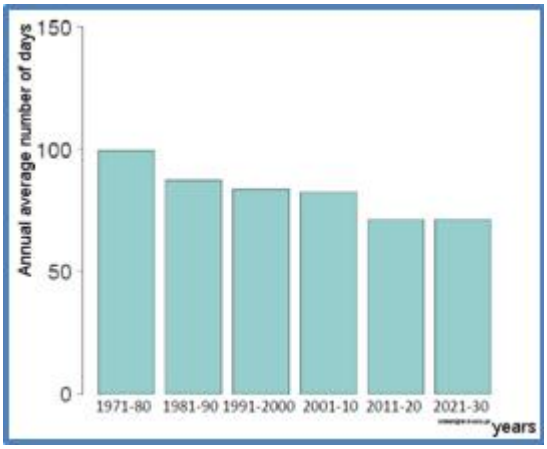


Figure 14. Number of days with snow cover in cm (in the years 1971-2030)

### *3.2. Expected spatial diversification of climatic conditions in Poland*

A spatial analysis of changes in selected climate elements indicates inconsiderable modifications in averaged climatic conditions, with an upward trend in the air temperature. This may entail an increase in the variability and more frequent occurrence of extreme events over the analyzed period. The spatial analysis of scenarios is presented in the maps of Poland illustrating the difference between the status of a relevant element in the reference period 1971-2000 and in the period 2001-2030. This enables an easier assessment of expected changes. For the spatial analysis of changes in climatic conditions, the number of days with values exceeding specific thresholds likely to be of importance to the economy has been chosen.

Figures 15 and 16 reveal that an increase in hot periods ($t_{max}$ >25°C) covers the entire country so does a decrease in the number of days with frosty periods ($t_{min}$ <-10°C), and the largest changes should be expected in south-eastern Poland.

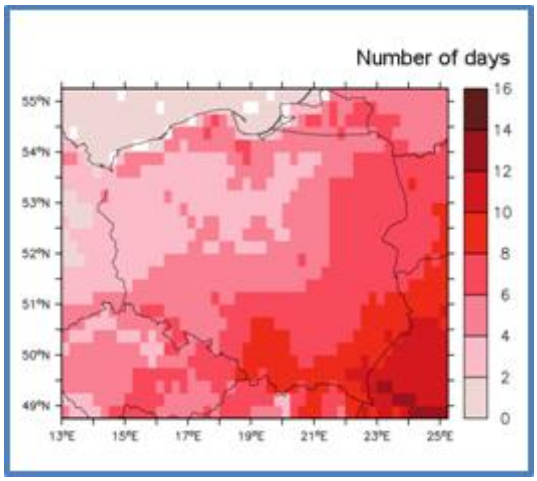


Figure 15. Increase in the number of days with the maximum temperature exceeding 25°C when compared to the reference period.

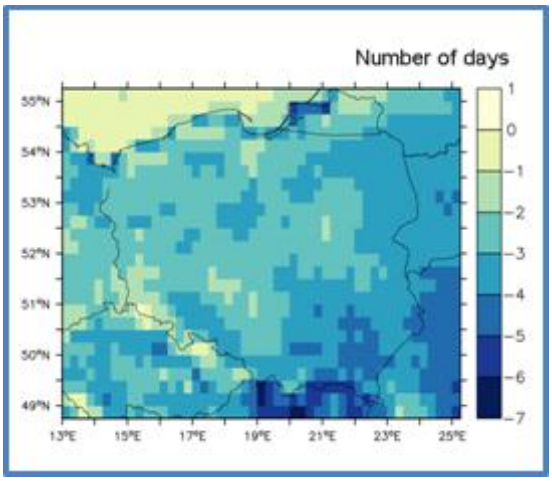


Figure 16. Decrease in the number of days with the maximum temperature below -10°C when compared to the reference period.

The consequence of these variations in the temperature, particularly in the maximum one, is the longevity of dry periods (with the daily amount of precipitation <1 mm) and wet periods (>10 mm/d). Dry periods extend most in the eastern and south-eastern Poland, so do wet periods (Figure 17 and 18). However, in case of torrential rains (>20 mm/day), an increase in the frequency should be expected in southern Poland, especially in the area of Bieszczady mountains, and a decrease of such precipitation – in central Poland , particularly in its western part.

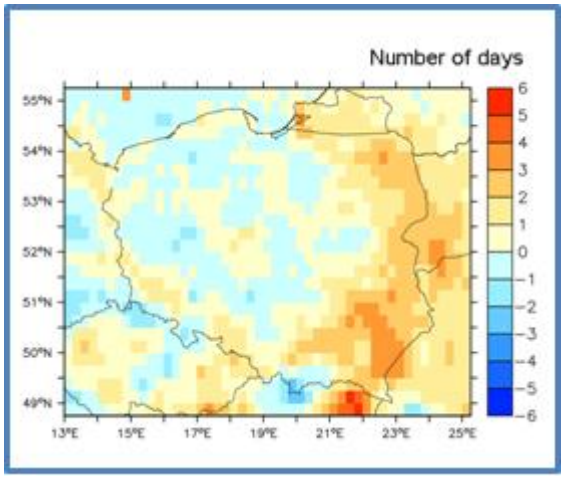


Figure 17. Difference between the period 2001-2030 and the reference period: duration of dry periods (< 1mm/d)

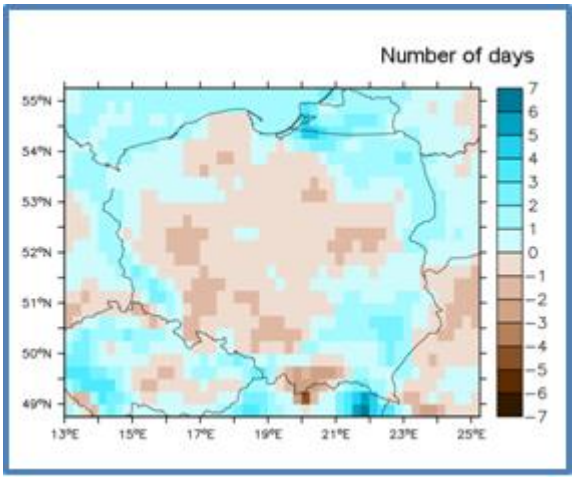


Figure 18. Difference between the period 2001-2030 and the reference period: duration of wet periods ( >10 mm/d)

On the other hand, the extension of the vegetation period should be expected in entire northern and western Poland, particularly intensivie in Wielkopolska and at the coast. Shortening of the heating period covers the entire country, however, will be most visible in north-eastern Poland (Figure 19 and 20).

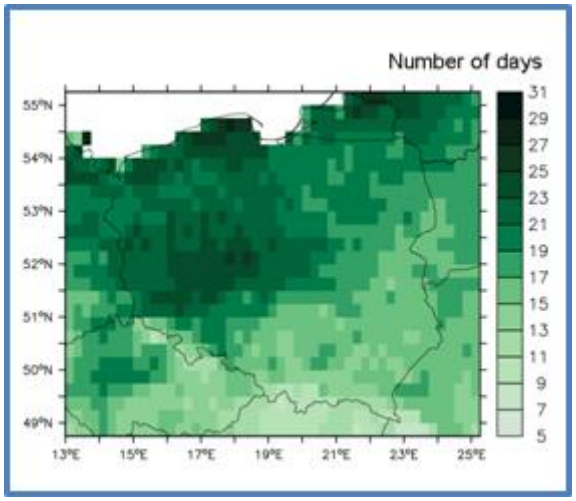


Figure 19. Difference in the duration of the vegetation period (for the 5°C threshold) between the period 2001-2030 and the reference period.

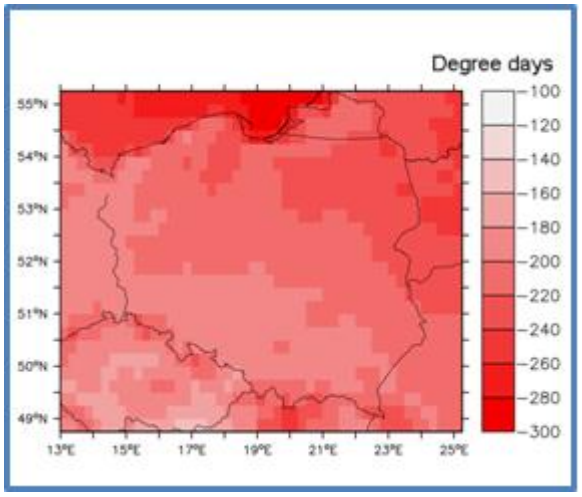


Figure 20. Difference in the number of degree days (for the 17°C threshold) between the period 2001-2030 and the reference period.

## *3.3. Impact of climate change on vulnerable sectors and areas by 2030*

### 3.3.1. Water management

Poland is a country of relatively small water resources and the efficiency of their use is low. What is more, in some regions occur periodical problems with water supply.

Carried out analyses showed no significant trends in maximum river flows, however, their frequency has increased twice in the years 1981-2000 when compared to the years 1961-1980. Thus, the risk of various types of floods occurs virtually all across Poland (Figure 21) and is related not only to climate change, but also to anthropogenic factors.

Incorrect spatial development, in particular, investing in risk areas, including flood zones of rivers, and the insufficient retention capacity of natural and artificial reservoirs, not only in river valleys, limits effective actions in situations of an excess or deficit of surface waters. There is a risk that in the future these extreme events will occur with the increased frequency. The results of analyzed scenarios show an increased probability of flash floods caused by heavy precipitation likely to cause flooding of areas where spatial development is implemented improperly. The formation of water resources is largely affected by snow cover. Forecasts predict that the duration of its lingering will be gradually reduced and in the middle of the 21$^{st}$ century it may be, on average, by 28 days shorter than it is now. The decrease in the maximum value of the water content in snow may have both a positive and negative effect. The positive effect of the decrease in the water content in snow cover, will be a lower probability of snowmelt floods. However, this may contribute to the deterioration of the soil structure and the condition of ecosystems.

