CLIMATE OF RISK

HOW CAN PREVENTION AND INSURANCE REDUCE THE IMPACT OF NATURAL DISASTERS ON THE ENVIRONMENT?

Honorary patronage

MINISTRY OF THE ENVIRONMENT

PIU
POLISH CHAMBER OF INSURANCE

Report prepared by

Deloitte.

Warsaw, 2019

Polish Chamber of Insurance
18 Twarda St., 00-105 Warsaw,
office@piu.org.pl
Phone: +48 22 420 51 05

Deloitte Sustainability Consulting Central Europe
Deloitte Advisory Sp. z o.o.
Al. Jana Pawła II 22, 00-133 Warsaw

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INTRODUCTION

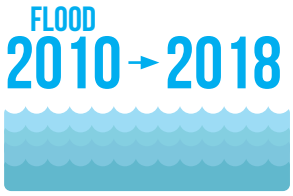
Weather events in Poland over recent years have made disaster risk management a top priority. One of the key issues is insurance. It guarantees economic equilibrium for society and businesses as well as public and private property. The world must tackle the problem of increased exposure; namely a larger number of people and higher-valued property are susceptible to weather-related damage. This requires the implementation of new solutions and preventive measures for natural disasters.

This report demonstrates the impact of increased risk exposure, indicates the role of insurance in these types of occurrences and presents recommendations for the development of a natural disaster risk management system in Poland.

KEY FIGURES

TOTAL COST OF THE 2018 DROUGHT FOR THE POLISH ECONOMY

PLN **2.6** BILLION
IN LOST VALUE ADDED

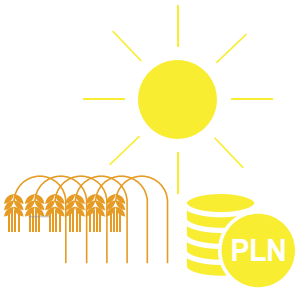


IF THE 2010 FLOOD HAD TAKEN PLACE IN 2018, IT WOULD HAVE COST

PLN **16.2** BILLION
PLN 3.4 BILLION (OR 20.9%) MORE THAN IN 2010.

IF EXTREME WEATHER EVENTS AND ADDITIONAL RANDOM FACTORS, SUCH AS MASSIVE CYBER ATTACKS, HAD CAUSED A BLACKOUT THROUGHOUT POLAND FOR 8 HOURS ON 12 DECEMBER 2018, THE LOSSES WOULD HAVE AMOUNTED TO

PLN **2.6** BILLION



AMOUNT PAID TO FARMERS FROM INSURANCE AGAINST WEATHER EVENTS IN 2008-2018:

PLN **3.21** BILLION

NUMBER OF INSURANCE AGREEMENTS AGAINST DAMAGE CAUSED TO CROPS BY HAIL RISK IN 2018:

128,633

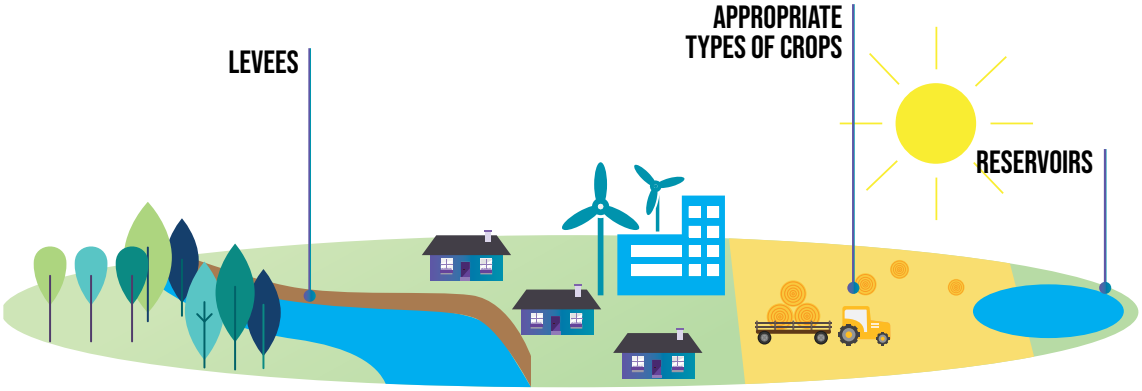
POLISH CITIES WITH THE HIGHEST EXPOSURE TO A NATURAL DISASTER:

WARSAW
CRACOW
TRI-CITY

Even a flawlessly designed risk management system cannot completely eliminate the effects of a disaster of an unparalleled scale (e.g. the Millennium Flood). As a result, the increasing frequency of natural disasters requires the efficiency of processes used to limit the risk to be improved through adequate education, **preventive and adaptive** measures as well as **risk transfer**, which is made possible by insurers.

However, security and stabilisation in the event of weather-related disasters can only be ensured by integrated actions of state authorities, society and the insurance sector. It should be remembered that **insurance is an element of and not a substitute for risk management**, as shown in the diagram below.

EXAMPLES OF PREVENTIVE AND ADAPTIVE MEASURES



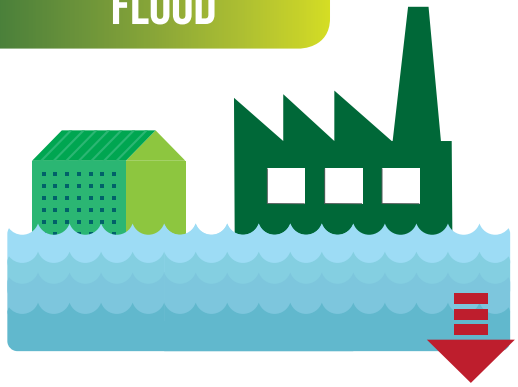
INSURANCE IS AN ELEMENT OF AND NOT A SUBSTITUTE FOR RISK MANAGEMENT

INTEGRATED ACTIONS OF STATE AUTHORITIES, SOCIETY AND THE INSURANCE SECTOR

CAN IMPROVE SOCIAL AND ECONOMIC RESISTANCE TO THE IMPACT OF NATURAL DISASTERS

THE 2010 FLOOD

A total of 24,000 families suffered during the 2010 flood, while the estimated losses amounted to more than **PLN 12 billion**. Only less than **13%** of these losses had insurance coverage, which demonstrates the low level of property insurance in Poland and a lack of social awareness about the effects of natural disasters.

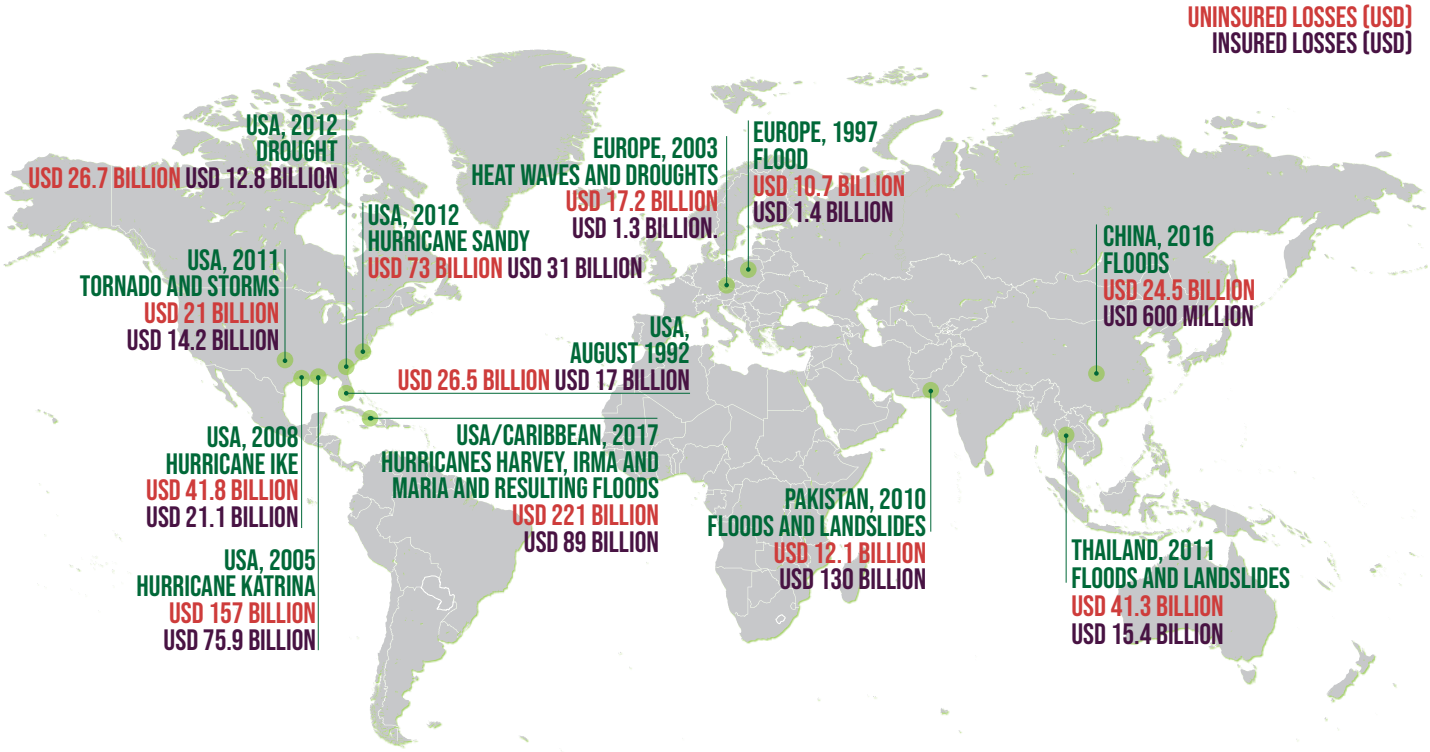


INSURANCE COVERAGE ONLY

13%

One of the direct consequences of climate change and global warming is the increased frequency and intensity of natural disasters. Additionally, economic development results in higher risk exposure as it increases the value of both private and public property. The global population is also growing, which is why natural disasters result in previously unrecorded human casualties and material losses.

SELECTED LARGEST NATURAL DISASTERS IN TERMS OF LOST RESOURCES (1997-2017)



Source: Own study based on Munich Re, figures adjusted for inflation

IN 2017 ALONE, MATERIAL LOSSES CAUSED BY NATURAL DISASTERS AMOUNTED TO MORE THAN USD **335** BILLION

OF WHICH INSURANCE COVERED ONLY APPROX. USD **140** BILLION[1]

THE GLOBAL INSURANCE GAP FOR NATURAL DISASTERS IN 2017 USD **195** BILLION

Although awareness of potential threats is growing in Poland, we are underestimating the probability of natural disasters. In the meantime, we should focus more on predicting the negative impact of changes which are already taking place. One of the key issues is appropriate protection of property and, more importantly, life and health.

CHAPTER 1
INCREASED EXPOSURE TO THE IMPACT OF EXTREME EVENTS AND DISASTERS

1.1. GLOBAL EXPOSURE – KEY TRENDS

Costs arising from disasters are increasing. As property which may be potentially destroyed accumulates, more severe losses are suffered by businesses, households and the public sector. Accumulation of property and urban development can be measured on the basis of the size of built-up areas.

FIGURE 1. BUILT-UP AREA BY REGION [KM^2] IN 1990, 2000 AND 2014

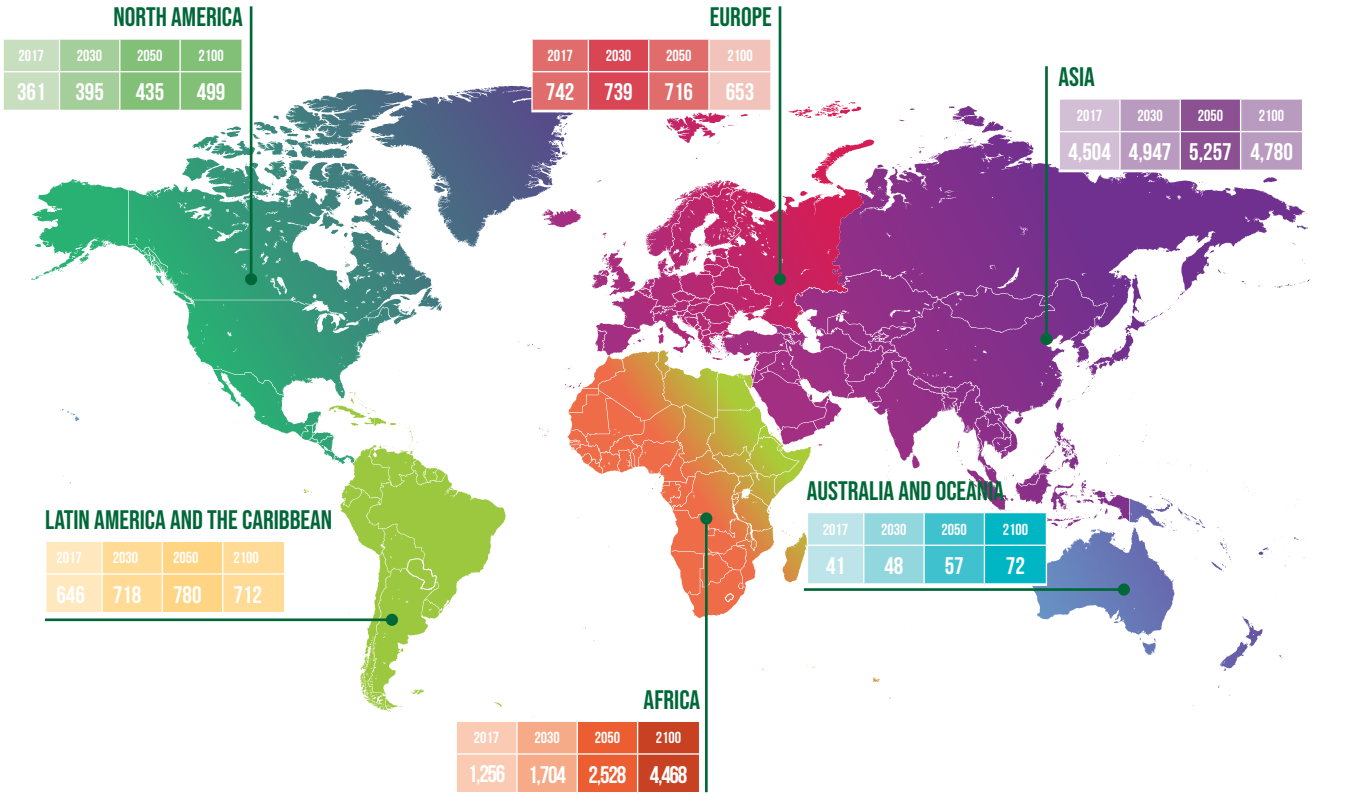
	UNITED STATES	EUROPEAN UNION	CHINA	INDIA	NIGERIA
1990	110,869	110,766	57,317	16,490	5,404
2000	130,152	125,041	73,786	22,082	7,305
2014	150,856	144,550	102,888	32,375	12,221

Source: Own study based on OECD and World Bank data[2]

Global population growth

According to forecasts, the global population is going to increase by approx. 1 billion by 2030, when it will reach the record size of 8.6 billion.[3] This growth will result primarily from the demographic situation in Africa and Asia.