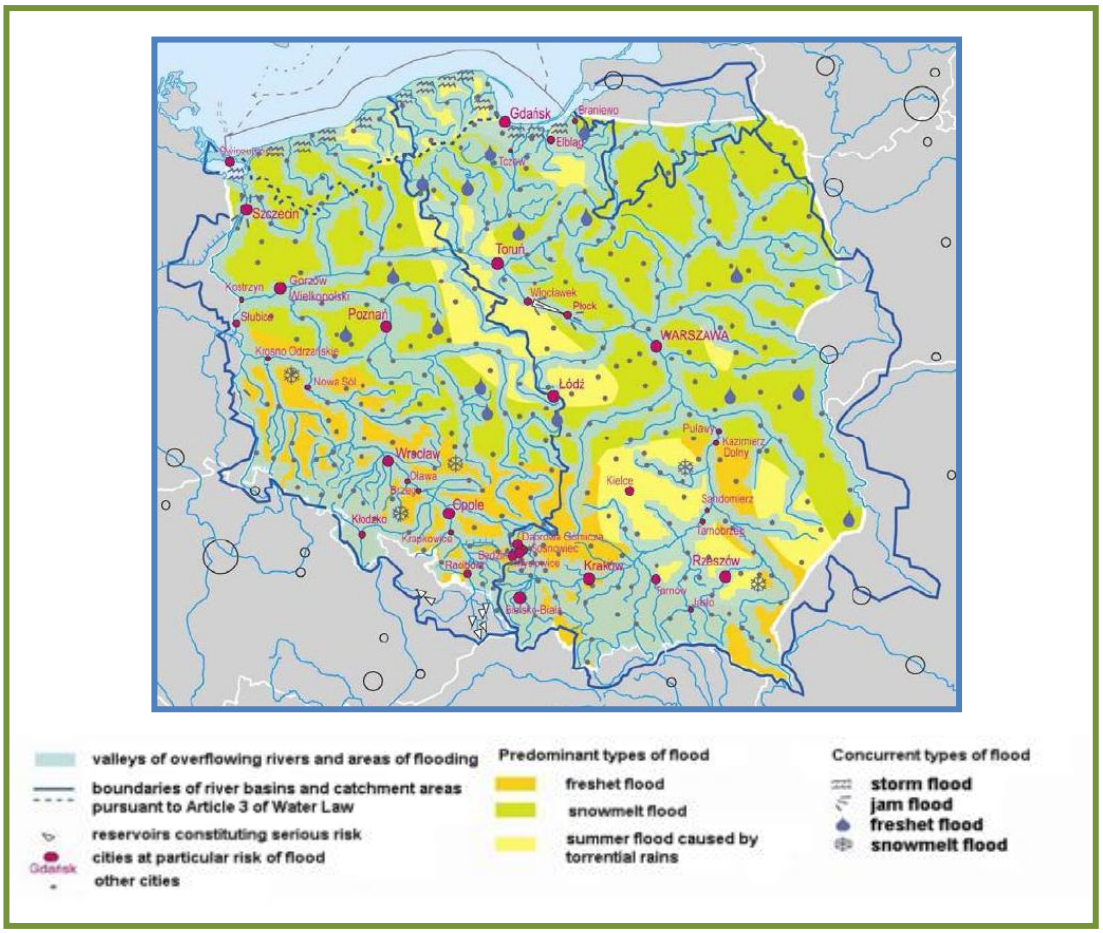


Figure 21. Flood hazard in Poland

*Source: KPZK 2030 (Monitor Polski of 2012, No 252)*

The sector most vulnerable to shortages of water is agriculture, where water needs, according to the forecasts, will increase by 25-30%[10]. In case of periods with a deficiency of precipitation, individual voivodeships may be at risk of the deficit of water available for the economy (Table 3), in particular the Mazowieckie Voivodeship.

Table 3. Difference (in $hm^3$) between average resources and water abstractions for the period 2021-2050

| Voivodeship | Average difference | Voivodeship | Average difference |
|---|---|---|---|
| **Dolnośląskie** | 2 416 | **Podkarpackie** | **3 441** |
| **Kujawsko-Pomorskie** | 1 522 | **Podlaskie** | 2 270 |
| **Lubelskie** | 2 088 | **Pomorskie** | 3 070 |
| **Lubuskie** | 1 361 | **Śląskie** | 2 428 |
| **Łódzkie** | 1 335 | **Świętokrzyskie** | **628** |
| **Małopolskie** | 3 344 | **Warmińsko-Mazurskie** | **3 575** |
| **Mazowieckie** | **93** | **Wielkopolskie** | 1 084 |
| **Opolskie** | 1 036 | **Zachodniopomorskie** | 2 071 |
| **Poland** | | **32 063** | |

*Source: KLIMADA*

[10] In the perspective by 2050, source – KLIMADA project.

### 3.3.2. Biodiversity and legally protected areas

Climate change will affect distribution range of species, reproductive cycles, vegetation periods and interactions with the environment. However, different species and habitats react differently to climate change – some will be affected positively, some will not. Most forecasted changes are based on variability of average climate parameters: precipitation, temperature, wind direction, but it happens equally often as a result of extreme events like floods, strong winds and downpours. As a result of these changes, biodiversity is a subject to gradual transformations.

The expected climate warming will result in migration of species, including invasive alien species, mainly from Southern Europe, North Africa, Asia, along with the simultaneous withdrawal of species which are not adapted to high temperatures and drought in the summer and are not used to heavy frosts. However, migration of species, which is a form of adaptation to climate change, may be prevented by the "ecological obstruction" of human-transformed landscapes: lack of the ecological continuity of plant formation, obstruction of ecological (river and forest) corridors, low saturation of the landscape with natural elements that may be "environmental islands" for individual species (e.g. minor peat-bogs, marshes, water bodies). Another serious consequence of climate warming is a foreseen sea level rise, which will result in changes in coastal ecosystems such as intensification of erosion and increased salinization of coastal zones. These changes will also affect coastal and inland dunes habitat, where indirect changes, such as increased wind speed or soil salinity, will take place. Areas lying in the lakeland, natural and semi-natural meadow formations and grasslands and peat-bogs are also exposed to the effects of the climate warming due to lowering of groundwater levels and progressive eutrophication. Also Polish lowlands are exposed to reduction in wetlands, including gradual drying up and disappearance of peat-bogs, humid forests and woods.

Observed and foreseen variations in the hydrological regime of the entire country have a direct impact on biodiversity. We may observe modifications in the structure of precipitation during the vegetation period, i.e., more frequent droughts in the summer and spring and an increase in the amount of torrential rains, including hail. Due to the frequency of these events, we must be prepared for the increased number of extreme situations i.e. floods, droughts, landslides and water erosion in watercourse beds. Effects of these changes will be particularly visible in the areas of the Polish Upland, where biodiversity may be easily impoverished and direct damages may happen. Also the period of lingering of snow cover and its thickness will be reduced. The problem of changes in the hydrological regime also applies to habitats of fresh waters, both running and stagnant. This group is exposed to changes because of an increase in torrential rains, dry periods, eutrophication processes and disturbances in the flow of water in reservoirs. What is more, as a result of forecast climate change small surface reservoirs (marshes, ponds, water bodies, small shallow lakes, streams and small rivers) will continue to disappear. This constitutes a threat to many species that either indirectly live in these areas or use them as drinking water reservoirs and may also result in the extinction or migration of species.

### 3.3.3. Forestry

One of the factors highly diversifying occurrence of forests in Poland, apart from geological conditions are climatic conditions, that are bound together with the ecological optimum of individual species. Therefore, we should expect that as a result of climate change, major changes will affect the stand composition and types of forests. Ecological optimums of tree species may be moved to the north-east, and the boundary of forests in the mountains may increase. Soil requirements of tree species may constitute a barrier to matching stand compositions in these areas with changes in the average temperature and amount of precipitation. This poses breeding problems which are difficult to predict. The most vulnerable to climate change are the mountain ecosystems. Present mountain forest communities may lose up to 60% of species and the productivity of forest stands and their durability may rapidly decrease. An increase in evaporation, related to the rise in the temperature, as well as reduction in the thickness and duration of lingering of snow cover will contribute to a decrease in humidity in forests, while increasing the risk of fires and accelerating the process of soil mineralization. The warming process and increased risk of drought is conducive to diseases' and pests' development, including invasive species and this trend will continue. Therefore, we need to be prepared for huge damages, as native species are not resistant to new threats. Warmer winters will have a positive impact on hibernation of pests and reduced snow cover will facilitate hibernation of herbivores. In addition to the reduced stability of forests (greater susceptibility to damages from biotic and abiotic factors), limited availability of environmental resources (including wood) and ecosystem services (tourism, mitigating climate change by forests, carbon capture and storage, reduced natural water retention of forests) production and protection properties of forests will also be limited. The extended period with positive temperatures in autumn, with intense softening soil rainfall, combined with weakening of trees caused by diseases and pests may additionally increase the vulnerability of forests to winds and support an increase in the number of wind-broken trees. As a positive aspect, we can indicate the decreased frequency of fungal diseases which is associated with the extended dry period.

### 3.3.4. Energy

The influence of climatic conditions on the energy sector is diversified and depends on the type of activity, i.e. energy production, demand for electricity and heat, distribution of electricity and energy generation sources.

The Polish power system is dominated by overhead lines which, unlike cable networks, are highly exposed to failures caused by strong winds and excessive ice build-up. The occurrence of extreme weather events like hurricanes, intense storms, etc. may lead to a higher risk of damage to transmission and distribution lines and therefore, to limitations in supply of electricity. The most important phenomena affecting the risk of damage to transmission and distribution lines are: the occurrence of storms, including snow storms, catastrophic rime and strong wind. In connection of the frequent collision of various air masses over Poland, failures resulting from strong winds and days with the temperature +/-0°C, due to icing of cables, may take place.

The availability of cooling water is crucial for energy production. Water consumption for these purposes constitutes 70% of total water consumption in Poland. In terms of large variability of precipitation,

extreme situations (floods and droughts) and an increase in the non-stationary nature of flows may disturb the availability of necessary amounts of water used for cooling. This may result in lower traditional power plants efficiency with open circulation cooling and in reduction in amounts of energy generated by these installations. In gas-steam systems the performance level and power depend additionally on the air temperature used for fuel combustion. With the increasing temperature, the need for air compression increases and thus the efficiency and power of the installation decrease.

With increased air temperature evaporation of surface waters increases, disturbances in water management occur, which will consequently affect the cultivation of plants, including energy crops. In case of long and torrential rains, biomass plantations can be destroyed or excessive moisture will negatively affect their energy efficiency. There may be a reduction in interest or cancellation of the development of biomass energy technologies. In case of hydropower installations, water deficiency may significantly lower their performance. In case of wind energy, energy conditions will deteriorate. Climate change will result in significantly increased unpredictability of very strong winds, hurricanes and long windless periods. The use of this energy source may therefore be associated with an increased risk due to predictability of energy generation as well as the damages to installations.

An increased importance of distributed renewable energy sources should reflect the deterioration of wind conditions (long periods of calm weather or short periods with hurricane winds). Biomass production will also be subject to the same restrictions as entire agricultural production particularly due to reduced availability of water and limited production capacity. Only in case of solar energy, we may expect an improvement in conditions in summer due to extended periods of sunny weather and their deterioration in winter, caused by longer periods with clouds. Development of new plant species, more resistant to changing weather conditions and innovative cultivation techniques to be used in the very dry and humid environment will be key in the field of energy crops.

Feedback may take place between adaptation actions and reduction in greenhouse gas emissions. Some of adaptation actions carried out in one area may deteriorate the effectiveness of actions in another area, for example an increase in the use of air-conditioning units or larger production of artificial snow for ski slopes contributing to increased consumption of energy and water. In turn, the developed cultivation of energy crops and biomass may limit the availability of water resources.