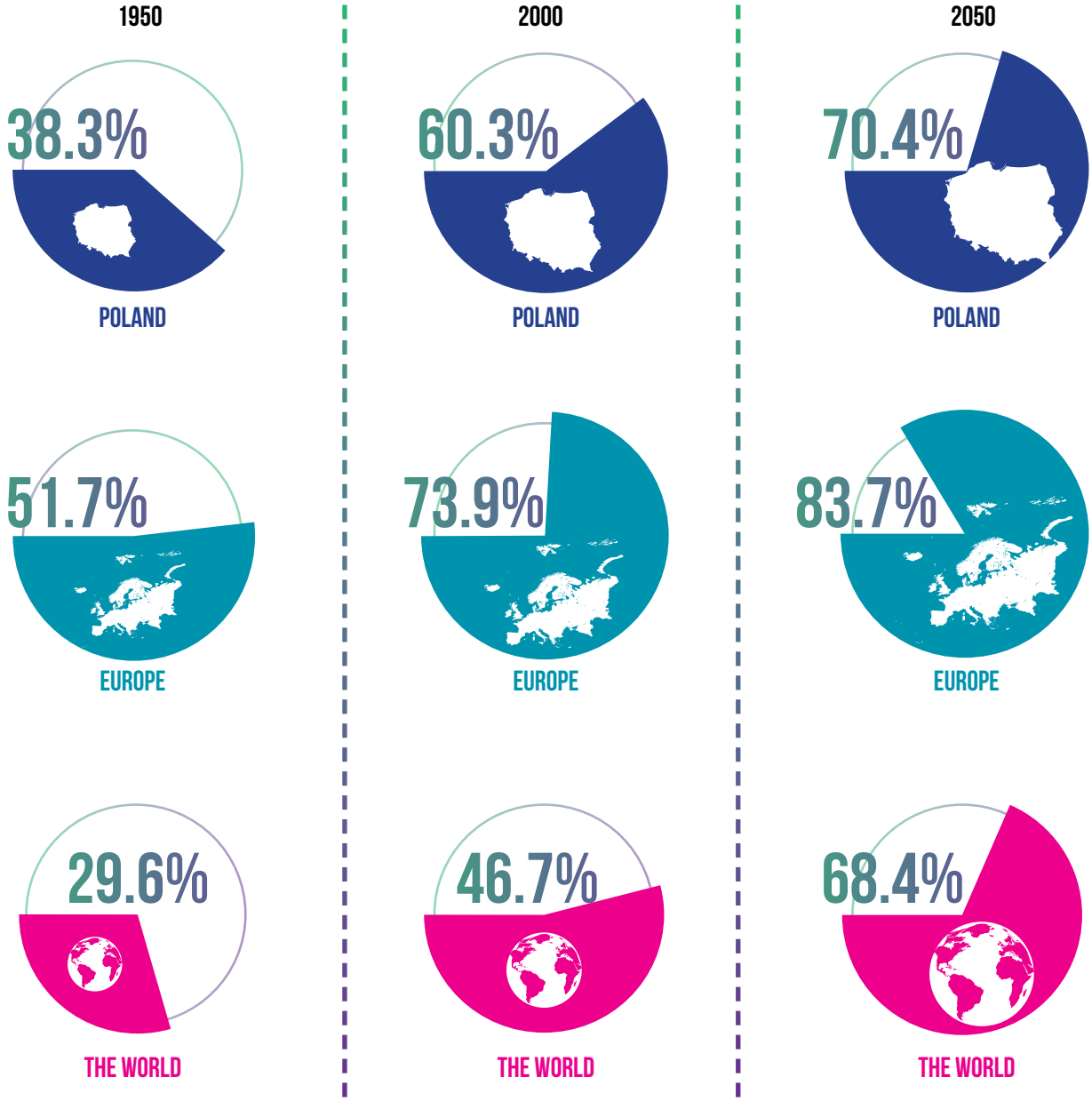
FIGURE 2. FORECAST OF GLOBAL AND REGIONAL POPULATION BY 2100 (MILLIONS OF PEOPLE)[4]



Advancing urbanisation

According to the data for 2015, 53.9% of the global population lives in cities, while in 1950 the figure was only 29.6%. In Poland, 60.3% of the population is urbanised. This places Poland above the global average, but below the European average of 73.9%. The UN forecast indicates that until 2050 urbanization will continue to grow and in Poland it will reach 70%. By 2050, the world's urban population will have increased even by 2.5 billion.[5]

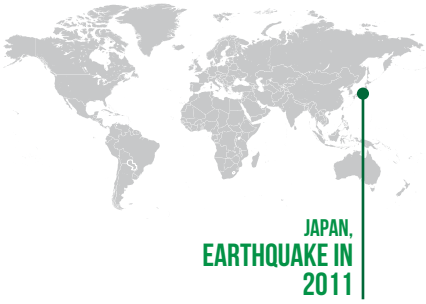
FIGURE 3. PERCENTAGE OF URBAN POPULATION (1950-2050) [%][6]



As a result, cities have a crucial impact on people's safety, the environment, resources and urban infrastructure.[7] They are places where a major portion of economic assets, private property and human capital is concentrated. At the same time, cities are densely built-up, making evacuation more difficult. They are also characterised by a small share of biologically active area and low levels of water retention.

Natural disasters translate into GDP of the global economy. The consequences of disasters impact not only direct partners of companies but also their suppliers and subcontractors, i.e. further participants of the supply chain.[8]

EXAMPLES OF THE EFFECTS OF NATURAL DISASTERS ON THE SUPPLY CHAIN



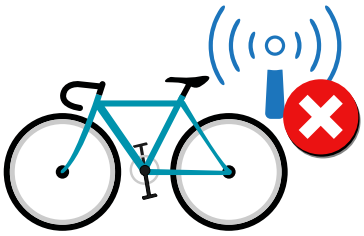
JAPAN,
EARTHQUAKE IN 2011

COMPANIES DEPENDENT ON JAPANESE MANUFACTURERS WERE LEFT WITHOUT VEHICLE PARTS

CLOSURE OF MANUFACTURING PLANTS

TOYOTA, NISSAN AND GM WERE FORCED TO CLOSE SOME MANUFACTURING PLANTS IN JAPAN AND THE USA DUE TO THEIR INABILITY TO SHIP OR RECEIVE MANUFACTURING COMPONENTS

GERMANY,
FLOODING OF THE NEXTBIKE SYSTEM SERVER AS A RESULT OF DISASTER IN 2013



NEXTBIKE SYSTEM FAILURE IN SEVERAL POLISH CITIES

THAILAND,
FLOOD IN 2011

THE SECOND LARGEST MANUFACTURER OF HARD DRIVES IN THE WORLD

APPROX. 10% INCREASE IN PRICES OF HARD DRIVES GLOBALLY

QUEENSLAND (AUSTRALIA)
FLOOD 2010/2011

REDUCED COAL EXPORTS LED TO AN INCREASE IN ITS PRICES WORLDWIDE

The increasing average air temperature contributes to the melting of glaciers and ice sheets and causes the sea level to rise. Compared to 2000, the average sea level around the world could increase by 9-18 cm by 2030 and even by 130 cm by 2100.[9] **Rising water levels may lead to permanent flooding of low-lying areas.** In the case of Bangladesh, an increase by 45 cm could result in flooding of 10% of the country's area.[10] It is estimated that by 2050, up to 200 million people could migrate from regions affected by rising sea levels.[11] At the same time, many oceanic islands or countries such as the Netherlands or Guyana could end up completely under water.

PERCENTAGE OF POPULATION THREATENED BY FLOODING DUE TO RISING GLOBAL OCEAN LEVELS, WITH A TEMPERATURE INCREASE OF 2°C SINCE BEFORE THE INDUSTRIAL REVOLUTION

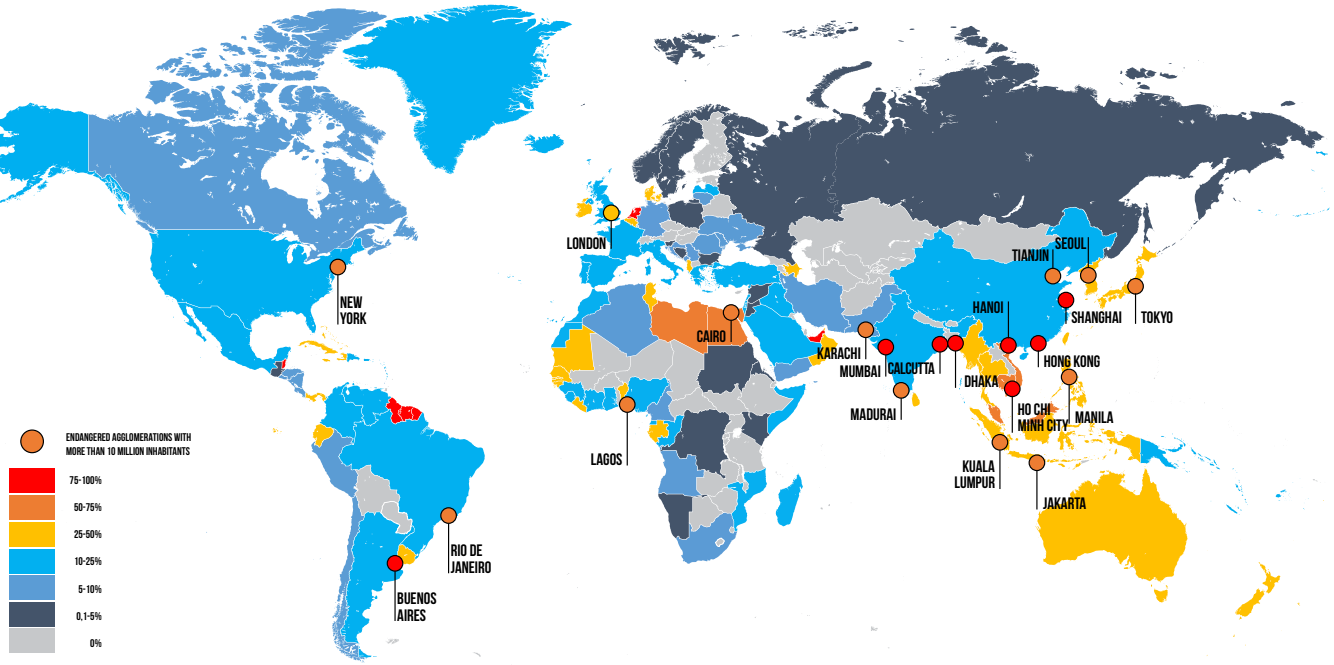
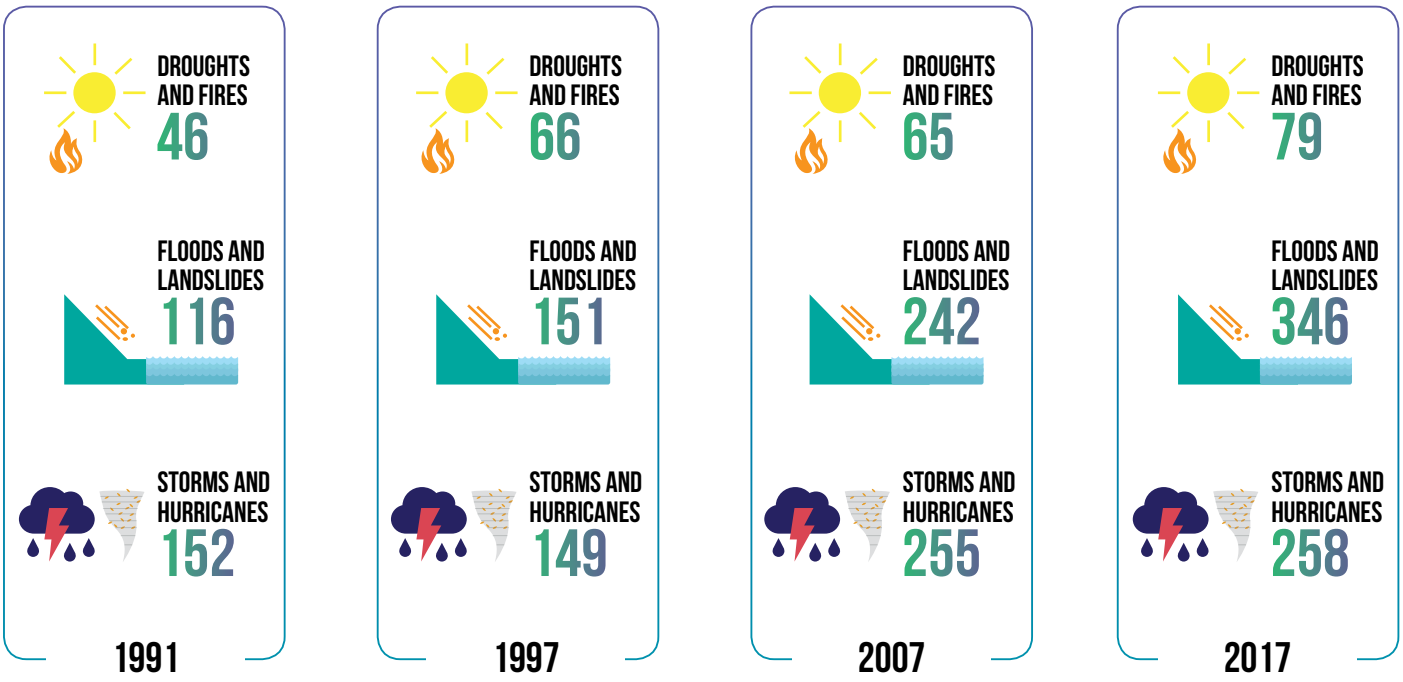
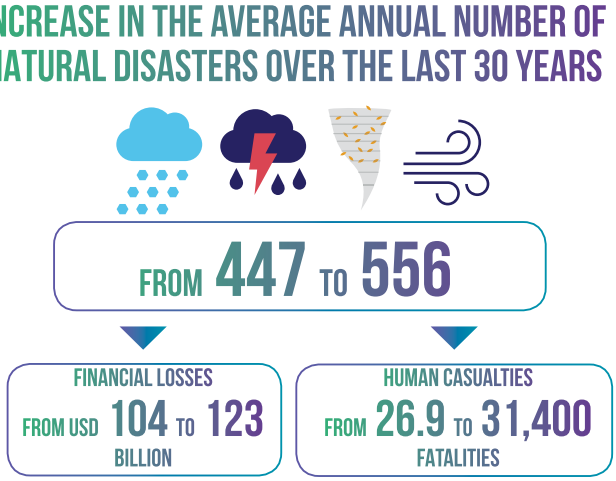


FIGURE 4. FREQUENCY AND TYPES OF NATURAL DISASTERS (1990-2017)



Source: Munich Re

Most losses are without insurance coverage. Over the last decade, the average annual number of natural disasters globally has increased (from 447 to 556) along with financial losses (from USD 104 to 123 billion) and human casualties (from 26,900 to 31,400 fatalities) compared to the average for the last 30 years.[12] In the past 10 years, 33.8% of financial losses on average had insurance coverage, which represents a small increase compared to the values for 30 years of 30.7%. The year 2017 brought about particularly severe material losses, reaching USD 335 billion, primarily as a result of Hurricanes Harvey, Irma and Maria in the USA and the Caribbean.[13]

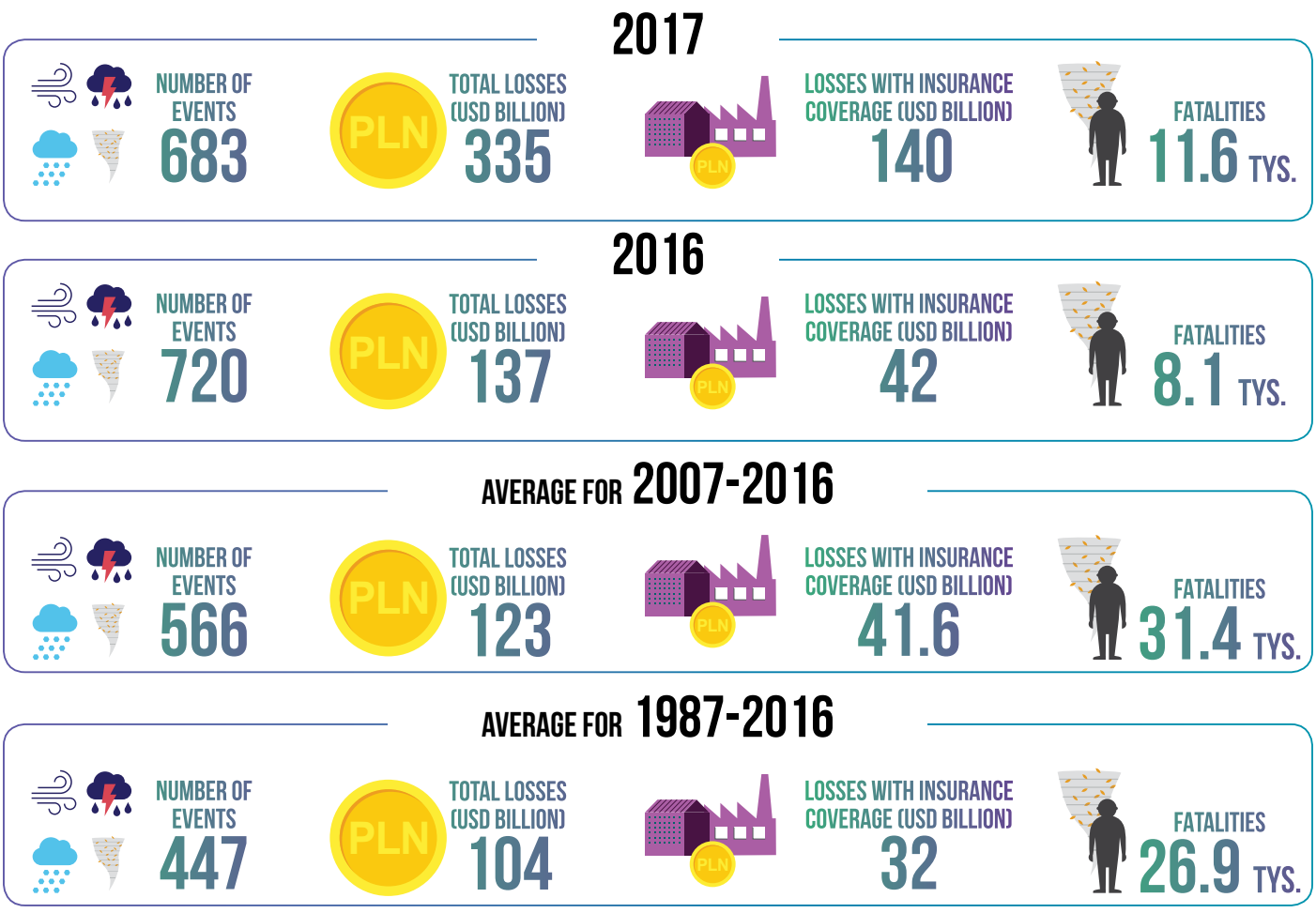


According to alternative data, there were 335 natural disasters in 2017, most of which were storms (127) or floods (126).[14]

USD 123.2 BILLION
AVERAGE ANNUAL GLOBAL LOSSES CAUSED BY NATURAL DISASTERS OVER THE LAST 10 YEARS

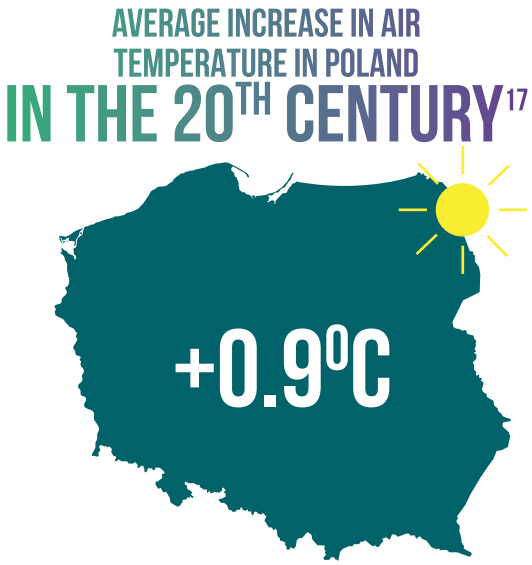
33.8%
AVERAGE GLOBAL PERCENTAGE OF LOSSES CAUSED BY NATURAL DISASTERS WITH INSURANCE COVERAGE OVER THE LAST 10 YEARS

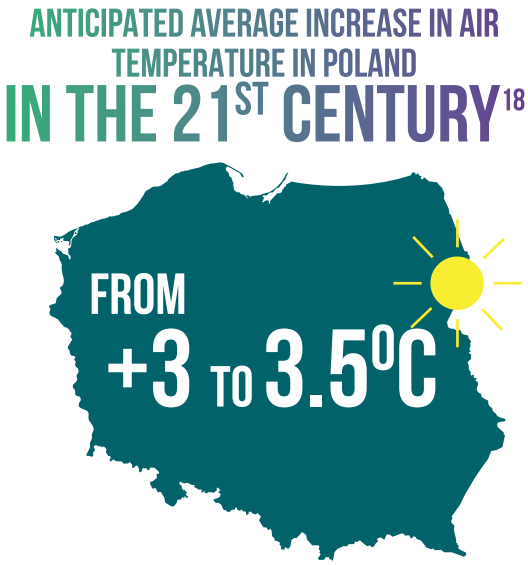
FIGURE 5. FREQUENCY AND TYPES OF NATURAL DISASTERS (1987-2017)[15]



1.2. EXPOSURE IN POLAND — KEY TRENDS AND FORECASTS

In the 21st century, Poland will also be affected by global warming with more frequent heat waves (temperatures above 35°C may occur for more than 20 days per year) and warmer winters.[16] This will lead to deteriorated conditions for plant growth — access to water will be more difficult and vegetation will become more prone to diseases. Paradoxically, this warming does not mean that low temperatures will cease to be a problem.



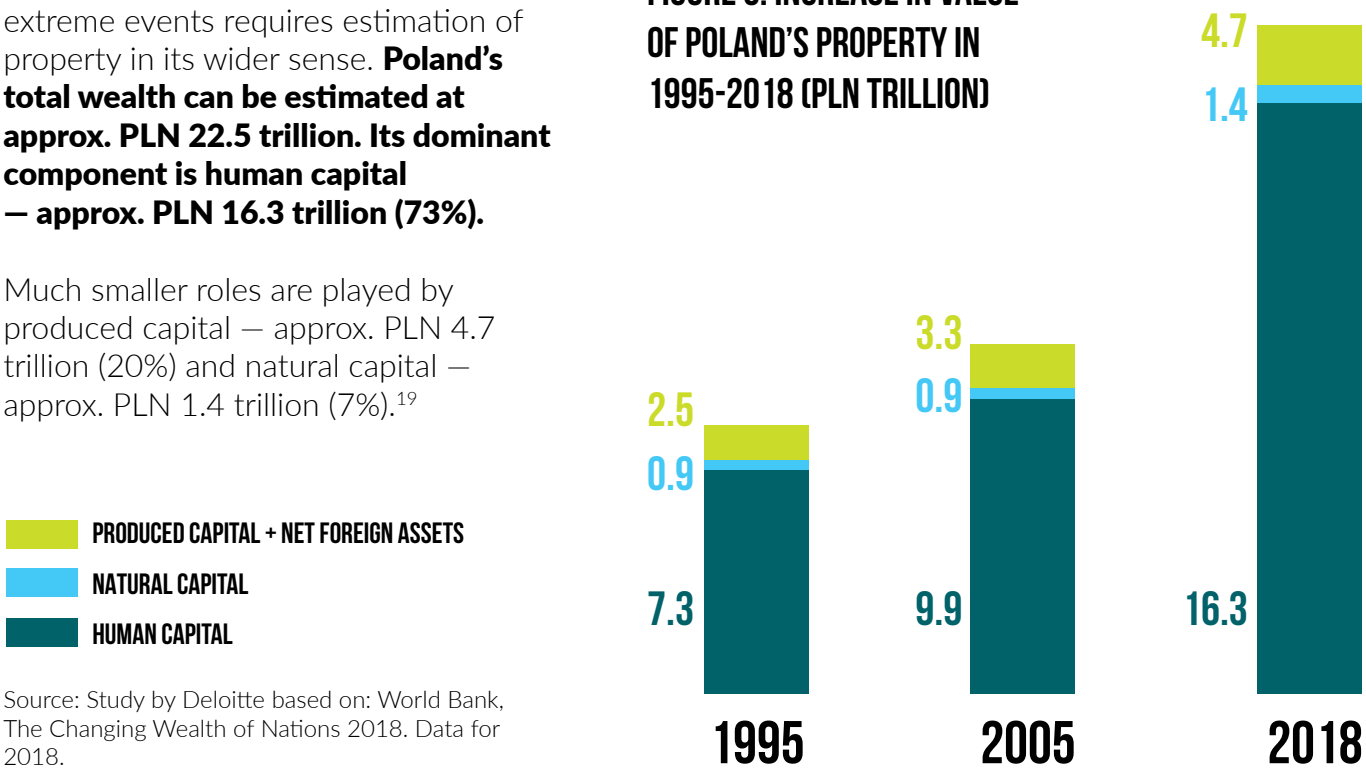


Warm, snowless winters interrupted by rapid temperature drops, without snow cover providing protection for plants will cause staggering losses in agriculture and gardening. Similarly, an earlier beginning of the vegetation season will involve higher probability of damage caused by spring frost. Global warming will also entail certain limited economic benefits for Poland, e.g. lower expenditure on heating, the possibility to grow new plants or a longer vegetation period.

A comprehensive assessment of Poland's exposure to risks of disasters and extreme events requires estimation of property in its wider sense. **Poland's total wealth can be estimated at approx. PLN 22.5 trillion. Its dominant component is human capital — approx. PLN 16.3 trillion (73%).**

Much smaller roles are played by produced capital — approx. PLN 4.7 trillion (20%) and natural capital — approx. PLN 1.4 trillion (7%).[19]

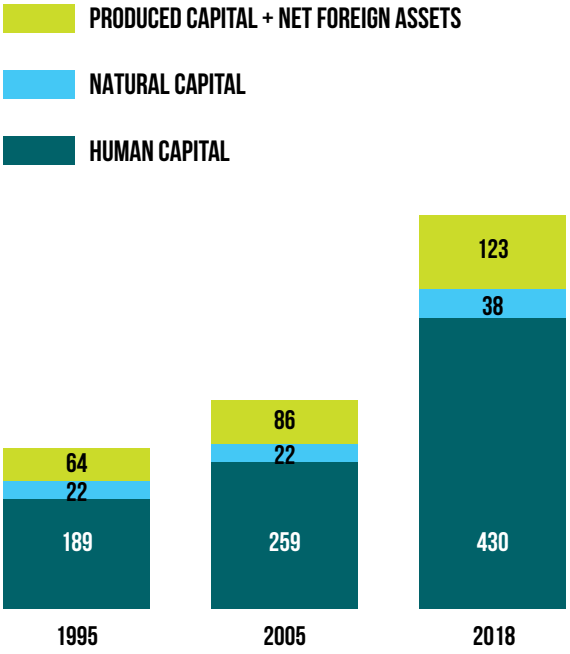
FIGURE 6. INCREASE IN VALUE OF POLAND'S PROPERTY IN 1995-2018 (PLN TRILLION)



Source: Study by Deloitte based on: World Bank, The Changing Wealth of Nations 2018. Data for 2018.