### 3.3.5. Coastal zone

Observed and foreseen climate changes have a very negative impact on coastal zones in Poland, usually causing difficulties in functioning of the maritime economy. Apart from the obvious impact of a sea level rise, negative phenomena include most of all, an increased frequency and intensity of extreme events. In case of the Baltic Sea, this applies to the possible increase in the number, intensity and duration of storms. In addition it may include an increased irregularity of these phenomena, i.e. after long periods of relative calm, series of storms occurring rapidly one after another and preventing regeneration of the shore may take place. An additional element accelerating the coastal erosion is the warming of winters, as a result of which we should expect reduction in ice cover protecting beaches against storm waves and thus against coastal erosion. Parts of the Polish coast which are the most vulnerable to sea erosion are the Hel Peninsula and Central Coast, including spits of coastal lakes. The Wisła Spit, made of Wisła sand, carried from the estuary by waves may be subject to abrasion as a result of improper hydrotechnical procedures. In addition, increased waves, improperly planned and carried

out (without taking into account geodynamical processes and contemporary knowledge about them) works to reinforce the shore may result in the local disappearance of beaches and abrasion of coastal dunes that fulfill protective functions. In case of insufficient counteraction, this will lead to the hard-to-reverse fragmentation of the base of the Peninsula.
Scenarios of the sea level changes show that, in the period 2011-2030, the annual average sea level along the entire coast will be higher by about 5 cm in relation to the value of the reference period, i.e. 1971-1990. A very important consequence of climate change will be an increased frequency of storm floods and more frequent flooding of low-lying areas and degradation of coastal cliffs and the seashore, which will result in a strong pressure on the infrastructure in these areas. A particularly difficult problem may be increasing periodic shortages of drinking water caused by contamination or salinization of groundwater, which is a main source of drinking water for many towns, e.g. Gdańsk. Another problem might be flooding of the municipal and industrial wastewater treatment plants by flood waters, which will lead to an uncontrolled emission of pollutants into the sea environment.

Another negative phenomenon is the progressive eutrophication resulting from the increased supply of nitrogen and phosphorus compounds and the increased water temperature. Higher temperature in winter may cause the disappearance of species characteristic of cold waters and the emergence of species occurring in warmer waters.

### 3.3.6. Mountain areas

Mountain areas in Poland are regions particularly vulnerable to climate change, both in terms of nature and economy. Natural mountain habitats are highly vulnerable to climate change and the most significant changes in vegetation may apply to the subalpine and alpine zone.

A rise in the air temperature has, first of all, a negative impact on water relationships Increased evaporation together with the unchanged amount of precipitation will lead to reduction in water resources supplying water to major river basins. This will be particularly dangerous during drought periods. Reduced flows of rivers and streams will cause water shortages in submontane towns, deepen economic problems and contribute to an increase in water pollution. Higher water temperature will foster the eutrophication in lakes and flood reservoirs.

A change of water conditions and the increased frequency of downpours causing violent surges and erosions of slopes will result in an increased transport of dragged and suspended material. It may cause sliming of river sections and reservoirs, which may result in shallowing riverbeds and thus in an increase a risk of flood or reduction in the water quality. It is as particularly dangerous phenomenon associated with downpours are landslides that are stronger in mountain and submontane areas. They are a result of soaking of a surface layer of soil or rocks due to prolonged downpours. As it can be seen in the figure (Figure 22), particularly sensitive regions are the areas of Southern Poland. To a lesser extent – steep riverbanks and upland areas.

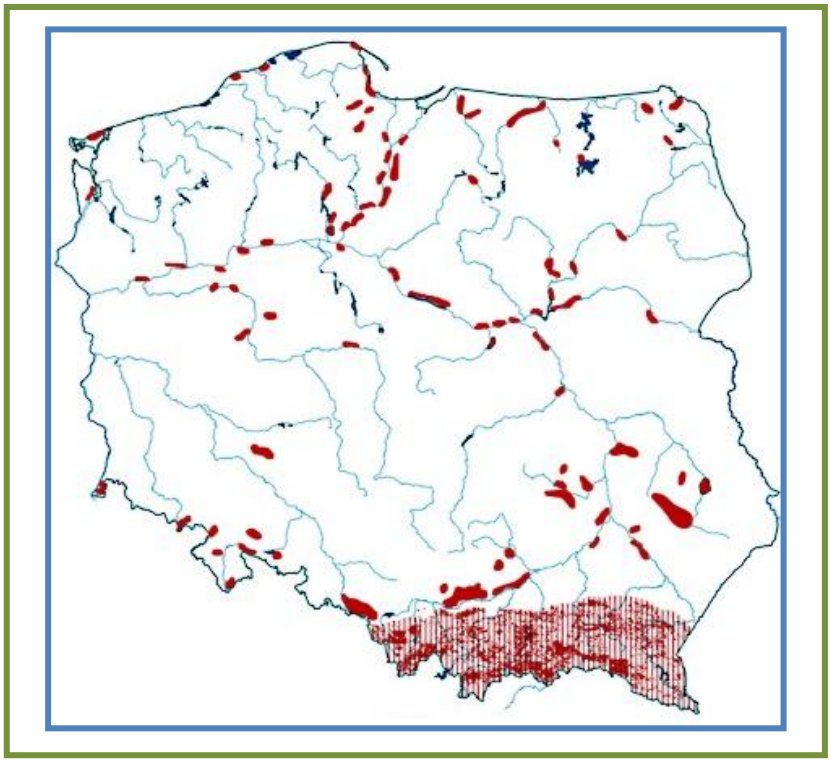

Figure 22. Distribution of areas exposed to mass movement of soil in Poland. Developed according to the results of recordings of 1968-1970 for extra-Carpathian Poland and to PIG materials.
*Source: PIG-PIB*

Another problem associated with precipitation are changes in snow cover. A rise in the temperature results in the shortened period of lingering of snow cover and its instability, especially at the heights of more than 1000-1200 m above sea level It is one of factors determining the proper functioning of ecosystems that depend on the lingering period and thickness.

### 3.3.7. Agriculture

In terms of the needs of plant production, the most important are changes in the characteristics of two basic elements of climate, i.e. temperature and precipitation.
Forecasts carried out show that as a result of higher temperatures, the vegetation period is longer. In the multiannual period 1971-2000, the vegetation period in Poland lasted 214 days (an average for the entire country), while in the decades after 2020 it is expected to last even up to 230 days. The difference between these periods would be 16 days. Consequently, agricultural practices will be shifted and the crop productivity will change. As a result of the aforementioned changes, conditions for thermophilic plants such as corn, sunflower, soy, vines and wheat will improve so the quality of the harvest will be better than now. However, the earlier beginning of the vegetation period will increase a threat to crops due to the occurrence of late spring frosts. The greatest changes in the vegetation period will take place in the northern and north-western part of Poland. Also, a rise in the temperature will increase a threat on the part of plant pests, which, just like plants, will respond with the accelerated development and will be a greater threat to crops.

Foreseen climate change and related increase in the frequency and intensity of droughts in agriculture will result in increased demand for irrigation water. From prognostic calculations of values of water

deficiencies in soil for selected plants, it results that there is a continuous process of excessive drying of soil and increasing a risk of drought. This problem may to the greatest extent affect the Wielkopolskie voivodeship, Kujawy and Western and Central Poland. Basing on analysis of these results there is foreseen a threat of farming drought in the decades after 2020. Apart from drought, also intense precipitation poses a threat to plant production. In connection with the increased frequency of intense precipitation in summer, we may expect increased drainage needs. Analyses carried out indicated that we should expect the increased frequency of years with yield losses arising from the adverse course of weather.

In the field of animal production, climate change and thus an increase in the yield variability of crops and pastures may result in shortages of feed in holdings and a rise in prices. An increase in the number of very hot days will strengthen risk of heat stress in animals, which may result in reduction in the productivity of herds. A change in thermal conditions during the vegetation period as well as winter can lead to the increased occurrence of diseases which affect the health of farm animals and so far have been of lower importance.

### 3.3.8. Transport

The transport sector is particularly vulnerable to several elements of the climate, especially to strong winds, downpours, flooding and landslides, snowfall and ice phenomena, storms, low and high temperature and lack of visibility (fog, smog). The vulnerability and the impact of climate change on transport may be analyzed in relation to individual types of transport.

Road transport, due to its spatial nature, is particularly vulnerable to changing climatic events. Strong winds resulting in, *inter alia*, blocked roads and damaged road infrastructure and vehicles may grow stronger in the future. Similar changes may be observed in case of rapid rainfall and snowfall, whose occurrence disturbs the transport smoothness. Problems related to the increasing occurrence of high temperatures also affect negatively both vehicles and road infrastructure elements. Particularly troublesome for them are long-lasting heat periods. More frequent occurrence of temperatures close to zero in winter will result in an escalated occurrence of fog, which, by reducing the visibility, will have a negative impact on road transport while multiple passage through the point of 0°C in the absence of snow cover results in the rapid degradation of the surface.

Rail transport is also vulnerable, especially to incidental climate phenomena. Strong winds and hurricanes as well as heavy rains, that cause flooding and landslides, whose frequency will increase, may damage rail infrastructure elements. Together with the progressive warming process, cases of track deformation and fires of rail facilities may increase and, also, work conditions and comfort of travel will deteriorate.

In the context of air transport, of great importance will be changes in temporary weather conditions, and according to forecasts, such situations will occur much more frequently than ever before. A fundamental hazard are strong winds and icing. In addition, the problem of fogs, which may periodically completely stop the possibility of transport by air, particularly in case of regional and worse-equipped airports, will escalate.

Inland water transport, although little used in Poland, is also exposed to effects of climate change, because it is strictly dependent on water states of rivers. It is particularly exposed to high water states – flood states and low water states – related to droughts. During the analyzed period, we need to be prepared for an increase in the frequency of both adverse phenomena and thus for handicaps in the operation of inland navigation.

Sea transport is gaining in importance through a continuous increase in the number of transshipments, both in large seaports and in smaller ports, in which transshipping of materials for infrastructure investments carried out along the coast also starts increasing. Higher sea states will result in a need to rebuild the infrastructure part which is not adapted to new sea level elevations, which may have an impact on the level of implemented transshipments and the possible development of these ports.

### 3.3.9. Spatial development and urbanized areas

Adaptation of Polish areas to new climatic conditions and related phenomena is currently one of the most important challenges, especially for the central, regional and local administration. There is a feedback between the spatial development and climate change and a need to adapt to climate change. Climate change will lead to reduction in resources of area available for a given type of pursued or planned activity – *inter alia*, due to an increased flood risk, landslide risk, escalated processes of water and air erosion, water deficit, raising and lowering of the groundwater level. Climate change in the spatial context affects the entire complex of spatial development problems (Figure 23), which may generate social conflicts and limit development possibilities.