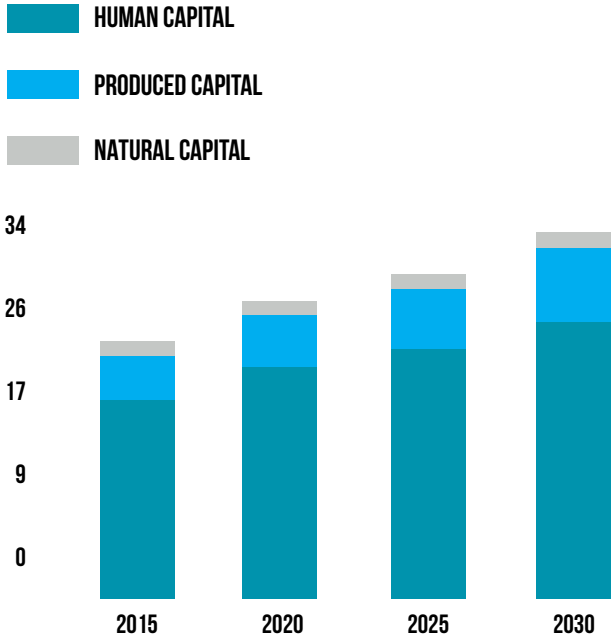
Over the last two decades, the **value of produced capital**, comprising assets of households, businesses, municipal assets and those controlled by the State Treasury, has increased almost twofold. Produced capital has increased as a result of investments made by businesses and the public sector, including investments subsidised with EU funds.
As a result, **property in Poland which now requires protection against fire, flood or violent wind is worth PLN 2.2 trillion more than in 1995**.

FIGURE 7. INCREASE IN VALUE OF POLAND'S PROPERTY PER CAPITA IN 1995–2018 (PLN THOUSAND)



Source: Study by Deloitte based on:
World Bank, The Changing Wealth of Nations 2018. Data for 2018.

FIGURE 8. FORECAST FOR POLAND'S PROPERTY BY 2030



Source: Deloitte analysis

According to estimates, the value of property which needs protection against the impact of natural disasters will grow in Poland in the upcoming years.

1.3. EXPOSURE AND SOCIO-ECONOMIC VULNERABILITY IN POLAND – SPATIAL DIVERSITY

Risk exposure is highly **spatially diversified**. People, companies and assets are concentrated in cities. On the other hand, **socio-economic vulnerability is also significantly diversified in geographic terms.** However, this is primarily due to the **income of inhabitants, the quality of public services or infrastructure**.

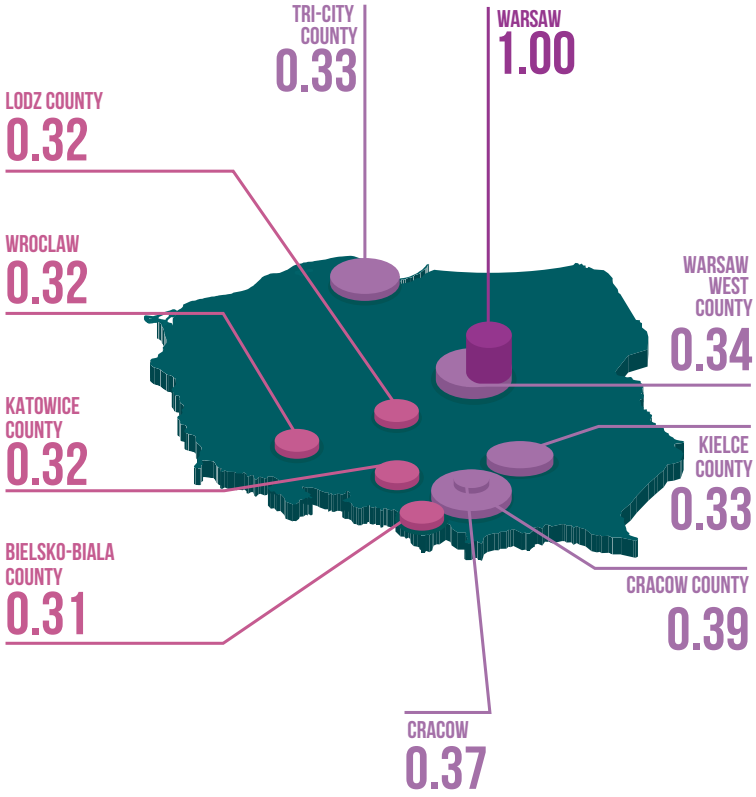
The exposure index shows how many people and goods in a given area are exposed to the impact of natural disasters.

The socio-economic vulnerability index depicts the vulnerability of the local community to the negative impact of extreme events (both short- and long-term).

The highest exposure index is observed in urban subregions – primarily Warsaw, followed by Cracow and Tri-City. With the largest population and the highest amount of fixed assets located in large cities, this result is to be expected.

FIGURE 9. 10 SUBREGIONS WITH THE HIGHEST COLLECTIVE EXPOSURE INDEX (1 MEANS THE MAXIMUM INDEX VALUE)

Source: Deloitte analysis



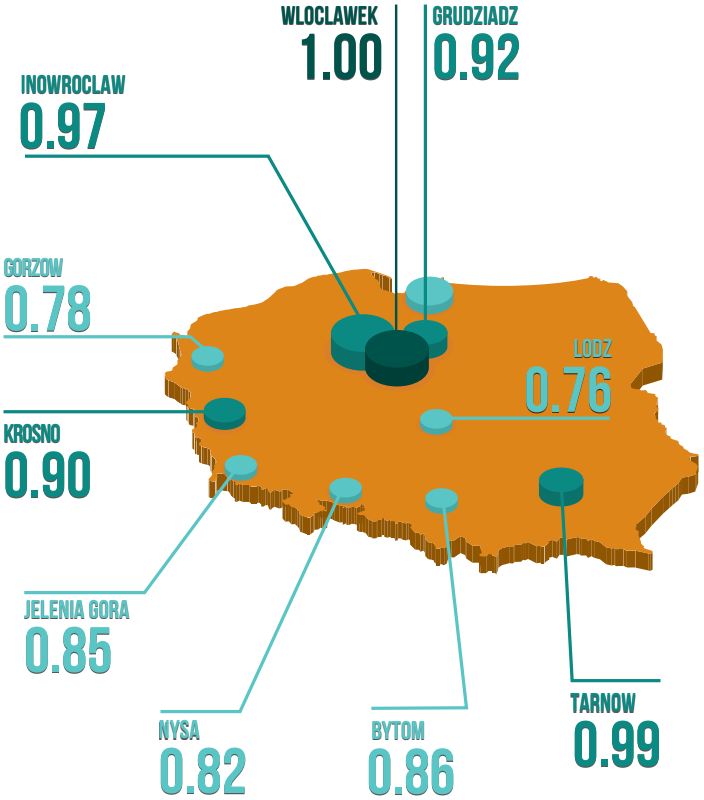


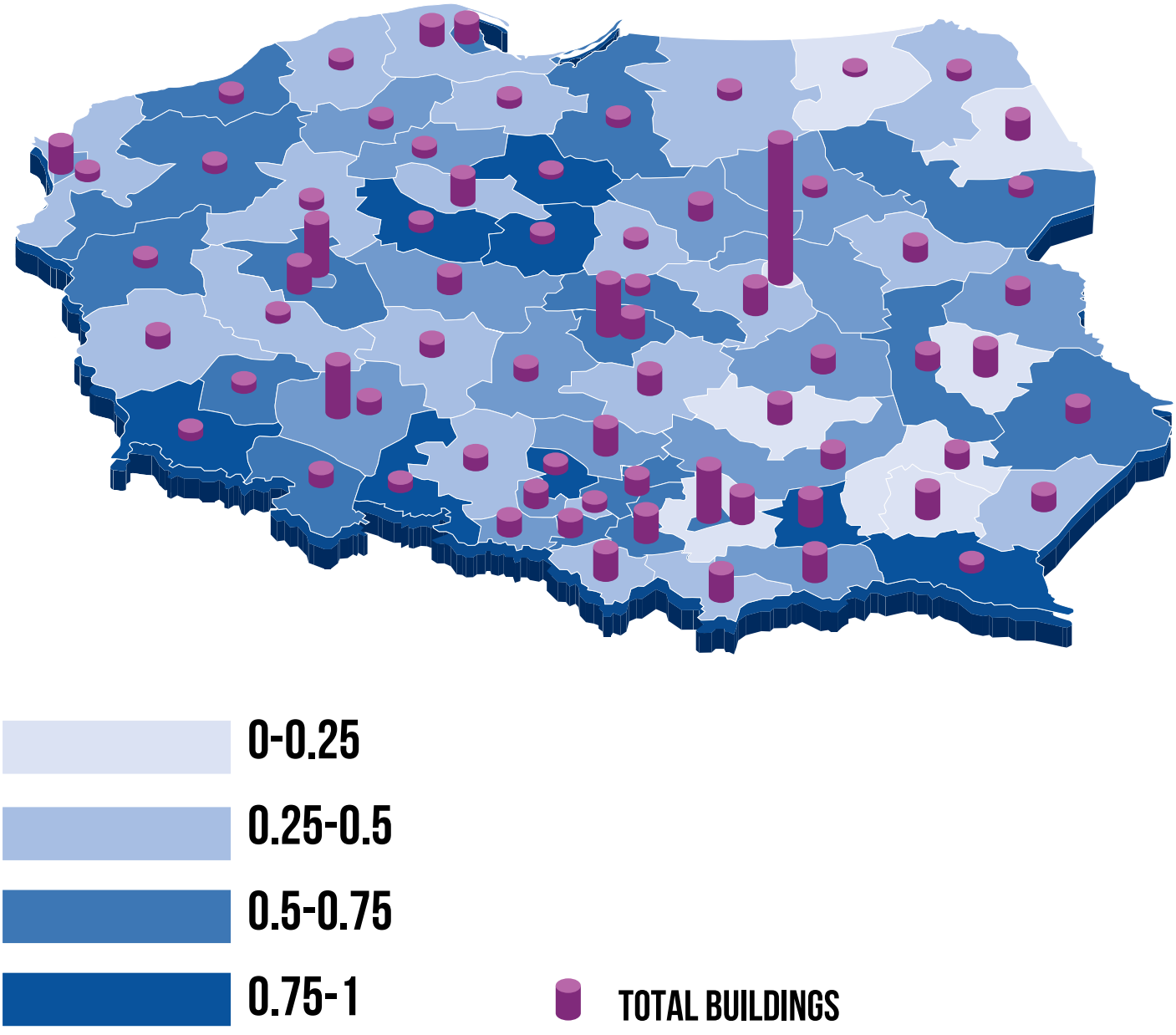
FIGURE 10. 10 SUBREGIONS WITH THE HIGHEST COLLECTIVE SOCIO-ECONOMIC VULNERABILITY INDEX

Source: Deloitte analysis

It is interesting to note that the results for the vulnerability coefficient are completely different. Here, the urban subregions are ranked relatively low, undoubtedly as a result of better living conditions in cities and more advanced infrastructure, which reduces socio-economic vulnerability to the impact of disasters.

From the point of view of risk managers, places with both high risk exposure and high socio-economic vulnerability are particularly important.
In the event of a disaster, its costs in such places will be the highest, while damage liquidation and reconstruction may take longer, prolonging the negative consequences of the extreme event.
Silesia is a region with a relatively high concentration of residential buildings and socio-economic vulnerability.

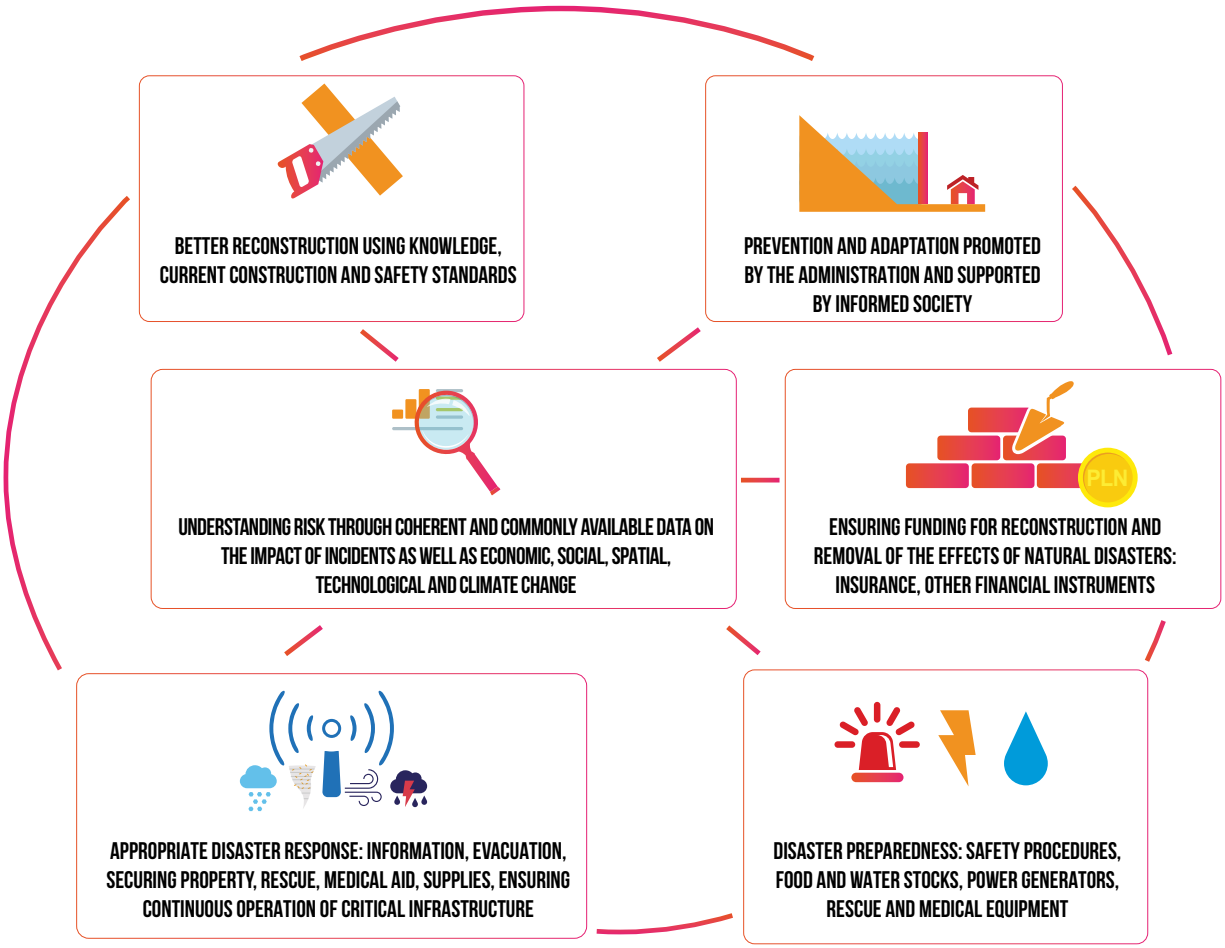
FIGURE 11. COLLECTIVE VULNERABILITY COEFFICIENT VS. THE NUMBER OF RESIDENTIAL BUILDINGS IN TOTAL IN SUBREGIONS



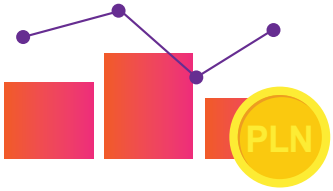
Source: Deloitte analysis

CHAPTER II
EXTREME EVENT RISK MANAGEMENT

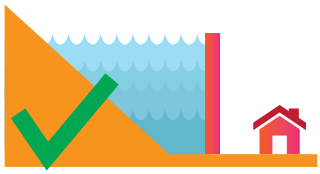
Systemic management of the risk of natural disasters is necessary in order to reduce losses (i.e. the number of fatalities, injuries and property damage) in spite of climate change and increasing social and economic exposure. It should be based on the simultaneous coordination of the areas presented in the figure below. For the measures to be effective, they must be taken on the basis of risk knowledge rather than erroneous information or ideas about it.



Insurance plays an important role in every stage of the risk management process.



Insurers accumulate extensive data resources concerning damage and payments, as well as subjects and objects of insurance. The result is an essential pool of knowledge that enables us to understand and identify risks and their financial impact.



Insurers award bonuses for customer actions which contribute to the reduction of risk or financial consequences. Companies or natural persons that are skilful at risk management can normally expect lower insurance premiums.

In the case of large-scale disasters, insurers have extensive experience in efficient claim settlement and providing financial aid to those in need. However, the effectiveness and duration of claim settlement depend on the cooperation with the public administration in charge of the functioning of the infrastructure (roads, telecommunication network, power grid, etc.).

Insurers support reconstruction after extreme events, ensuring cost-effectiveness and the inclusion of existing disaster risks in the reconstruction plans. In certain cases, the efficiency of the reconstruction process may depend on state intervention in selected markets (e.g. construction materials), aimed at increasing supply and reducing prices.

FIGURE. 12. TASKS OF INSURERS AND THE STATE IN THE RISK MANAGEMENT SYSTEM

TASKS OF INSURERS

- COLLECTION OF RISK DATA
- PREVENTION AND EDUCATION
- RISK ASSESSMENT
- CREATION OF INSURANCE PRODUCTS
- EFFECTIVE CLAIM SETTLEMENT

TASKS OF THE STATE

- PREVENTION AND EDUCATION
- CREATING AND SHARING MAPS OF NATURAL DISASTER THREATS
- ADEQUATE SPATIAL DEVELOPMENT POLICY
- ADAPTING CONSTRUCTION STANDARDS TO THREATS, STRENGTHENING THE ROLE OF CONSTRUCTION SUPERVISION

Source: Maciążek A., 2011[20]

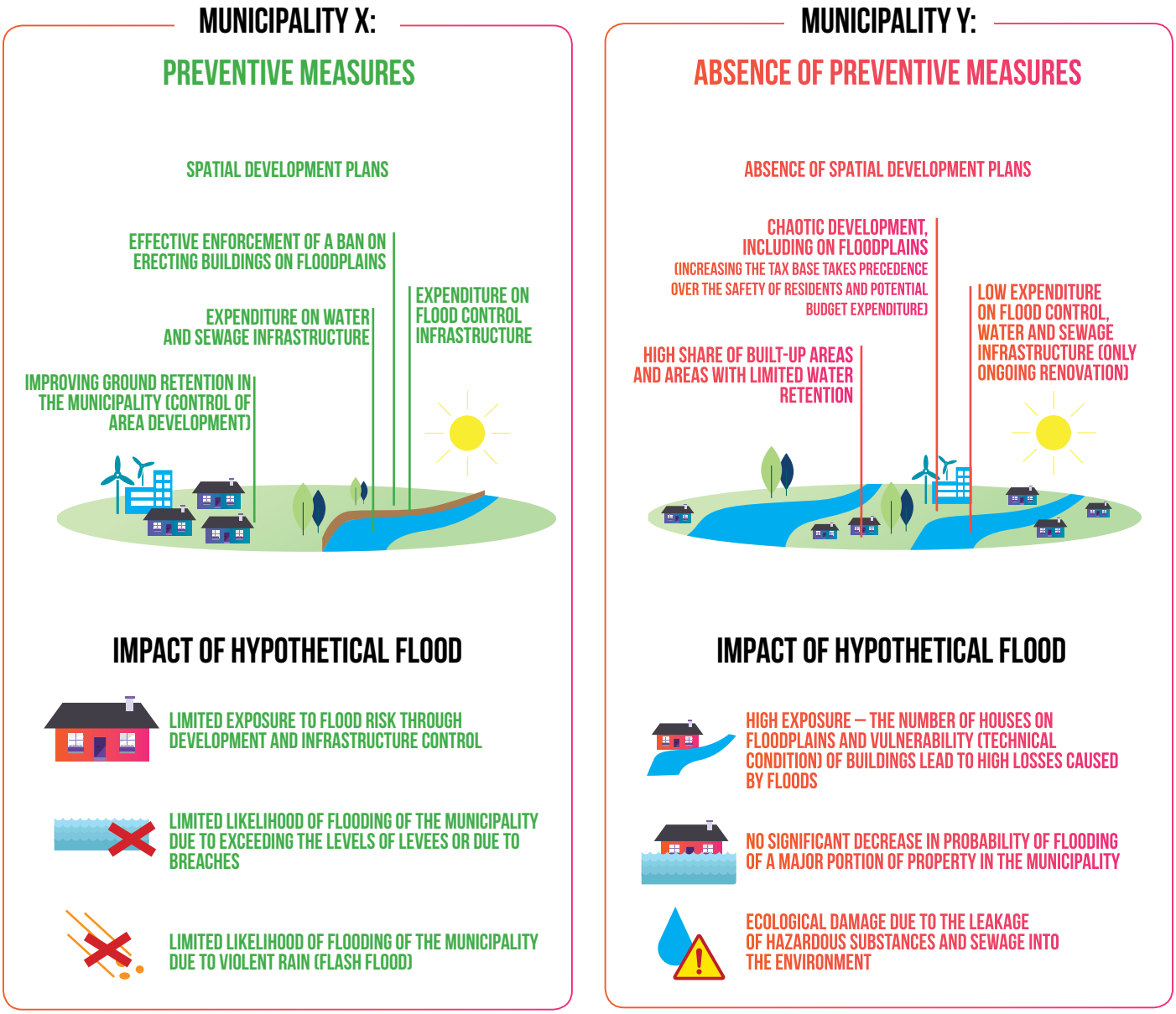
Prevention and insurance complement one another and fulfil different functions in risk management methodology. Investments in safety decrease the probability of damage or reduce its value. Therefore, insurance of a given risk is more economically efficient. In the case of insurance of highly probable risks with a significant value of damage caused, in order to ensure the security of their customers (who are also insured against other risks) insurance companies need to cover high exposure to potential losses with high equity. As a result, in certain cases, effective prevention is a necessary condition for a given risk to be insurable.

Highly probable events, which may involve potentially significant losses, can be insured thanks to cooperation between the insurance sector and the state, e.g. in the form of a public-private partnership. Such cooperation may involve:

prevention,
which translates into the reduced probability of an extreme event,

mitigation,
which reduces the impact of a negative event after its occurrence.

FIGURE 13. FLOOD RISK – THE IMPACT OF PREVENTIVE MEASURES



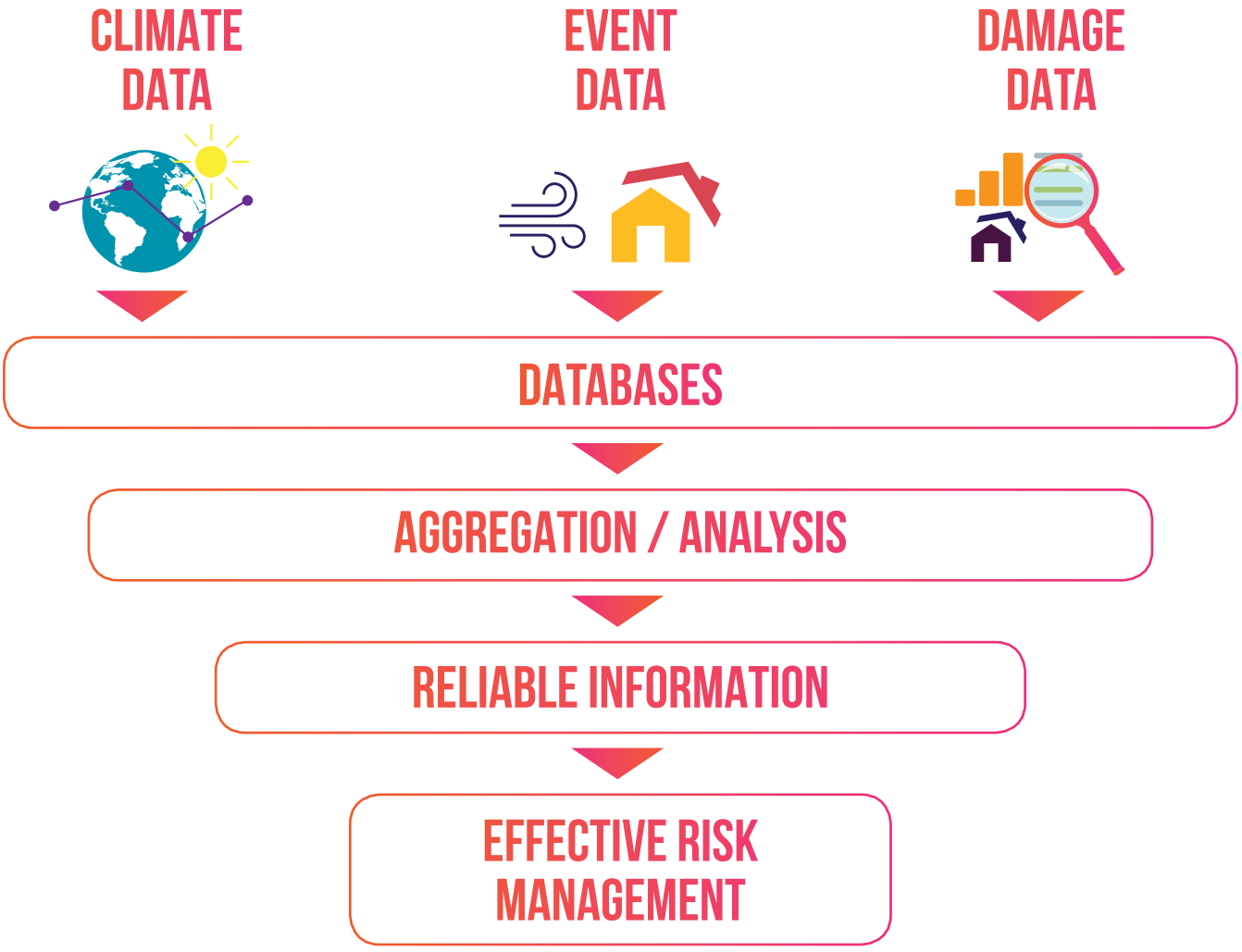
Source: Deloitte analysis

In response to growing costs and socio-economic vulnerability to natural disasters, UN member states concluded an international agreement in Sendai in 2015.
The document assigns the main role in disaster risk management to central administration while simultaneously assuming that responsibility should also be entrusted to other entities, including local self-governments or the private sector. The authority coordinating the implementation of the Framework for Disaster Risk Reduction 2015–2030 in Poland is the Government Security Centre.

Implementation of the Sendai Framework agreement is intended to improve safety from catastrophic events by achieving seven key objectives in line with the 2030 Agenda and Sustainable Development Goals (SDGs).

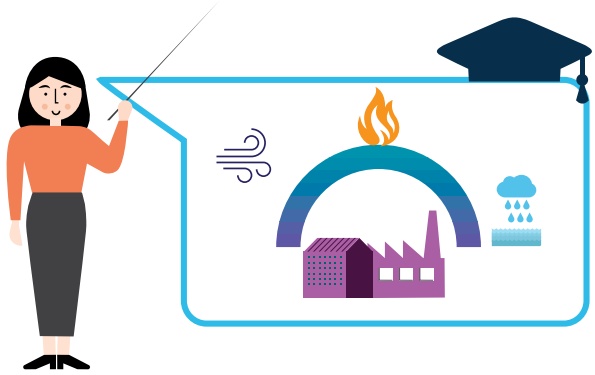
Key objectives of the Sendai Framework

- Reduce the average global mortality index
- Reduce the number of injured globally by 2030 compared to 2005-2015
- Reduce direct economic loss in relation to GDP



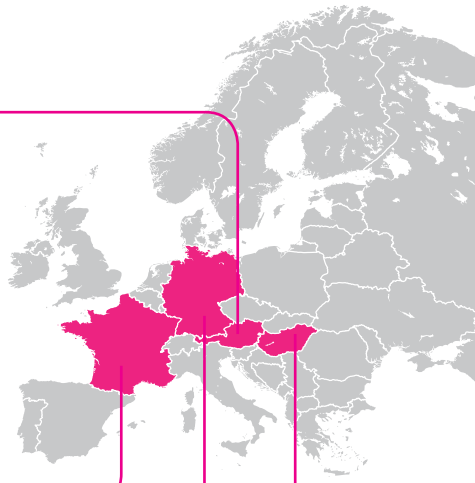
The Sendai Framework agreement focuses on two areas of activity: improved readiness to effectively respond in the event of a threat and inclusion of risk management measures in the rebuilding and reconstruction phases in order to reduce the risk of future events. The agreement places emphasis on maintaining business continuity as well as on introducing innovation in risk reduction.

The Sendai Framework agreement recommendations point to education and training as key issues for prevention and protection of the population. This includes disseminating knowledge among citizens and entities involved in natural disaster response as well as promoting regular preparatory measures for natural disasters.