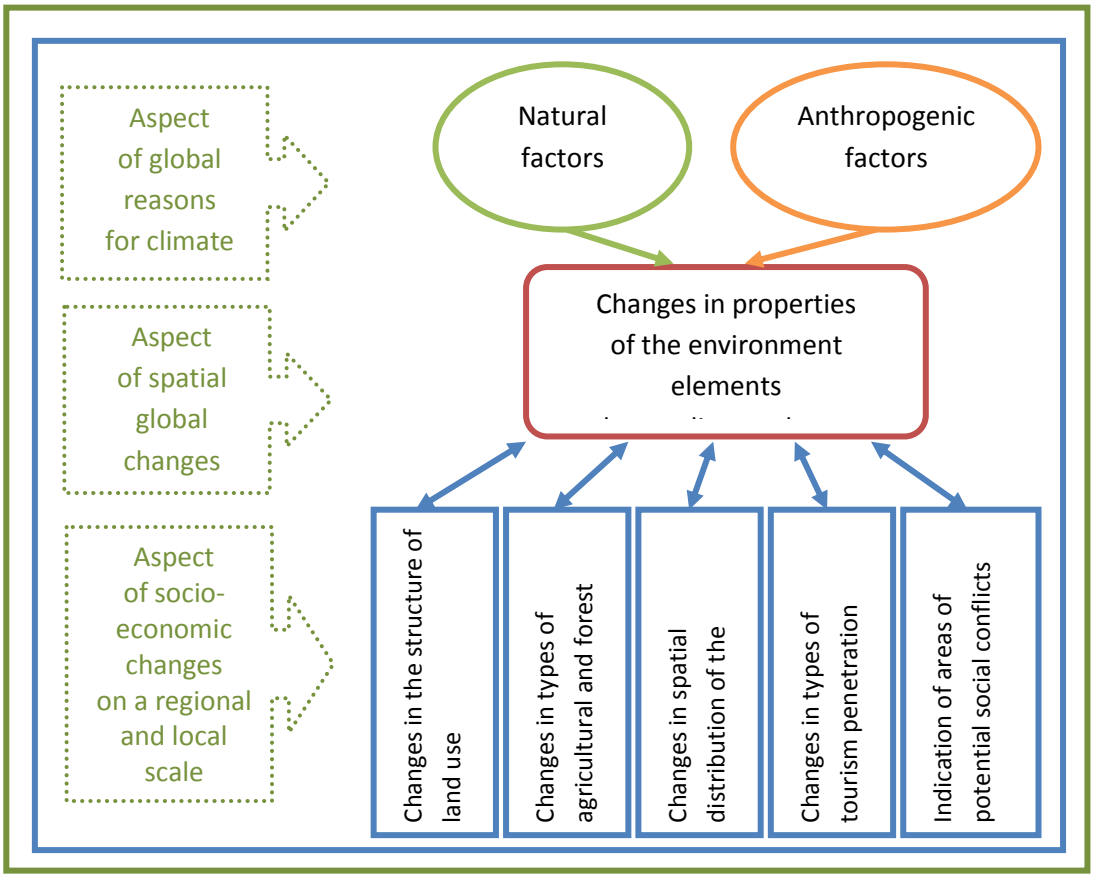


Figure 23. Impact of climate change on changes in the functioning of the socio-economic system in the spatial context (B. M. Degórscy 2012).

Urbanized areas constitute a special category within the structure of the geographical space, characterized by a high density of human population and thus they are highly vulnerable due to a negative impact of the anthropopression[11]. Cities are directly at risk, especially of three extreme events: intensification of urban heat islands, strong downpours causing flooding and drought conducive to the water deficit in cities. Strong winds are a smaller threat because they lose strength in the areas with large surface roughness in cities (this threat may apply to small towns and suburbs with dispersed development). An urban heat island results from a process of energy exchange between the ground and the atmosphere, disturbed by artificial surfaces (asphalt, concrete, tiled roofs, etc.). In addition, it is reinforced by an increasing temperature which promotes heat stress, stagnation of the air above the city, an increase in the concentration of air pollutants, including particulate matter and smog.

Floods are an indirect threat, due to the fact that most metropolitan areas are located in valleys of large rivers. Downpours, just like floods pose a threat to urban infrastructure by flooding, landslides and destruction of transport routes, buildings and property.

### 3.3.10. Construction

In case of negative temperatures and snow, a mitigation in the intensity of the impact of these elements on the construction sector, which does not imply – due to previous long-term experience – the need to mitigate technical requirements contained in standards is expected. Particular attention should be paid to winds and precipitation because high fluctuations of extreme values are expected. A change in the impact of these climatic factors should be reflected in the design of both foundation and load-bearing structure. The impact of rains is important particularly with regard to the problem of the drainage systems efficiency, the location of buildings in areas exposed to a risk of flood and the occurrence of landslides of slopes and abrasion of bridge supports. Wind forecasts indicate the escalation of extreme events such as windwhirls or hurricanes, although it is difficult to determine zones particularly vulnerable to this phenomena. Attention should be paid to a large dynamics of changes in climatic conditions that may negatively affect both performance of works and qualities of construction products, including their durability.

### 3.3.11. Health

Climate change may indirectly affect health through the creation of conditions for the growth of air pollutants (secondary dusting and ozone) and water, growth of bacteria causing food poisonings as well as infectious diseases transmitted by insects. Climate change affects the entire society, however, particularly vulnerable to climate-dependent diseases are groups of increased risk such as the elderly, the sick, the disabled, the homeless, the poor and children. In the area of health protection, climate change may manifest itself strongest in a form of the increased skin cancer incidence and melanoma deaths as well as deaths related to cardiovascular and respiratory system diseases. A positive effect of the progressive warming of winter periods is reduction in the number of deaths caused by hypothermia.

A foreseen rise in the temperature in summer and an increase in the number of hot days will result in a gradual increase in *Salmonella* poisonings, assuming that the sanitary state of the society and

[11] All human activities (planned and incidental) affecting the natural environment.

catering will remain at its current level. Also, a group of diseases, in case of which the number of incidence will increase, are tick-borne diseases which are clearly seasonal, mainly Lyme disease, particularly dangerous in forest areas of Northern Poland. Along with the extension of pollen seasons, allergic symptoms will exacerbate. Climate change contributes to an increase in the number of cases of disease and deaths through changes in the frequency and intensity of extreme climate phenomena and is conducive to the spread of diseases which have not occurred in moderate latitudes so far. Therefore, climate change will affect the functioning and activity of health care institutions as well as the quality of life and health of citizens.

### *3.4. Summary of hazards and benefits resulting from climate change*

The results of forecasts show that by 2030 climate change will have a two-fold, positive and a negative impact on the economy and society.

Higher average air temperature will also have positive effects, *inter alia*, in a form of the extension of the vegetation period, reduction in the heating period and extension of the tourist season.

However, expected negative consequences of climate change are dominant. Climate change involves a not substantially altered but they become more random and uneven, resulting in longer rainless periods, punctuated by torrential rains. The groundwater level will decrease, which will negatively affect biodiversity and nature protection forms, in particular, reservoirs and wetlands. Changes will also be observable in winter, where the lingering period and thickness of snow cover will be reduced and the evaporation process will escalate, which will affect a decrease in water resources of the country. Also, the effect of climate change will be an increased frequency of extreme weather events and disasters, which will have a significant impact on vulnerable areas and the national economy. Torrential rains involving a risk of floods, flooding and landslides – mainly in mountain and upland areas but also on slopes of river valleys and cliffs along the seashore will be of basic importance. More and more frequently, it will be possible to observe strong winds and even incidental whirlwinds and lightnings which may significantly influence, *inter alia*, the construction industry and the energy and transport infrastructure.

Direct negative climate change effect is also escalation of the eutrophication in inland and coastal waters, increased threat to life and health as a result of thermal stress and increased air pollution, greater demand for electricity in summer, reduction in the cooling potential of power plants resulting in a decline in production capacity and many more.

# Chapter 4. Objectives and course of actions in the process of adaptation to climate change by 2020

The adaptation action package in respect to individual sectors is a key component of SPA 2020. In accordance with assumptions of the White Paper, it is necessary to mainstream adaptation actions into national policies. Therefore, course of action as well as individual interventions have been indicated in association with relevant national development strategies. It is also necessary to strengthen actions at the national level through their appropriate specification and implementation at the regional and local levels.

Courses of adaptation action, indicated in SPA 2020, are first of all a response , to occurring climate change described in Chapter 2 and to its current and foreseen impacts for vulnerable sectors indicated in Chapter 3. The intensity of adaptation actions will depend among others on dynamics of climate change in the perspective of 2020 and in subsequent decades.

## *4.1. Major objective of SPA 2020*

In the nearest years, a key remaining challenge of the development policy in Poland will be to ensure the economic growth with the preservation and efficient use of environmental resources and adaptation to climate change. An answer to this challenge are objectives set out in this chapter, which will be achievable only by carrying out actions at the national, regional and local levels.

**The major objective of SPA is to ensure sustainable development and efficient functioning of the economy and society in the conditions of climate change.**

The main goal will be achieved through the implementation of specific objectives and action lines indicated as a part of these objectives being an essential element of SPA 2020. Specific objectives have been defined to correspond to integrated development strategies which are crucial from the point of view of adaptation (BEiŚ, SZRWRiR, SRT, KSRR, SIEG, SRKS, SSP, SBNRP). Also, the objectives and actions of SPA 2020 are consistent with the National Development Strategy 2020 and integrated strategies. In addition, the following horizontal actions will contribute to the implementation of the main objective and specific objectives:

- **Legislative actions.** Key identified areas of legislative intervention are:
  - adoption of the new Water Law, including: legal regulation of the economic profitability of water use and creation of incentives to reduce water consumption in the economy,
  - introduction of legal regulations regarding natural risk assessments and analyses, including geological risk, and forecast of changes in geological conditions as a result of climate change,
  - introduction of obligatory spatial development plans at the regional and local level, especially for flood areas, areas at risk of flooding and landslides, urbanized areas, naturally valuable areas and coastal zones and coastal water zones, taking into account the cross-border areas,

- amendment to the Act of 28 September 1991 on forests, in terms of taking adaptation actions into account,
- adaptation of legal acts and technical regulations on documenting changes in geological conditions and natural resources, design, construction and adaptation of the transport infrastructure to climate change, especially in areas at risk of flood, flooding and landslide,
- creation of legal basis for the resettlement of the population from areas at permanent risk.

- **Organizational actions** cover improvement in management structures, including crisis management, rescue and civil protection and defining the needs with regard to strategic planning, taking into account cross-border aspects. They are to provide support, *inter alia*, by priority treatment of actions supporting the adaptation process in case of public procurement and to prepare guidelines for specifying the procedures for limiting the impact of climate change, in particular by taking into account adaptation actions in strategic and operational documents at the national, regional and local level.

- **Information actions.** Appropriate orientation and exchange of information between institutions involved in the SPA 2020 implementation using existing platforms of cooperation within the development management system (e.g. the Coordinating Committee for Development Policy and institutions, including teams and working groups functioning as part of the implementation of appropriate development strategies) is one of basic conditions for success in the implementation of actions. Taking actions is to serve the exchange of information, knowledge, experiences and good practices. This will strengthen the synergy of actions and increase the involvement
  in the implementation process of adaptation actions at the national, regional and local level. In addition, within the KLIMADA project it is planned to create a special information platform for climate change.

- **Research and creation of research programmes.** First of all it is important to strengthen support for scientific research on the subject of adaptation. Actions implemented in terms of adaptation to climate change in the area of research and development works shall be in accordance with priorities and strategic lines of research and development works specified in the National Research Programme adopted on 16 August 2011 by the Council of Ministers. It is necessary to establish a system for the exchange of information and to ensure a sustainable stream of financial resources for research and implementation with regard to technologies supporting adaptation. Actions implemented in the field of adaptation to climate change should include:

  - creation of programmes and financing research in the following areas: energy, construction, geology, transport, agriculture and forestry management, water and maritime management,
  - development of environment and human health valuation methodologies, the taking into account the national specificities and climate change (including the valuation of ecosystem services),
  - development and implementation of new quality standards of equipment, devices, building, construction and consumption materials allowing to prevent or reduce negative effects of extreme climate phenomena,

– creation of a forests network, representative for specific regions (reference forests), taking into account the climate gradient with the single system of monitoring and reporting changes according to a uniform methodology.