The Sendai Framework agreement indicates that equipping competent individuals with adequate regulatory and financial means is also part of crisis management. The entities involved should be able to cooperate with civil society and communities, particularly at a local level. They should also have funds for promoting quality standards, such as certificates and awards for appropriate risk management.

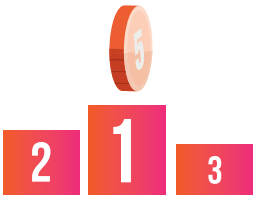
Examples of measures taken by individual countries or entities which adhere to the principles of appropriate risk management:



The Austrian HORA project was aimed at creating a flood model for all rivers and streams in Austria. The results contain detailed maps of flood risk for different annual probabilities, which are published on the project's website. Using these solutions, citizens can estimate the vulnerability of their buildings and premises to potential future flood hazards. Using proprietary Visdom software, the project combines rainwater drainage modelling, hydrodynamic simulation and geospatial analysis (GIS) methods.[21]

The inclusion of natural disaster insurance coverage is obligatory in **France** for all property insurance policies. The French Caisse Centrale de Réassurance (CCR), established in 1982, is a public-private partnership that provides reinsurance guaranteed by the government. The CCR programme was based on the national solidarity principle, leading to availability of disaster insurance for everyone with strictly defined premiums, valued proportionally, regardless of the risk.

Once every two years, the **Munich Re Foundation** presents the RISK award to the value of EUR 100,000 to projects dedicated to risk reduction and disaster management. In 2017, the award was granted to the Nursing Association of Nepal (NAN) for a project focused on increasing disaster readiness, which utilises information and communication technologies to support prevention and development control of infectious diseases.



In Hungary, an annual report by the 'National Directorate General for Disaster Management Ministry of the Interior' has been prepared for several years. The aim of this publication is to familiarise the readers with the organisation's work and activities by presenting statistics on events, the people involved and equipment used. The report describes catastrophic events which occurred in a given year and the measures taken as a result.

“We need to continuously develop social awareness of the risk of natural disasters through formal school education and informal, local education.
Knowledge-based awareness enables us to avoid threatened areas, understand the severity of warnings, make decisions that are appropriate for a given situation and respond accordingly. It also enables us to make the right decisions in terms of spatial planning, insurance and reconstruction.”

Dorota Rucińska, PhD
University of Warsaw
Faculty of Geography and Regional Studies

CHAPTER III
DISASTER RISK MANAGEMENT IN POLAND

Property in Poland, particularly owned by natural persons and local governments, is insufficiently insured. That is why central authorities are significantly burdened with claim settlement for natural disasters. Due to the insufficient percentage of insured property in Poland, particularly property owned by natural persons and local governments, central authorities have to assume a considerable amount of the burden of damage liquidation for natural disasters. Such an approach is less efficient than creating a system with more involvement from the insurance sector. However, it would require higher insurance awareness and an improved level of education in risk management.

60%

OF ALL PROPERTY ACCUMULATED BY BUSINESSES HAS INSURANCE COVERAGE[22]

60%

OF SINGLE-FAMILY RESIDENTIAL BUILDINGS ARE INSURED AGAINST FLOOD RISK

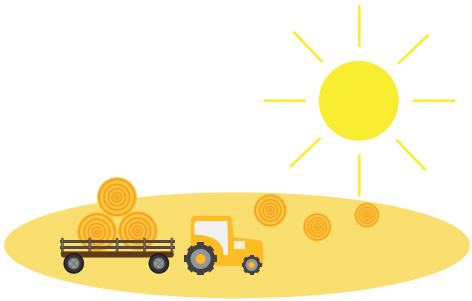
90%

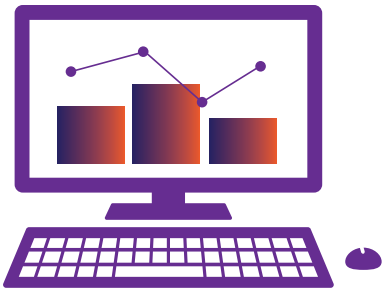
THE ESTIMATED PERCENTAGE OF INSURED RESIDENTIAL BUILDINGS IN AGRICULTURAL HOLDINGS. THIS IS DUE TO THE OBLIGATION TO TAKE UP THIS INSURANCE; HOWEVER, THIS OBLIGATION DOES NOT APPLY TO HOUSEHOLD MOVABLE PROPERTY

Polish projects (or projects in which Poland participates) in the field of natural disaster risk management:

The ADMS Project

The Institute of Soil Science and Plant Cultivation of the State Research Institute operates the Agricultural Drought Monitoring System for Poland (ADMS) on behalf of the Ministry of Agriculture and Rural Development. The aim of this service is to indicate areas at municipality level which may suffer potential losses caused by drought affecting crops.





The CPITS Project

The aim of the 'Extreme Hazards Country Protection IT System' is to create a system which improves the protection of the economy, environment and society against extreme hazards, in particular flooding. The main objective of this project is to be achieved by taking stock of available data resources, designing a systemic solution, developing databases and risk and hazard maps, developing and implementing an IT system and increasing social awareness of hazards and crisis situations.

RescEU

This is a new European system for combating natural disasters, which involves the establishment of a European-level force reserve for civil protection, using tools such as aircraft, specialised water pumps, municipal search and rescue centres, field hospitals and rescue teams. The reserve is intended to supplement national assets and is to be managed by the European Commission to support countries affected by disasters such as floods, forest fires, earthquakes and epidemics. This system was launched, for example, in the form of rescue activities by the State Fire Service during forest fires in Sweden, 2018.

44 MPA

The Ministry of the Environment has created an innovative project involving the development of plans for the adaptation to climate change in 44 Polish cities. The aim of the project is to assess the vulnerability to climate change and plan adaptive measures appropriate for the identified threats in cities of more than 100,000 inhabitants. In view of the large scale of this project (covering two years and approx. 30% of Poland's population), it is the only initiative of this kind in Europe, in which the Ministry supports local authorities and administration in coordinating activities aimed at adapting to the impact of climate change. Urban adaptation plans (UAPs) for climate change are developed in collaboration with the authorities, experts and inhabitants, resulting in innovative adaptive solutions.

RCB alert

This is a new system for notifying alerting the population in the event of a threat. It is only used when there is high probability of a threat to life or health in a given area. RCB alerts are created on the basis of information about potential threats received from ministries, services (e.g. the police, fire services, border guard), offices and central institutions (e.g. the Institute of Meteorology and Water Management, as well as provincial offices). They are sent via text messages generated by operators of all networks, based on information sent by the Government Security Centre, to individuals located in the area of the potential threat, limited by county. A pilot system was launched for the first time during the summer of 2018 and should become fully functional on 12 December.[23]

DESCRIPTION OF SELECTED WEATHER PHENOMENA AND THEIR IMPACT IN POLAND OVER RECENT YEARS

Storms in Kashubia in 2017. The storms resulted in National Forests suffering the most significant losses in their history. Approx. 45,000 hectares of forests were destroyed. Although wood obtained from the fallen trees was suitable for sale, the preliminary losses of the National Forests were estimated at PLN 1 billion.[24] Six people perished and more than 50 were injured. Wind damaged or ripped off roofs of nearly 4,000 buildings across the country. By the end of September 2017, insurers estimated compensation payments of PLN 400 million. The example of Kashubia shows the importance of efficient infrastructure for the effective operation of insurance. Most of the buildings and vehicles destroyed by the storm were insured. **However, due to the lack of access to the internet and mobile phones, as well as unpassable roads, the injured were unable to contact insurance companies and report damage during the first days following the disaster.**

THE LOSSES OF NATIONAL FORESTS WERE ESTIMATED AT PLN 1 BILLION

Frost and hail in 2017. The volume of harvest and profitability of agricultural produce depends largely on weather conditions.

In 2017, March was exceptionally warm, causing flowers to develop earlier than usual. Two cold spells in April and early May resulted in the mass destruction of flower buds, flowers and young fruit. Additionally, the quality of the fruit was lower than usual since some fruit-growers opted against spraying, having deemed it unprofitable due to the anticipated small harvest volume. Considerable losses were also caused by hail, which damaged apples in orchards. These apples were only suitable for industrial processing and could only be sold at prices below the price of fruit intended for direct consumption.

APPROX. 30% LOWER HARVEST VOLUME IN POLISH ORCHARDS WAS THE RESULT OF SPRING FROST IN 2017

PLN 45 MILLION WAS THE AMOUNT PAID BY INSURERS TO FARMERS IN 2017 DUE TO SPRING FROST. ONLY A SMALL PART OF THE AREA WAS INSURED

Orchard output in Poland is concentrated in several relatively small areas (Grojec, Nowy Sacz, Trzebnica). Adverse meteorological events, even in a small area, can cause damage to a considerable portion of all orchards. Due to exposure to weather risk, preventive measures are becoming a challenge. This example also demonstrates the important role played by science and innovative engineering solutions aimed at developing systems and devices to protect orchards against hail and frost.

Flood in 2010. In May and June 2010, floods occurred in Poland and other Central European countries. For Cracow itself, it was the largest-scale flood since 1813. The flood control actions lasted three weeks and the city's losses were estimated at **PLN 170 million**.[25]

APPROX. PLN 1.7 BILLION

WAS THE AMOUNT OF COMPENSATION PAID BY INSURANCE COMPANIES TO VICTIMS OF THE 2010 FLOOD IN POLAND[26]

"Discussions about cooperation for effective climate risk management and other issues are becoming more frequent in Poland. Insurers cover increasingly more risks associated with climate change, approaching this matter in a comprehensive manner. They are also collecting even more detailed data, which will enable more informed and effective risk management. Public institutions are also taking action in this area. There is a sense of legitimacy and progressive openness to the mutual exchange of data, information and knowledge, which should be seen as a testimony to a common endeavour aimed at ensuring the security of the state and its citizens regardless of the circumstances. What I mean is civil planning, carried out within the framework of a crisis management system, critical infrastructure protection standards, the developing theme of business continuity management, as well as scientific and teaching activities."

Senior Captain Paweł Gromek, Eng. PhD

Vice-Dean of the Faculty of Civil Safety Engineering
Main School of the Fire Service

CHAPTER IV
EFFECTS OF INCREASED EXPOSURE FOR POLAND – SIMULATIONS

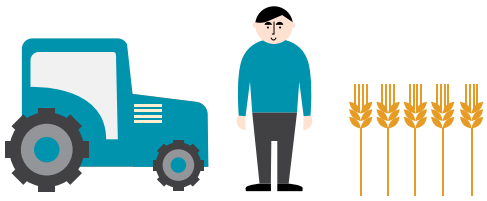
Natural disasters cause much more severe damage to the economy than the damage resulting exclusively from direct losses. Negative effects are "disseminated" through financial and commercial connections.

A complete estimation of the impact of cataclysms is very difficult since it would need to include the costs of business interruption, as well as the costs of lost opportunities (alternative costs). In practice, precise estimates of direct losses in the form of reduced output, sales volume or impairment loss on assets are frequently missing. The larger the disaster, the more complex its impact on the economy because apart from decreases in output, sales, etc., it causes changes in the behaviour of consumers and companies in the market. Prices can also change drastically.

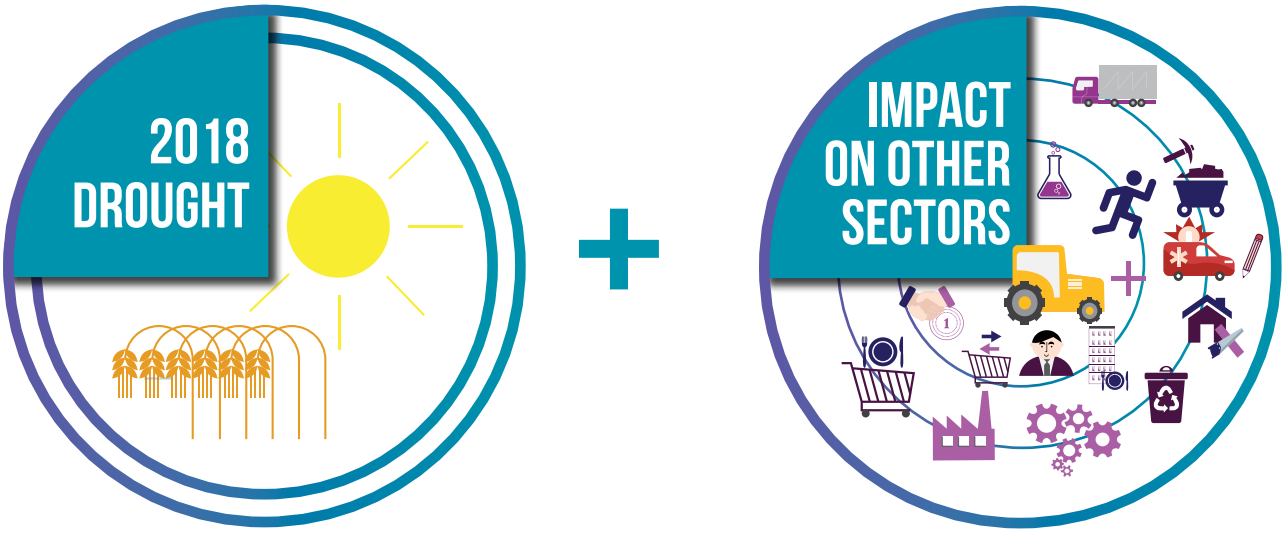
4.1. LOSSES IN THE POLISH ECONOMY DUE TO THE 2018 DROUGHT

Agriculture in Poland generates approximately PLN 43 billion in gross value added (data for 2017), making up approx. 2.2% of the country's GDP.

This sector is relatively vulnerable to external factors – weather conditions, climate change, as well as changes in the prices of agricultural raw materials in global markets. As a result, the volume and value of output in agriculture is highly variable, creating the need for a developed public-private partnership (between the state and the insurance sector) in order to minimise the negative impact of random events.



AGRICULTURE IN POLAND = 2.2% OF NATIONAL GDP



PLN 1.5 BILLION

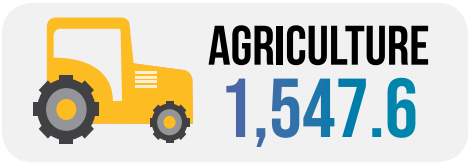
Lost gross value added in agriculture due to 2018 drought amounted to PLN 1.5 billion.[27]

+ PLN 1 BILLION

Total cost of the 2018 drought for the Polish economy is approx. PLN 1 billion higher and amounts to PLN 2.6 billion.[28] **This amounts to approx. 0.13% of GDP.**

This is primarily due to lost value added (the main component of GDP) in commerce, professional services, financial and insurance services, food processing, municipal services and the chemical industry.