## Objective 1. Ensuring the energy security and good environmental status

In the context of the environmental protection and energy security, adaptation to climate change is of great importance, both to ensure the safety and quality of citizens' life, as well as necessary conditions for the functioning of the economy. Adaptation actions in these sectors will be of multi-directional nature. They will also involve many entities and significant financial resources.

### Action line 1.1 – adaptation of the water management sector to climate change

Adaptation of the water management sector to climate change aims at improving the functioning of the sector in the conditions of both excess and shortage of water. Proposed actions will strengthen the water management system in Poland, facilitate access to good quality water, reduce negative impacts of droughts and floods, improve and maintain the good state of waters and water-dependent ecosystems (including implementing actions consisting in the protection of inland waters against the eutrophication) and improve the safety and economic efficiency of water management. The scope of proposed actions covers the entire country. It is important that flood protection actions, in the first instance, use solutions which are the least intrusive to the natural environment, in particular non-technical flood protection methods. When implementing those , special attention should be paid both to areas at risk of flood (river valleys, mountain and submontane areas), areas with increased water needs (Wielkopolskie, Opolskie, Łódzkie) and those with water deficiency (Mazowieckie and Świętokrzyskie).

| **Action line 1.1 – adaptation of the water management sector to climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority actions | Reforming water management structures with consideration of adaptation to climate change. | MŚ/ MAC | BEIŚ | 1.2 Water management for protection against floods, drought and water shortages. |
| 1.1.1 | Developing and implementing assessment methods of flood and flooding risk. | MŚ/ MAC | BEIŚ | 1.2 Water management for protection against floods, drought and water shortages. |
| 1.1.2 | Flood risk management, including the provision of critical infrastructure; increasing retention capacities and restoration of waterways. | MŚ/TSU | BEIŚ | 1.2 Water management for protection against floods, drought and water shortages. |
| 1.1.3 | Restoring and maintaining the good state of waters, water ecosystems and water-dependent ecosystems. | MŚ | BEIŚ | 1.2 Water management for protection against floods, drought and water shortages. |

### *Action line 1.2 – adaptation of the coastal zone to climate change*

Adaptation of the coastal zone to climate change apply to areas located along the coastline of the Baltic Sea. A primary objective will be to strengthen monitoring of the flood protection system and prevention of degradation of shorelines as well as the development of coastal zone monitoring. Particular attention should be paid to the area of Żuławy Wiślane and the Tricity metropolitan area and the estuary of the Odra River with Szczecin and Świnoujście, and among areas of unique natural values – Słowiński and Woliński National Parks and the Coastal Landscape Park. At risk, there also is the area of the Hel Peninsula, spits of coastal lakes and the Wisła Spit.

| **Action line 1.2 – adaptation of the coastal zone to climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Taking into account the current and potential sea level rise and flood risk in investment plans in the coastal zone and coastal waters. | MTBiGM/ Maritime Offices/TSU | BEIŚ | 1.2 Water management for protection against floods, drought and water shortages. |
| 1.2.1 | Stabilization actions of the shoreline and the prevention of erosion, disappearance of beaches and degradation of cliffs. | MAC/MTBiGM/ Maritime Offices /MRR | BEIŚ | 1.4 Organization of space management |
| 1.2.2 | Strengthening and development of permanent monitoring of the seashores state and the coastal zone. | MTBiGM/ Maritime Offices /MRR | BEIŚ | 1.2 Water management for protection against floods, drought and water shortages.<br><br>1.3 Preservation of the richness of biodiversity, including multifunctional forest management |

### *Action line 1.3 – adaptation of the energy sector to climate change*

Climate change will have various impacts on the energy sector, taking into account, in particular, the forecast fluctuation of the average temperature. It will be necessary to adapt the energy system to fluctuations in demand for both electricity and heat, *inter alia*, through the implementation of sustainable low-carbon energy sources. It will also be essential to use renewable energy sources: solar energy, wind energy, biomass and hydropower (taking into account the risks referred to in Chapter 3). In the energy sector, basic adaptation actions relate mainly to issues of extreme weather events. The observed need to diversify energy sources may be supported by combustion of waste which cannot be recycled, with recovery of energy. Municipal waste emerging in a distributed manner becomes available locally, and the possibility of its combustion allows to provide the adequate sanitary condition in the event of the occurrence of extreme phenomena in a given area.

| Action line 1.3 – adaptation of the energy sector to climate change | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority actions | Preparation of the energy system to changed conditions with consideration to the peak winter and summer energy demand. | MG/Energy distributors | BEIŚ | 2.4. Modernization of the commercial electric power sector, including preparations for the introduction of nuclear energy |
| 1.3.1 | Development of alternative energy production capacities at the local level, especially for heating and air conditioning in areas with the lower population density. | MG/ TSU | KSRR<br>SZRWRiR<br>BEIŚ<br>KPM | 1.3.5 Diversification of sources and efficient energy use and response to natural hazards.<br>5.5. Increasing the use of renewable energy sources in rural areas<br>2.6. Increase in the importance of renewable distributed energy<br>4. Promoting the sustainable development of urban centres including preventing negative phenomena of sub-urbanization. |
| 1.3.2 | Providing emergency energy sources and transmission in cases in which the use of primary sources will not be possible. | MG/Energy distributors/TSU | BEIŚ<br>KPM | 2.4. Modernization of the commercial electric power sector, including preparations for the introduction of nuclear energy<br>1. Increasing the ability of cities to create the development, growth and employment |
| 1.3.3 | Securing of emergency cooling sources in commercial power plants. | MG/Energy distributors/TSU | BEIŚ<br>KPM | 2.4. Modernization of the commercial electric power sector, including preparations for the introduction of nuclear energy<br>1. Increasing the ability of cities to create the development, growth and employment. |
| 1.3.4 | Design of transmission networks, including, *inter alia*, underground and overhead networks, taking into account extreme weather situations, in order to limit the risk of, *inter alia*, deposition of ice and snow on them, flooding and destruction in case of strong wind. | MG/MAC/PSE Operator S.A. | BEIŚ | 2.4. Modernization of the commercial electric power sector, including preparations for the introduction of nuclear energy |
| 1.3.5 | Promoting the development of RES, in particular microinstallations in agriculture. | MG/Energy distributors | KSRR<br>BEIŚ | 1.3.5 Diversification of sources and efficient energy use and response to natural hazards.<br>2.7. Energy development of suburban and rural areas |

### *Action line 1.4 – protection of biodiversity and forest management in the context of climate change*

Protection of biodiversity and forest management in the context of climate change is a very important issue, because the problem of loss of biodiversity is growing along with climate change. From the point of view of the protection of habitats, the most important are actions related to the preservation of wetlands and their restoration wherever possible. Also, important will be actions conducive

to implement sustainable forest management in the conditions of climate change, as well as preparing forest ecosystems for the increased pressure resulting from the escalation of extreme weather events, *inter alia*, periods of drought, heat waves, heavy precipitation, strong winds.

| **Action line 1.4 – protection of biodiversity and forest management in the context of climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Preparation of strategies, protection plans, protection programmes or protective task plans for the nature preservation, taking into account the changes in climatic conditions. | MŚ/GDOŚ | BEIŚ<br><br>SZRWRiR | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management.<br><br>5.1 Protection of the natural environment in the agricultural sector and of biodiversity in rural areas |
| 1.4.1 | Development of programmes of forestry adaptation to climate change, taking into account the circumstances and needs of the industry, energy, agriculture, tourism and recreation, regional development, biodiversity. | MŚ/DGLP/ GDOŚ | BEIŚ<br><br>SZRWRiR | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management.<br><br>5.4 Sustainable forest and hunting management in rural areas |
| 1.4.2 | Increasing the forestation rate both in case of artificial afforestation and natural succession and rationalization of land use, reduction in the fragmentation of forest complexes. | MŚ/MRiRW/ forest owners and managers and authorities supervising their activity | BEIŚ<br><br>SZRWRiR | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management.<br><br>5.4 Sustainable forest and hunting management in rural areas |
| 1.4.3 | Introduction of ecosystem forestry rules into forestry management, dynamic protection of existing biodiversity using both natural genetic processes (adaptation) and human activities, aimed at preserving existing biodiversity, gearing artificial selection also towards features of adaptation to changing climatic conditions. | MŚ/forest owners and managers and authorities supervising their activity | BEIŚ | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management. |
| 1.4.4 | Continuation of the implementation and the development of instruments for the protection of the agricultural space, forest space and soil resources of high production value | MRiRW/MŚ | SZRWRiR | 5.3 Adaptation of agriculture and fisheries sectors to climate change and their participation in preventing this change. |
| 1.4.5 | Stand differentiation, especially during reconstruction, in terms of: density, composition (increasing the share of deciduous species), height structure, age, patch/mosaic structure | MŚ/ forest owners and managers and authorities supervising their activity | BEIŚ | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management. |
| 1.4.6 | Continuation of the programme of soil protection against erosion, continuation and extension of small retention and soil retention especially in forests and grassland. | MŚ/forest owners and managers and authorities supervising their activity | SZRWRiR<br><br>BEIŚ | 2.5.1 Development of the water and reclamation infrastructure and other infrastructure mitigating natural hazards.<br><br>1.2 Water management for protection against floods, drought and water shortages. |

| | | | | |
|---|---|---|---|---|
| 1.4.7 | Monitoring, control and prevention of the spread of foreign species that threaten native species or natural habitats. | MŚ/GDOŚ/forest owners and managers and authorities supervising their activity | BEIŚ | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management. |
| 1.4.8 | Monitoring of forests for reactions of trees to climate change, *inter alia*, phenological observations, zonal changes in coverage of species, particularly in mountain areas. | MŚ/forest owners and managers and authorities supervising their activity | BEIŚ | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management. |
| 1.4.9 | Monitoring in connection with the natural dynamics of ecosystems and periodical assessment of protected natural areas, creation of a data collection and processing system. | MŚ/GDOŚ | BEIŚ | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management. |
| 1.4.10 | Enhancing the forest fire protection through the development of systems for monitoring fire hazard and fire infrastructure related to the forest protection. | MŚ/forest owners and managers | BEIŚ,<br><br>SZRWRiR | 1.3 Preservation of the richness of biodiversity, including multifunctional forest management.<br><br>5.3 Adaptation of agriculture and fisheries to climate change and their participation in preventing this change. |

### *Action line 1.5 – adaptation to climate changes in spatial development and construction*

Preparation of Poland to new climatic conditions and extreme weather events is a matter of great socio-economic importance. Therefore, actions in this area should aim at covering the entire territory of the country with an effective system of spatial planning to ensure an appropriate and sustainable use of areas, taking into account IT tools such as Geoportal. Also, in the construction sector, it will be necessary to take into account a potential impact of extreme events caused by climate change.

| **Action line 1.5 – adaptation to climate change in spatial development and construction** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Preparing rules of development of areas exposed to a flood risk and protected areas, green areas in cities, coastal belt and construction of public utility buildings. | MTBiGM/MRR/MŚ | BEIŚ<br><br>SSP<br><br>KPM | 1.2 Water management for protection against floods, drought and water shortages.<br>7.5 Improving the emergency management system.<br>4. Promoting the sustainable development of urban centres including preventing negative phenomena of suburbanization. |
| 1.5.1 | Introduction of restrictions with regard to general construction and additional requirements for the protection of buildings with basements against flooding in floodplains, in the coastal zone and in areas at risk of mass movements. Introduction of rules of safe investing | MTBiGM | SIEG<br>SSP<br><br>KPM | 3.2 Supporting the development of sustainable construction at the stage of planning, design, erecting buildings and their management throughout their life cycle<br><br>7.5 Improving the emergency management |

| | | | | |
|---|---|---|---|---|
| | in cliffs. | | | system.<br><br>3. Rebuilding development capacity through revitalization of socially, economically and physically degraded urban areas. |
| 1.5.2 | Implementation of actions protecting against landslides. | MAC/TSU | BEIŚ<br><br>SSP | 1.4 Organization of space management<br><br>7.5 Improving the emergency management system. |
| 1.5.3 | Introduction of a requirement of on-line access to local spatial development plans and of advice for persons and companies wishing to invest in zones at risk. | MRR/MTBiGM | BEIŚ<br><br>SSP | 1.4 Organization of space management<br><br>3.2.3 Supporting the development of using spatial information with the use of digital technologies. |

### *Action line 1.6 – ensuring the functioning of the effective health protection system in the conditions of climate change*

Climate change is conducive to an increase in cases of disease and deaths through changes in the frequency and intensity of extreme weather events and to the spread of diseases which have not occurred in moderate latitudes so far. At particular risk are the most vulnerable groups as well as farmers and foresters exposed to infectious diseases transmitted by arthropods (e.g. ticks). There have been no detailed analyses to assess quantitatively the changes in cases of disease or deaths for reasons related to climate change so far, partially due to the fact that it is difficult to separate this change as a basic reason. Therefore, it is necessary to establish a system for monitoring and warning against climate phenomena and their derivatives which may adversely affect the health and quality of life.

| **Action line 1.6 – ensuring the functioning of the effective health protection system in the conditions of climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Limiting the health effects of thermal stress and extraordinary climate phenomena in vulnerable population groups. | MZ/TSU | SRKL<br><br>SSP | Fourth area - Health<br><br>5.1 Effective health protection system |
| 1.6.1 | Epidemiological, clinical and climate-physiological studies in the aspect of cases of climate-dependent diseases. | MZ | SRKL | Fourth area - Health |

## Objective 2. Efficient adaptation to climate change in rural areas

Rural areas, largely due to the agricultural activity carried out there, are particularly sensitive to climate change. This points to the need for adaptation actions both in terms of civil protection in crisis situations

and necessary adaptations in plant and fisheries production. Identified actions are complementary to the package of actions indicated in SZRWRiR.

### *Action line 2.1 – creation of local systems for monitoring and warning against hazards*

Monitoring of climate change well in advance is of particular importance in agricultural production. The results of monitoring should be a part of the information activity in support of the development of agricultural production and the use of modern agrotechnical methods. On the other hand, monitoring of emergency situations in rural areas is of crucial importance to the population, infrastructure and agricultural holdings and should be directly related to the local warning system.

| **Action line 2.1 - creation of local systems for monitoring and warning against hazards** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Development of systems for monitoring and early warning of possible consequences of climate change for plant and animal production. | MRiRW/TSU | SZRWRiR | 5.3 Adaptation of agriculture and fisheries to climate change and their participation in preventing this change. |

### *Action line 2.2 – organizational and technical adaptation of the agricultural and fishery activity to climate change*

Identified actions aim at advice and technological adaptation as well as resource management adequate to challenges of climate change.

| **Action line 2.2 – organizational and technical adaptation of the agricultural and fishery activity to climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Investment support for holdings and training and technological advice taking into account aspects of adapting agricultural production to the increased climate risks and preventing climate change. | MRiRW | SZRWRiR | 5.3 Adaptation of agriculture and fisheries to climate change and their participation in preventing this change. |
| 2.2.1 | Improving the system of creating and managing reserves of food, seed material and feed in case of crop failures. | ARR | SZRWRiR | 5.3 Adaptation of agriculture and fisheries to climate change and their participation in preventing this change. |

## Objective 3. Development of transport in the conditions of climate change

Most elements of the transport system, in particular infrastructure, are exposed to the direct impact of climatic factors, by functioning in direct contact with atmospheric factors. In order to take effective adaptation and preventive actions, it is necessary to carry out a correct assessment of the transport infrastructure's sensitivity to climatic factors, being an effect of an analysis of climate and weather data and their impact on the state of the infrastructure.

### *Action line 3.1 – developing design standards taking account of climate change*

Actions under this action line are to lead to developing recommendations and standards on the transport infrastructure at the stage of design and construction. It is also important to provide effective monitoring of the infrastructure sensitivity to climate change.

| **Action line 3.1 – developing design standards taking account of climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Taking changed climatic conditions into account in the process of design and construction of the transport infrastructure. | MTBiGM/transport infrastructure managers/ MRiRW | SRT<br>SZRW<br>RiR | 3.3.1 Creation of an integrated transport system<br><br>2.2.1 Development and modernization of the local road and rail infrastructure |
| 3.1.1 | Establishment of permanent monitoring or adaptation of existing monitoring systems for controlling elements of construction and transport infrastructure sensitive to climate change and creation or adaptation of warning systems for technical services | MTBiGM/transport infrastructure managers | SRT | 3.3.2 Creation of conditions for the efficient functioning of transport markets and the development of efficient transport systems. |

### *Action line 3.2 – management of transport routes in the conditions of climate change*

Thanks to implementing actions in this field, it will be possible to reduce extreme situations in transport, resulting from climate change, and as a consequence, to ensure the smoothness of transport thanks to plans of response in emergency situations.

| **Action line 3.2 – management of transport routes in the conditions of climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Review or creation of actions and plans developed to maintain transport routes traffic capacity or to re-route and use alternative means of transport | MTBiGM/ GDDKiA/PKP/ TSU/voivodes | SRT | 3.3.2 Creation of conditions for the efficient functioning of transport markets and the development of efficient transport systems. |

## Objective 4. Ensuring the sustainable regional and local development with consideration to climate change

In the light of a series of actions linked directly or indirectly with adaptation and referred to in various strategic documents, in this chapter – in the context of the regional and local development – the need to ensure proper monitoring, warning as well as response was pointed out. In addition, in Objective 4 the particular sensitivity of cities to climate change and thus its importance in the process of adaptation has been noticed.

### *Action line 4.1 – monitoring of the state of the environment and early warning and response systems in the context of climate change (cities and rural areas)*

Monitoring of the impact of climate change is a very important action and has been indicated in relation to specific sectors and areas under relevant action lines of SPA 2020. However, it is necessary to ensure coordination at the national level, particularly in the context of crisis management, rescue and civil protection.

| **Action line 4.1 – monitoring of the state of the environment and early warning and response systems in the context of climate change (cities and rural areas)** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Preparation of risk management strategies at the national, regional and local level, taking into account adaptation activities. | MSW/RCB/MAC/ MTBiGM/MRR | BEIŚ<br><br>SSP | 1.2 Water management for protection against floods, drought and water shortages.<br>7.5.1 Improving the functioning of crisis management structures. |
| 4.1.1 | Implementation of local monitoring systems, warning and response to extraordinary climate phenomena (e.g. patency of the sewage system and drainage systems of underground structures, situations conducive to an increase in air and water pollutants) in cities. | TSU/MTBiGM /MRR | KPM | 4. Promoting the sustainable development of urban centres including preventing negative phenomena of suburbanization. |
| 4.1.2 | Prevention and mitigation of effects of disasters and increasing the effectiveness of response. | MSW/MAC /PSP | SSP<br><br>KSRR | 7.4 Rescue and civil protection (fire protection, preventive, rescue and fire-extinguishing activity).<br><br>1.3.5 Diversification of sources and efficient energy use and response to natural hazards. |

### *Action line 4.2 – urban spatial policy taking climate change into account*

Actions related to the spatial policy take into account consequences of climate change for cities. Their result should be, *inter alia*, adaptation of sanitary installations and sewage systems to increased torrential rains, small urban retention and expansion of green and water areas in the city.

| **Action line 4.2 – urban spatial policy taking climate change into account** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Taking into account, in urban development plans, of the need to expand green and water areas, ventilation corridors and allowable preferred way of heating buildings. | TSU/MTBiGM/ MRR | BEIŚ<br>KPM<br>KSRR | 1.4 Organization of space management.<br>3. Rebuilding development capacity through revitalization of socially, economically and physically degraded urban areas.<br>3. The most important challenges of the regional policy by 2020. |
| 4.2.1 | Development of urban adaptation plans, taking into account management of precipitation waters (or taking into account the adaptation component in other strategic and operational documents). | TSU | BEIŚ<br>KPM<br>KSRR | 1.2 Water management for protection against floods, drought and water shortages.<br>1. Increasing the ability of cities to create the development, growth and employment.<br>3. The most important challenges of the regional policy by 2020. |
| 4.2.2 | Natural revitalization, including restoring original functions of degraded green areas and reservoirs, with a particular focus on small retention in cities. Replacement of hermetic ground surfaces with permeable ones. | TSU | BEIŚ<br>KPM<br>KSRR | 1.4 Organization of space management.<br>3. Rebuilding development capacity through revitalization of socially, economically and physically degraded urban areas.<br>3. The most important challenges of the regional policy by 2020. |

## Objective 5. Stimulating innovations conducive to adaptation to climate change

Currently available technologies, as well as methods of managing the economy in its various sections, may appear insufficient in the context of challenges related to adaptation to climate change. We should search for new, innovative organizational and technical solutions to support adaptation. A primary objective should be to stimulate technological innovations and to introduce of mechanisms of cooperation of institutions in situations of multidimensional hazards associated with climate change. It is also necessary to adapt existing and to develop new sources of financing for studies on adaptation technologies as well as to publish effects of these works.

### *Action line 5.1 – promoting innovation at the level of organizational and managerial actions conducive to adaptation to climate change*

The action line includes non-technical actions, i.e. system and organizational innovations conducive to adaptation to climate change.

| **Action line 5.1- promoting innovation at the level of organizational and managerial actions conducive to adaptation to climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Development of procedures on cooperation of services and institutions with regard to needs to respond to multidimensional hazards connected with climate change, with particular emphasis on the aspect of coordination. | MSW/RCB/MŚ/ MAC | SSP | 7.5 Improving the emergency management system. |
| 5.1.1 | Promotion of innovative solutions in the field of adaptation of agricultural and fisheries production to climate change. | MRiRW/MNiSW/ MG | SZRWRiR | 5.3. Adaptation of agriculture and fisheries to climate change and their participation in preventing this change. |

### *Action line 5.2 – building the system of support for Polish innovative technologies conducive to adaptation to climate change*

In this action line, actions in the field of the creation, financing and implementation of innovative adaptation technologies have been indicated.

| **Action line 5.2 – building the system of support for Polish innovative technologies conducive to adaptation to climate change** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Analysis of the potential of the Polish economy for production and implementation of innovative adaptation technologies. | MŚ | BEiŚ | 3.2 Supporting new and promoting Polish energy and environmental technologies. |
| 5.2.1 | Consolidation/creation of new sources of financing for innovative adaptation technologies including research and implementation. | MŚ | BEiŚ | 3.2 Supporting new and promoting Polish energy and environmental technologies. |
| 5.2.2 | Creation of a Web platform to disseminate information on Polish adaptation technologies. | MŚ | BEiŚ | 3.2 Supporting new and promoting Polish energy and environmental technologies. |

## Objective 6. Development of social behavior conducive to adaptation to climate change

It should be stressed that effective adaptation to climate change is not possible without an adequate level of awareness of hazards and challenges among institutions involved in the process of adaptation and in the society. Therefore, it is necessary to implement educational actions both within the framework of formal education as well as extensive non-formal education contributing to raising public awareness. A primary goal will also be to increase the understanding of the impact of climatic processes on social and economic life.