FIGURE 14. ESTIMATED LOSSES DUE TO THE 2018 DROUGHT BY SECTOR AND SOURCE (PLN MILLION)

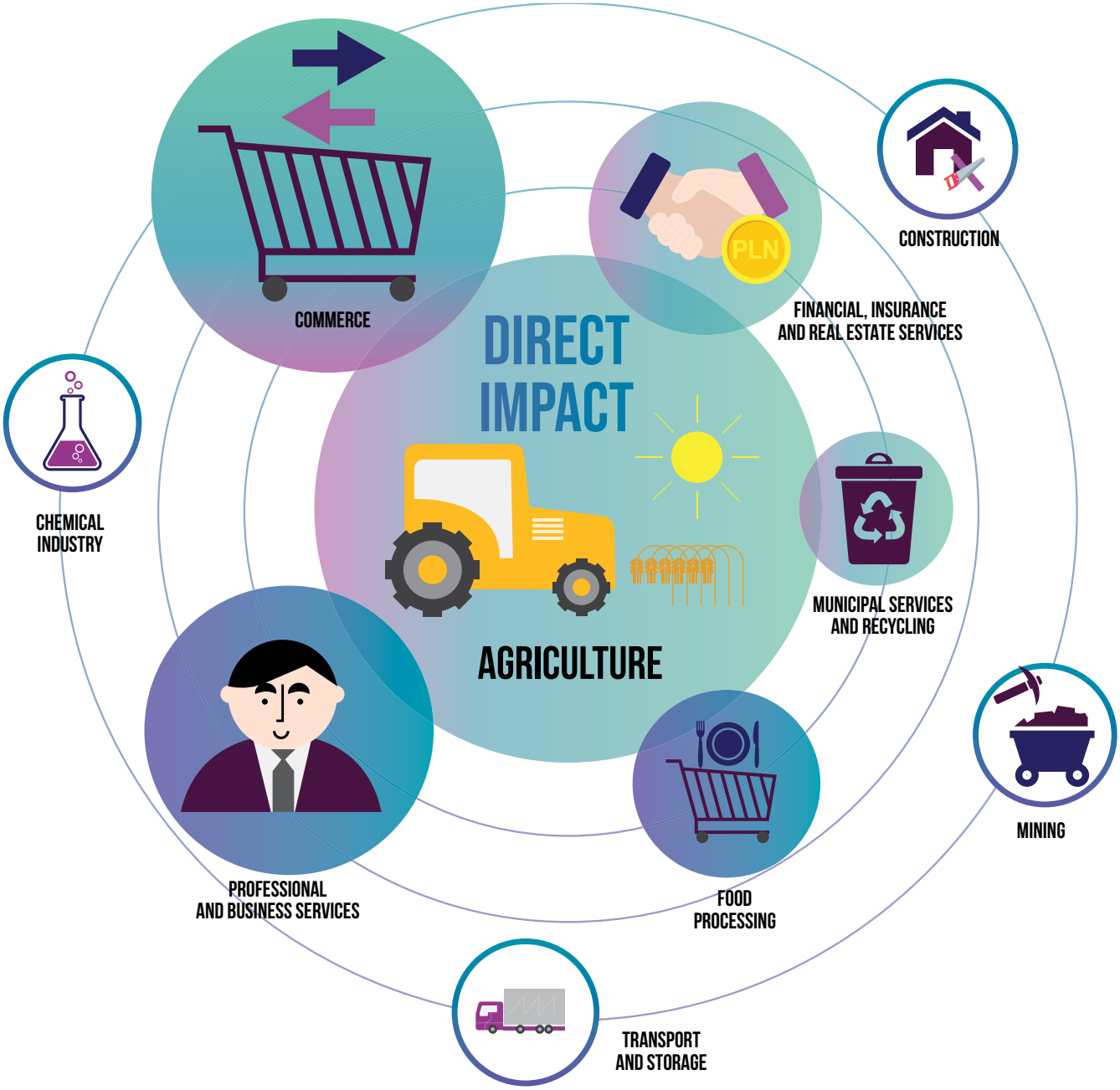


INDIRECT IMPACT DECREASE IN AGRICULTURAL DEMAND FOR GOODS AND SERVICES FROM OTHER SECTORS	INDUCED IMPACT DECREASE IN DEMAND OF HOUSEHOLDS WORKING IN AGRICULTURE AND SECTORS DIRECTLY AFFECTED BY DROUGHT	TOTAL SUM OF ALL EFFECTS
COMMERCE 214.9	COMMERCE 68.6	COMMERCE 283.5
PROFESSIONAL AND BUSINESS SERVICES 82.6	PROFESSIONAL AND BUSINESS SERVICES 47.1	PROFESSIONAL AND BUSINESS SERVICES 129.7
FINANCIAL, INSURANCE AND REAL ESTATE SERVICES 49.1	FINANCIAL, INSURANCE AND REAL ESTATE SERVICES 72.0	FINANCIAL, INSURANCE AND REAL ESTATE SERVICES 121.2
FOOD PROCESSING 95.3	FOOD PROCESSING 19.1	FOOD PROCESSING 114.4
MUNICIPAL SERVICES AND RECYCLING 53.4	MUNICIPAL SERVICES AND RECYCLING 24.9	MUNICIPAL SERVICES AND RECYCLING 78.3
CHEMICAL INDUSTRY 59.5	CHEMICAL INDUSTRY 9.9	CHEMICAL INDUSTRY 69.4
TRANSPORT AND STORAGE 49.8	TRANSPORT AND STORAGE 17.2	TRANSPORT AND STORAGE 67.0
CONSTRUCTION 19.7	CONSTRUCTION 19.2	CONSTRUCTION 38.9
MINING 23.2	MINING 6.6	MINING 29.8

Source: Deloitte analysis

It is extremely likely that the cost of drought for the economy as a whole is even greater than PLN 2.6 billion since it is not limited to losses in agriculture and related sectors, and employees. Insufficient precipitation has a negative impact on baseload and hydro power industry, aquatic tourism or forestry. Restriction of the available water resources may also translate into increased cost of water consumption and other water-related services (for certain classes of recipients), which constitutes a business risk for water-intensive branches of the economy.

IMPACT OF DROUGHT ON INDIVIDUAL SECTORS

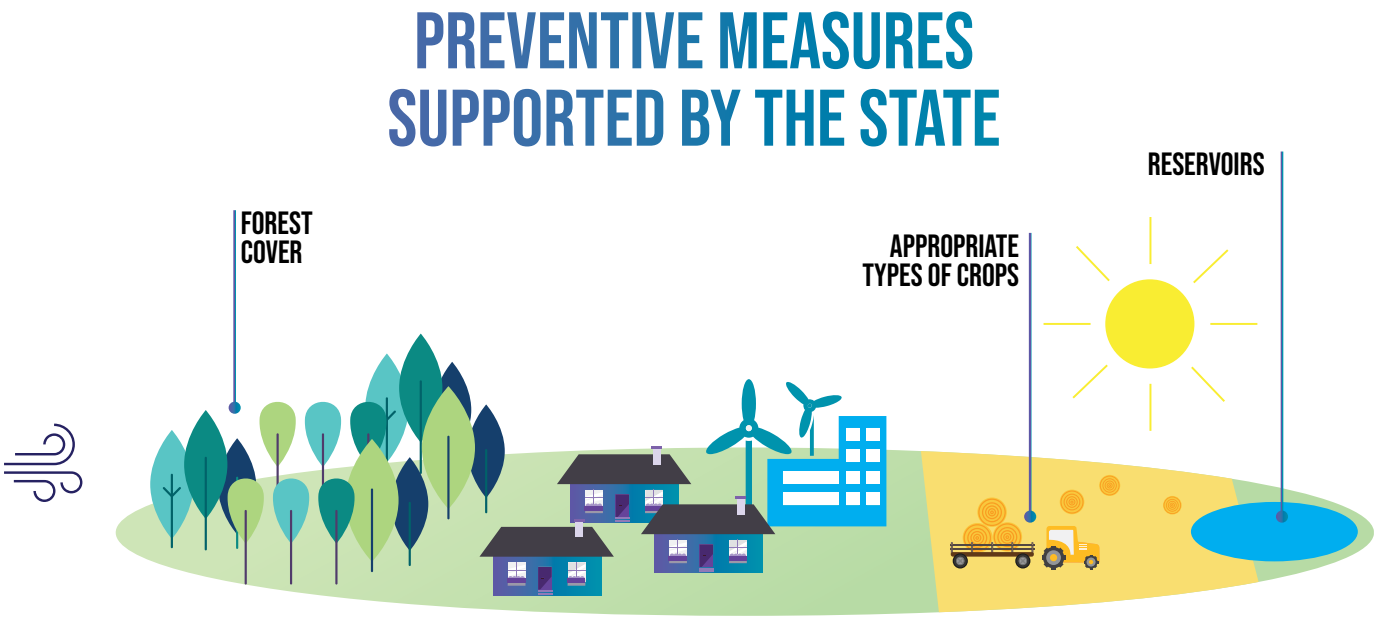


Summary

Delays in reporting and estimating losses and disbursement of aid by the state increase the probability of an adverse impact on the economy. **The agricultural drought will decrease Poland's GDP in 2018 by 0.13%, i.e. PLN 2.6 billion.** The fact that some of the losses are covered by financial aid from the state budget does not change the conclusions as the transfers cover the real economic loss and therefore cannot be used to satisfy other consumption and investment needs.

In order to reduce the negative impact of drought, preventive and educational measures initiated or supported by the state should be a priority.

Examples of such measures could be the appropriate structure and type of crops, ensuring adequate forest cover of areas threatened by drought and investments in water infrastructure (e.g. drainage ditches and small reservoirs, which will also improve fire protection during drought).



Insurance (weather derivatives) can play a material role in damage liquidation (weather derivatives), particularly for companies in the food and power industries. The market for weather derivatives is not developed in Poland,[29] however businesses can choose from among many types of insurance against lost profits (business interruption, BI), with coverage adapted to individual needs.

4.2. WHAT WOULD BE THE COST OF THE 2010 FLOOD TODAY?

Losses caused by floods will continue to increase in the future unless additional preventive measures are taken. Economic development and climate change are two main trends resulting in increasing exposure and the likelihood of a catastrophic flood.

1. Increased exposure as a result of economic development:

Increase in the value of property on floodplains (plots, buildings, etc.)

Investments on floodplains and migrations (new residential buildings, assets in companies, movable property, municipal property)

Increase in productivity of arable land and other agricultural areas

Protective structures (e.g. levees) can create a false sense of security and encourage the development of floodplains. As a result, in some countries, increased expenditure on flood protection causes increased expenditure on flood damage liquidation.[30]

2. Increased probability of floods caused by:

climate change in Poland, resulting in intensified and more frequent heavy rainfalls and storms during summer months, as well as increasingly frequent spring thaws and snowmelts.

land being used in a way which reduces its water retention (capacity to retain water), e.g. development of urban and suburban areas, expansion of transport infrastructure, deforestation, drainage of wetlands, etc.

The 2010 flood caused direct losses amounting to PLN 12.8 billion, i.e. approx. 1% of GDP. This is the estimated amount of destroyed private and public property as well as agricultural losses caused by flooding of arable land and pastures. Losses were recorded mainly in the Vistula basin (PLN 9.5 billion) and the most affected region was Lesser Poland (losses of nearly PLN 4 billion).[31] Approximately 270,000 instances of damage were reported to insurance companies.[32]

THE 2010 FLOOD

The three flood waves in 2010 resulted in 24,000 affected families in 14 provinces. Only Warminsko-Mazurskie and Zachodniopomorskie provinces did not suffer any losses. On the basis of available analyses of the flood range,[33] data from the Supreme Audit Office[34] and the Institute of Meteorology and Water Management[35] as well as coefficients for estimating the value of property based on the manner in which land is used, **losses caused by flooding of apartments and houses can be estimated at PLN 1.9 billion**. This amount covers not only the costs of renovation or reconstruction of property but also losses in movable property (vehicles, furniture, household appliances, electronic equipment, etc.).

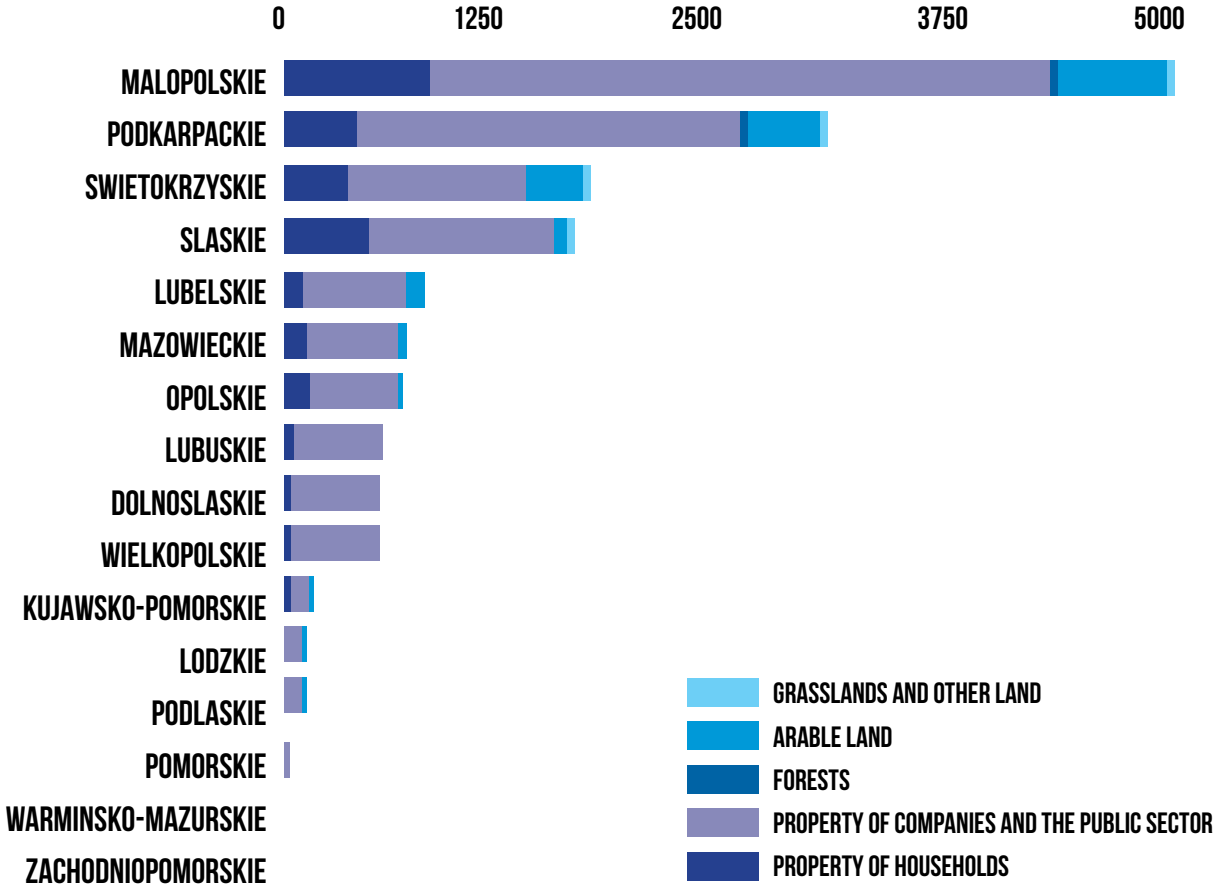
PLN 12.8 BILLION LOSSES = ANNUAL INCOME OF 230,000 PEOPLE (THE POPULATION OF GDYNIA OR CZESTOCHOWA)

If the same flood had taken place in 2018, it would have cost PLN 16.2 billion. That is PLN 3.4 billion (20.9%) more than in 2010. The estimated increase in costs is primarily due to the higher value of public and private property in the endangered areas, with contributing factors being investments of companies, local self-governments and the central budget (together with EU funds). This money was invested in farm buildings, plant and equipment, road and water infrastructure, municipal assets, etc.