### *Action line 6.1 – increasing awareness of risks related to extreme phenomena and methods of limiting their impact*

This action line showed actions from the field of widely understood education and awareness-building. Also, due to the importance of local aspects in the whole process of adaptation, it is necessary to ensure participation of communities and interested groups of stakeholders at the local level in adaptation actions.

| **Action line 6.1 – increasing awareness of risks related to extreme phenomena and methods of limiting their impact** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Education and raising awareness in the field of: climate change and methods to minimize its impact, impact of invasive alien species and the importance of and the need to save resources, especially water | MEN/MŚ/TSU | BEIŚ<br>SIEG<br>KSRR | 3.5 Promotion of ecological behaviours.<br>3.1.2. Raising social awareness and level of knowledge on challenges of the sustainable development and climate change.<br>3. The most important challenges of the regional policy by 2020. |
| 6.1.1 | Development, in primary school, grammar school and secondary school curricula, of issues of adaptation to climate change and the extension of further training programmes for medical personnel by the issue of climate-dependent, tropical and vector-borne diseases. | MEN/MŚ/MZ | BEIŚ<br>SIEG<br>SRKL | 3.5 Promotion of ecological behaviours.<br>3.1.2. Raising social awareness and level of knowledge on challenges of the sustainable development and climate change.<br>Fourth area – Health |
| 6.1.2 | Organization of training courses in the following areas: climate change and methods for preventing and reducing its consequences for residents of: areas at risk of floods, landslides and strong winds. | TSU | BEIŚ<br>SIEG<br>SZRWRiR | 3.5 Promotion of ecological behaviours.<br>3.1.2. Raising social awareness and level of knowledge on challenges of the sustainable development and climate change.<br>5.3 Adaptation of agriculture and fisheries to climate change and their participation in preventing this change. |
| 6.1.3 | Organisation of training courses for farmers with regard to climate change, and methods for preventing and reducing | MRiRW/TSU | SIEG | 3.1.2. Raising social awareness and level of knowledge on challenges of the sustainable |

| | | | | |
|---|---|---|---|---|
| | its impact. | | SZRWRiR | development and climate change<br><br>5.3 Adaptation of agriculture and fisheries to climate change and their participation in preventing this change. |
| 6.1.4 | Inclusion of local communities and self-government administration into actions to prevent the effects of climate change. | MŚ/TSU | SRKS<br><br>SSP<br><br>SZRRiR<br><br>KSRR<br><br>KPM | 2.1.2 Supporting the development, partnership and other forms of cooperation aimed at entrusting performance of public tasks to citizens.<br><br>7.5.1 Improving the functioning of crisis management structures.<br><br>1.4.2 Strengthening and development of social capital<br><br>3.4 Supporting building of social capital for regional development based on networks of cooperation between various entities of the regional policy.<br><br>5. Creation of conditions for the effective, efficient and partnership development management in urban areas, particularly in metropolitan areas. |

### *Action line 6.2 – protection of particularly exposed groups against the effects of adverse climate phenomena*

Climate change and related extreme phenomena like heat waves, hurricanes, flooding and floods require paying specific attention to social groups particularly vulnerable because of age, health status or material status. A different group includes people harmed as a result of rapid phenomena, in cases referred to it will be necessary to implement ad hoc aid mechanisms.

| **Action line 6.2 – protection of particularly exposed groups against the effects of adverse climate phenomena** | | | | |
|---|---|---|---|---|
| No. | Name of adaptation actions provided for in the SPA | Major responsible institutions | Name of the strategy | Selected areas of the development strategy containing adaptation areas |
| Priority action | Development of comprehensive solutions in the field of state aid granted for loss compensation in the event of natural disasters and development of the insurance system covering risks resulting from climate change. | MAC/MF/MRiRW/ MŚ | SZRWRiR<br><br>SSP | 5.3 Adaptation of agriculture and fisheries to climate change and their participation in preventing this change.<br><br>7.5.1 Improving the functioning of crisis management structures. |
| 6.2.1 | Dissemination of property insurance in areas at risk (Applies to all areas of permanently endangered i.e. by floods, droughts, landslides, erosion of banks, flooding in the coastal zone). | MAC | SSP | 7.5 Improving the emergency management system. |
| 6.2.2 | Strengthening the social welfare system in order to effectively prevent and combat the effects of climate change among the most vulnerable groups of society. | Ministry of Labour and Social policy | SSP | 7.5 Improving the emergency management system. |

### 4.2. Specificities of adaptation actions in regional terms

Voivodeships in Poland are diversified, *inter alia*, in terms of geography, society, economy and demography, which largely determines the individual vulnerability of individual territories to the effects of climate change. The nature and size of these differences allows to formulate a conclusion that in addition to basic, below-mentioned actions relevant to the entire territory of the country, it will be necessary to assess the vulnerability, taking into account regional and local specificities, which will be a basis for the creation of a catalogue of adaptation actions dedicated to a given territory.
Key horizontal actions, which should be implemented in all voivodeships, include:

- education with regard to climate change and reducing its effects,
- monitoring of changes in the vulnerability of the economy and society, and (in the longer term) progress in the implementation of regional and local adaptation strategies/plans,
- spatial planning at the regional and local level, taking into account climate change and adaptation,
- adaptation to climate change in cities, including the preparation and implementation of integrated adaptation strategies/plans,
- development of health services with particular regard to the sensitivity of residents to the occurrence of heat waves,
- limitation of the effects of hazards in agriculture, forests and ecosystems resulting from the emergence of invasive species and diseases, as well as taking into account specific adaptation of forests to an expected rise in the temperature during the process of afforestation,
- promotion of proper management in agricultural areas, technological support for holdings and technological advice taking into account aspects of adaptation of construction and agricultural production to changing climatic conditions,
- taking into account climatic trends in the process of design and construction of the transport infrastructure (climate proofing).

## Chapter 5. Implementation of SPA 2020

### 5.1 Monitoring and assessment of the implementation of objectives

Monitoring of the implementation of SPA 2020 will be carried out by the Ministry of the Environment based on the below-mentioned indicators at the level of objectives. Also, in view of the fact that adaptation actions have been indicated in other governmental strategic documents, their implementation will be subject to monitoring as part of these strategies.

Table 5. Indicators of monitoring SPA 2020.

| Name of indicator | Baseline value in 2010 | Expected value in 2020 | Data source |
|---|---|---|---|
| **Objective 1. Ensuring the energy security and good state of environment** | | | |
| National forestation rate (%) | 29,2% | 30% | GUS |
| Share of the area covered by valid spatial development plans in the total national geodesic area | 26,4% | 35% | GUS |

| | | | |
|---|---|---|---|
| Existence of flood risk management plans | No | Yes | MŚ/KZGW |
| Existence of landslide risk maps | 30% | 100% | MŚ |
| **Objective 2. Efficient adaptation to climate change in rural areas** | | | |
| Existence of the monitoring system of the impact of weather conditions on results of plant and animal production with consideration to the element of early warning against potential results of climate change to plant and animal production, in particular in supply of water (drought) | No | Yes | MŚ/ PSHM/ MRiRW/MAC/ PSH |
| **Objective 3. Development of transport in the conditions of climate change** | | | |
| Existence of the system for monitoring of transport infrastructure elements vulnerable to climate change, along with a module of warnings for technical services | No | Yes | MTBiGM /road infrastructure managers |
| **Objective 4. Ensuring the sustainable regional and local development with consideration to climate change** | | | |
| Existence of adaptation plans for cities with more than 100,000 residents | No | Yes | MŚ /TSU |
| **Objective 5. Stimulating innovations conducive to adaptation to climate change** | | | |
| Number of Polish environmental technologies supporting adaptation to climate change, verified under the ETV system | 0 | 50 | MŚ |
| **Objective 6. Development of social attitudes conducive to adaptation to climate change** | | | |
| Consumption of water from waterworks in households in cities per capita [$m^3$/year] | 35 | 32 | GUS |

In 2015, it is planned to carry out a mid-term assessment of the implementation of SPA 2020 objectives. As part of this assessment, indicators relating to individual actions (not indicated in SPA 2020) may be applied. The assessment will cover actions carried out at the national and regional level.

### *5.2 Entities involved in the implementation*

The implementation of actions identified in SPA 2020 will be a process requiring the involvement of many entities and institutions at the national, regional and local level. In accordance with the principle of multi-level governance and due to the horizontal nature of adaptation and the existing institutional framework of implementing the development policy in Poland, it is not planned to appoint new institutions or bodies responsible for coordination. The SPA 2020 implementation process will be carried out with a particular emphasis on communication and cooperation in the area of existing collaboration platforms under the development management system (e.g. the Coordinating Committee for Development Policy and institutions, including teams and working groups functioning as part of the implementation

of appropriate development strategies). Adaptation actions will be implemented pursuant to relevant regulations and by means of appropriate legal, financial and organizational instruments within the framework of the development policy. The implementation of SPA 2020 actions will involve in particular:

**central administration** – competent ministers (along with subordinate units) will be responsible for taking account of actions indicated in SPA 2020 in strategic documents, as well as in operational and legislative documents. The competence of relevant ministers will also include indication of funding sources of actions, with particular consideration given to the EU funds in the financial perspective 2014-2020;

**voivodeship self-governments** – it will be necessary to designate lines of adaptation at the regional (voivodeship) level, taking into account general lines set out in SPA 2020. Adaptation action lines should be indicated in the voivodeship development strategies, taking into account regional geographical, environmental, social and economic conditions. Depending on a decision of competent regulatory authorities at the voivodeship level, it will also be possible to develop regional strategies of adaptation to climate change;

**local self-governments** – at the local level, a large part of adaptation actions indicated in SPA 2020 will be implemented. A particular role in the implementation of SPA 2020 will fall to cities in which the adverse effects of climate change are accumulated, which points to the need to take account of adaptation in programming development actions, e.g. through the development of urban adaptation plans (especially for the largest cities). The implementation of integrated adaptation actions (e.g. through the preparation of local strategies/plans of adaptation to climate change) should also include other territories;

**business operators** – we should expect taking into account risks associated with climate change in strategic and financial planning in enterprises. In addition, climate change and the need for adaptation may become a factor stimulating the development of new technologies, *inter alia*, through the development of cooperation with research centers. Of importance will also be cooperation between entrepreneurs, for example, in the form of clusters.

# Chapter 6. Financing adaptation actions

Due to the horizontal and interdisciplinary nature of adaptation, it is not possible to estimate precisely and reliably costs of adaptation actions in national terms. In addition, as indicated in the previous chapters, SPA 2020 sets a framework for the adaptation policy in Poland, while the implementation of specific projects will have – in particular – the regional and local dimension. Therefore, at this stage it is not possible to indicate costs of actions that will be planned, e.g. based on an analysis of the vulnerability of a given territory (city/commune).

Funds for possible financing of actions in question as part of the state budget will be taken into account in the procedure of preparing the state budget for the next financial year within the limit of expenses specified in the financial act, in the appropriate budgetary part.

However, in this chapter, an estimate of costs of discontinuance of adaptation actions based on an analysis of losses has been made (see Chapter 2.3 and Table 6.)

Table 6. Losses caused by extreme climate phenomena and costs of inactivity (prices as of 2010)

| Range of years | Losses (in billion PLN) | Losses (% of GDP) |
|---|---|---|
| **2001-2010** | 54 | 0.50% |
| **2011-2020** | 86 | 0.49% |
| **2021-2030** | 120 | 0.52% |

*Source: IBS, 2012*

The probable consequence of failure to take adaptation actions will be losses at around PLN 86 billion in the perspective of 2020, which in the years 2021-2030 could amount to up to PLN 120 billion. The costs of inactivity are based on estimating potential losses associated with climate extreme events with an assumption that no additional preventive and adaptation actions have been taken[12]. Losses expressed as a percentage of GDP produced in a given period increase to a small extent in comparison to losses in absolute terms. This results from the fact that a large part of an increase in losses will be due to the society growing rich, the accumulation of assets and capital and the creation of the new infrastructure.

Adaptation actions will be financed from various sources, i.e. both national and foreign (especially EU) and from private funds (Table 7). In the context of the new EU financial perspective 2014-2020, it should be stressed that in the general regulation for funds (draft) the thematic objective 5, specific to adaptation actions “Promoting adaptation to climate change, risk prevention and risk management” has been separated. The detailed scope of financing of adaptation from the EU funds, including financial allocations, will be set out in the operational programmes at the national and regional level. The other major source of financing of adaptation will be the system of funds for environmental protection, in particular, the National Fund for Environmental Protection and Water Management, where financing of adaptation actions has been planned both in fund action strategies and in relevant priority programmes.

[12] Estimate based on the methodology developed under the KLIMADA project by IOŚ / IBS.

Table 7. Sources of financing for actions of adaptation to climate change in the years 2014-2020.

| **National public** | **EU as part of NFP 2014-2020** | **International** | **Private – national and foreign** | **Others** |
|---|---|---|---|---|
| NFOŚiGW | national and regional operational programmes | World Bank | Business operators, including SMEs | Commercial banks |
| Voivodeship funds for environmental protection and water management | LIFE instrument | International Monetary Fund | Associations | Foundations |
| TSU budgets | Instruments for the sustainable development of cities | Other | | Investment funds, including *venture capital* and *private equity* |
| Green Investment Scheme (income from sale of AAU units) | | | | |
| State budget | | | | |

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## *List of abbreviations*

**AAU** – *Assigned Amount Unit* – AAU units – units of assigned amount of emissions under the UN system
**ARR** – Agricultural Market Agency
**BEIŚ** – Energy Security and Environment Strategy
**DGLP** – State Forests General Directorate
**EEA** – *European Environment Agency*
**EU ETS** – *EU Emissions Trading Scheme*
**ETV** – Environmental Technology Verification
**GDDKiA** – General Directorate for National Roads and Motorways
**GDOŚ** – General Directorate for Environmental Protection
**GUS** – Central Statistical Officer
**TSU** – territorial self-government units
**KLIMADA** – project entitled „Development and implementation of the Polish National Strategy for Adaptation to Climate Change" implemented from the NFOŚiGW funds in the years 2011-2013
**KPM** – National Urban Policy
**KSRR** – National Strategy of Regional Development
**MAC** – Ministry of Administration and Digitization
**MEN** – Ministry of National Education
**MF** – Ministry of Finance
**MG** – Ministry of Economy
**MNiSW** – Ministry of Science and Higher Education
**MON** – Ministry of National Defence
**MPiPS** – Ministry of Labour and Social Policy
**MRiRW** – Ministry of Agriculture and Rural Development
**MRR** – Ministry of Regional Development
**MSW** – Ministry of Interior
**MŚ** – Ministry of the Environment
**SME** – sector of small and middle-sized enterprises
**MTBiGM** – Ministry of Transport, Construction and Maritime Economy
**MZ** – Ministry of Health
**NFOŚiGW** – National Fund for Environmental Protection and Water Management
**NPF 2014-2020** – New Financial Perspective programming period 2014-2020
**OECD** – *Organisation for Economic Co-operation and Development*
**PIS** – State Sanitary Inspection
**PKP** – Polish State Railways
**PSE Operator S.A** – Polish Power Networks Operator S.A
**PSHM** – Polish State Hydrological and Meteorological Services
**PSP** – State Fire Service
**RCB** – Government Centre for Security
**SIEG** – Strategy of Innovation and Economic Efficiency
**SPA 2020** – Polish National Strategy for Adaptation to Climate Change by 2020 with the perspective by 2030

**SRKL** – Human Capital Development Strategy
**SRKS** – Social Capital Development Strategy
**SRT** – Transport Development Strategy
**SSP** – Efficient State Strategy
**SZRWRiR** – Strategy for Sustainable Development of Agriculture, Rural Areas and Fisheries
**ŚSRK** – Mid-term National Development Strategy
**PPPL** – "Polish Airports" State Enterprise
**WPR** – Common Agricultural Policy
**WRS** - Common Strategic Framework

# ANNEXES

## *Annex 1. Conclusions and recommendations from the carried out strategic environmental impact assessment of the project „Polish National Strategy for Adaptation to Climate Change by 2020 with the perspective by 2030" (SPA 2020)*

Conclusions and recommendations contained in the forecast of the environmental impact of SPA 2020 have been classified in several areas: general recommendations in the area of the entire document, recommendations in the area of fundamental rules of the environmental protection and with regard to monitoring the effects of the implementation of SPA 2020.

With regard to recommendations concerning the entire document, it has been recommended to take account of all legally protected areas (at the level of diagnosis and action lines), thus the groundlessness of preference for areas being part of the NATURA 2000 areas has been indicated. This approach has been ultimately adopted in the document. In addition, in accordance with the recommendations of the forecast, the form of presenting information in the field of the territorial dimension of adaptation actions has been modified. The table of actions broken down by voivodeships has been abandoned for the benefit of key horizontal actions recommended for all voivodeships with an assumption that specific actions will be set out in relevant documents at the regional and local level, after carrying out an analysis of the vulnerability of a given territory to climate change.

Under remaining recommendations, recommendations relevant from the point of view of the specific objectives of SPA 2020 have been presented:

**Assessment of the objective „Ensuring the energy security and good state of environment"**

In the action line "adaptation of the water management sector to climate change", it has been recommended, *inter alia*, to give up new methods of assessing risks of floods and flooding for the benefit of harmonization and adaptation of existing ones.

In the action line "adaptation of the coastal zone to climate change", it has been recommended not to distinguish the sea level rise and potential flood risk but to indicate general phenomena and processes related to climate change. In case of monitoring of the state of seashores and coastal waters, it is recommended to use modern remote sensing systems as well as to publish the results of research.

In the action line "adaptation of the energy sector to climate change", groundless preference for solar energy among RES used has been indicated due to the limited efficiency and cost-effectiveness in case of development of this type of technology. In connection with this recommendation, an appropriate modification has been made to the content of SPA 2020.

In the action line "protection of biodiversity and forest management in the context of climate change", it has been recommended that the afforestation process not interfere with local biodiversity and forest

management itself be conducted in accordance with appropriate practices. Also, the forecast stressed the importance of free access to the results of monitoring necessary for further scientific analyses.

In the action line "adaptation to climate changes in spatial development and construction", it has been recommended to increase the importance of spatial planning in the development management process and to borrow models from good European practices. It has been recommended to transform spatial planning towards the pro-development policy and not only a routine procedure.

In the action line "ensuring the functioning of the effective health protection system in the conditions of climate change", it has been recommended to include in the document a problem of changes in concentrations of tropospheric ozone, which provides the protection against ultraviolet rays. It has also been recommended to introduce a programme of vaccinations against Lyme disease, the incidence of which may increase as a result of the development of the tick population.

**Assessment of the objective "Efficient adaptation to climate change in rural areas"**

In the action line "creation of local systems for monitoring and warning against hazards", the importance of universal access to measurement data and raw databases for research institutions has been stressed. In addition, educational activities and activities to disseminate the rules of good practices in farming have been described as necessary and the need for the adaptation policy implemented through modernization of the Polish countryside for the full use of current opportunities for rural development has been indicated.

In the action line organizational and technical adaptation of the agricultural and fishery activity to climate change", it has been recommended to broaden the scope of actions supporting adaptation of agriculture to climate change by the subject of water savings, *inter alia*, through avoiding cultivation requiring large amounts of water and using hydrogels to improve soil retention. It has also been recommended to intensify research on species resistant to prolonged droughts and frosts.

**Assessment of the objective "Development of transport in the conditions of climate change"**

In the action line "developing design standards taking account of climate change", it has been recommended that the designed infrastructure be resistant mainly to extreme weather events such as torrential rains and their consequences (floods, flooding) and, to a lesser extent, to the global rise in the temperature.

**Assessment of the objective "Ensuring the sustainable regional and local development with consideration to climate change"**

In the action line "monitoring of the state of the environment and early warning and response systems in the context of climate change (cities and rural areas)", it has been recommended to implement integrated spatial information systems and to create thematic maps, thanks to which it will be possible to define the areas that are particularly vulnerable to risks. Such materials will allow to provide permanent access to relevant information on the environmental and climate security for local authorities and communities.

In the action line "urban spatial policy taking climate change into account", it has been recommended to include, in the urban policy, aspects such as: creation of local adaptation plans, modernization

and the proper functioning of the sewage infrastructure, implementation of innovative solutions in construction and infrastructure and model development of green urban space.

**Assessment of the objective "Stimulating innovations conducive to adaptation to climate change"**

In the action line "promoting innovation at the level of organizational and managerial actions conducive to adaptation to climate change", the authors have indicated the groundless, in their opinion, fact of limiting the promotion of innovation to agricultural and fisheries production only.

In the action line "building the system of support for Polish innovative technologies conducive to adaptation to climate change" with regard to the Web platform, it has been recommended to use that tool for dissemination and promotion of Polish patent solutions related to adaptation, which will positively affect the development of the Polish economy.

**Assessment of the objective "Development of social attitudes conducive to adaptation to climate change"**

In the action line "increasing awareness of risks related to extreme phenomena and methods of limiting their impact", it has been recommended to increase the intensity of works on flood hazard and risk maps and it has been suggested to develop flood risk management plans on a scale of all river basins.

In the action line "protection of particularly exposed groups against the effects of adverse climate phenomena", it has been indicated to take account of the possibility of supporting the property insurance system from public funds and of actions minimizing consequences of extreme events adapted to the specific nature of specific territories (*inter alia*, in the field of infrastructure and construction).