THE 2018 FLOOD

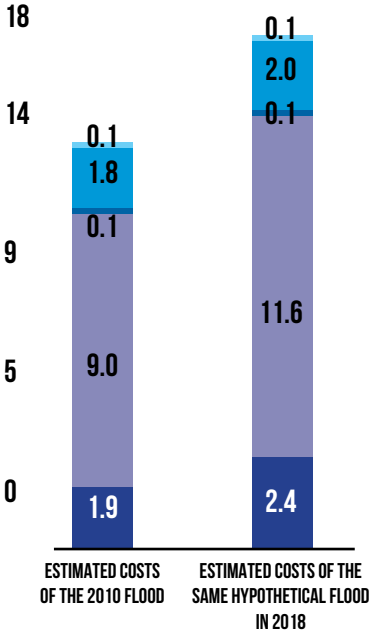
PLN 16.2 BILLION LOSSES = ANNUAL INCOME OF 300,000 POLES

FIGURE 15. SIMULATION RESULTS – CURRENT COST OF A FLOOD WITH 2010 PARAMETERS BY PROVINCE AND TYPES OF PROPERTY (PLN MILLION)



Source: Deloitte analysis

FIGURE 16. SIMULATION RESULTS – CURRENT COST OF A FLOOD WITH 2010 PARAMETERS AND COST OF 2018 FLOOD BY TYPE OF PROPERTY (PLN BILLION)

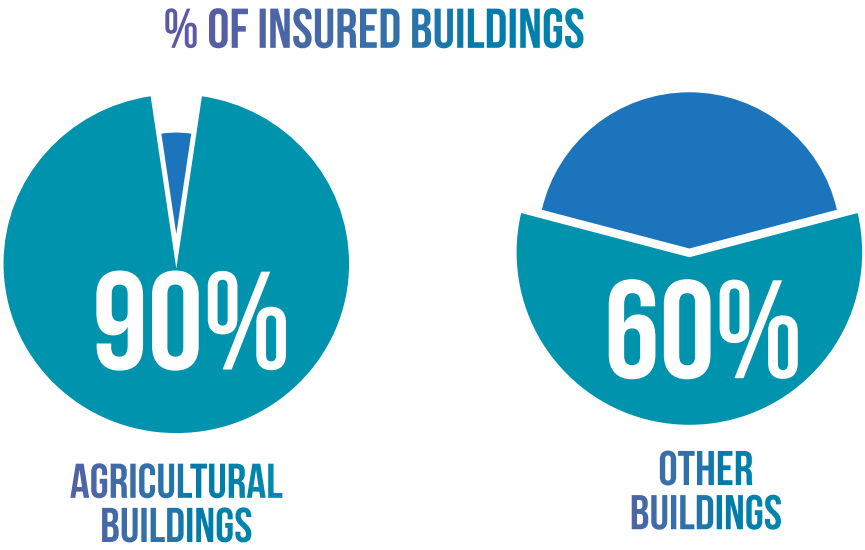


The south of Poland is under the biggest threat of flooding.

The estimated losses for Malopolska reach PLN 5 billion, PLN 3.2 billion for Podkarpackie and approx. PLN 2 billion for Swietokrzyskie province. This is a consequence of geographic conditions (the Carpathians with relatively high precipitation and the Sandomierz Basin, through which the Carpathian tributaries of the Vistula run) and increasing exposure (high population density, increasing industrialisation and relatively rapid economic growth). Additionally, the region is exposed to landslides (in particular the Beskids and the Carpathian Foothills).

Source: Deloitte analysis

In terms of forecast losses, an important problem is the so-called insurance gap, i.e. the percentage of uninsured entities (or their property). In 2010, insurance companies paid approx. PLN 1.6 billion to the injured, which constituted 12.5% of the value of losses. According to estimates of the Polish Insurance Association, 90% of agricultural buildings and 60% of other buildings are insured, with a higher percentage being attributable to property of companies rather than that of natural persons.[36]



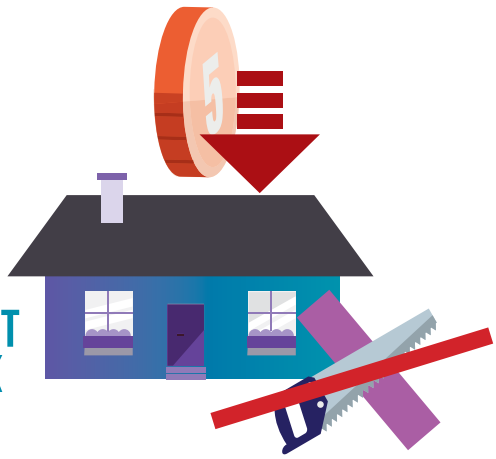
Summary

If the share of disbursements from insurance amounted to 12.5% of losses in 2018, losses amounting to as much as PLN 14.2 billion would have had to be covered by taxpayers or from private savings. This is based on the assumption that the injured parties would decide to rebuild. Such an amount of losses would be a shock to the economy, the state budget and local governments. First of all, it would reduce the size of or postpone planned investments and consumption.

The above amount of estimated direct losses should also be increased by indirect losses (costs) arising from interrupted business and lost profits (or increased costs). This type of risk can be insured with a standard policy against lost profits (business interruption) or one of its versions:[37]

- insurance against lost profits resulting from failure of machinery and equipment (machinery loss of profit);
- insurance against lost profits in connection with performance of construction and assembly works (advanced loss of profit);
- insurance against loss of rent.

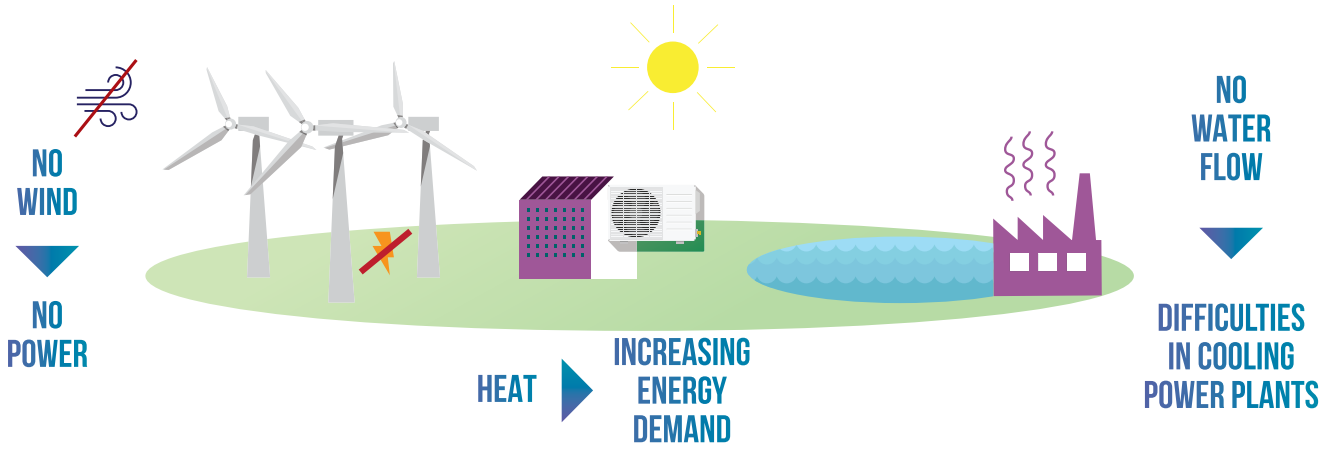
An absence of reconstruction would result in the value of property (assets) in the economy decreasing by PLN 14.2 billion, which amounts to four times the budget of Gdansk for 2018.[38] This would mean a decrease in the volume of potential output in the economy, both private (profitable) and public goods and services (e.g. destruction of school buildings would reduce the availability of education in selected areas).



PLN 14.2 BILLION = 4 X THE BUDGET OF GDANSK FOR 2018

4.3. EXPOSURE AND CRITICAL INFRASTRUCTURE IN POLAND. HOW MUCH DOES THE FIRST HOUR OF BLACKOUT COST?

Why should the risk of blackout in Poland not be neglected?
Summers in Poland are becoming increasingly hot and dry, reminiscent of a Mediterranean climate. Hot weather increases energy demand (e.g. due to air conditioning), and in windless weather, wind farms do not generate electricity. Additionally, long periods of heat waves translate into difficulties in cooling power plants due to the insufficient flow of water in rivers. High temperatures also increase losses in energy transmission. At the same time, the frequency and intensity of extreme events (storms, violent winds) which threaten the transmission infrastructure are increasing.



The economy is developing dynamically and in spite of improved energy efficiency, the energy demand is growing, which is becoming a challenge for the energy sector:

development of the processing industry – many businesses operate with a minimum level of stock or cannot stop manufacturing processes without enormous costs or risk, e.g. of polluting the natural environment;

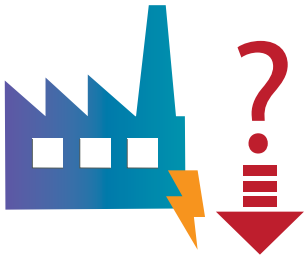
increase in consumer income and, as a consequence, purchasing power (e.g. with regard to devices powered by electricity);

high demand for energy in summertime also results from seasonality in the economy (it is the peak of the construction and renovation season), while good weather favours the construction industry;

companies cannot easily change working hours, partly due to provisions of the Labour Code (e.g. minimum rest time for employees, moving to night-time work involves additional costs);

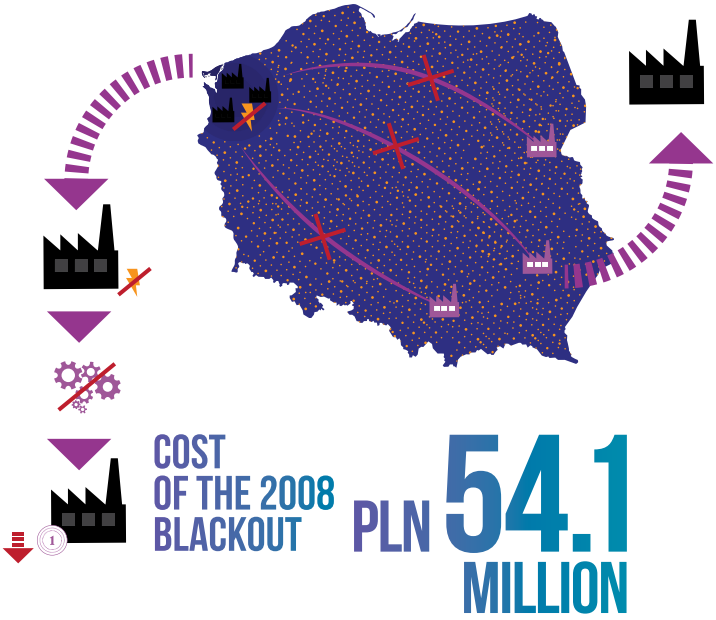
the need to renovate old units in power plants, while the construction of new ones is time-consuming and costly.

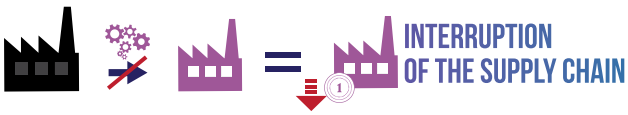
Poland lacks sufficient social awareness and risk management procedures. This increases both the risk of failure and losses following a blackout.



Many companies do not know in practice how they should act and how much they should reduce electricity consumption in order to do it efficiently and safely.

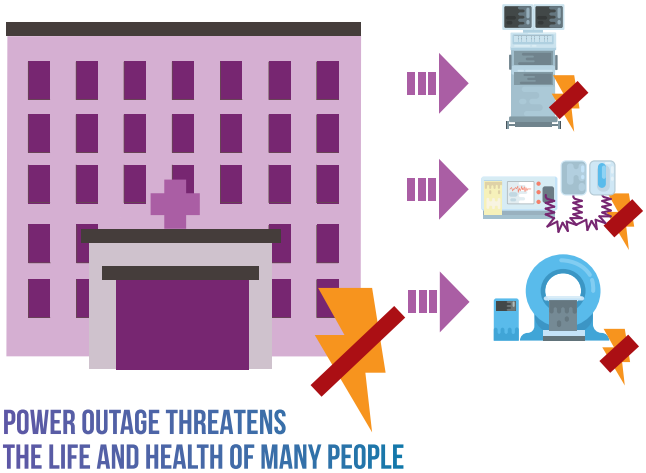
Responses of households to warnings and calls for restrictions in energy consumption are also insufficient.





A large-scale blackout took place in 2008 in Szczecin and nearby counties. The failure happened on 8 April due to wet snowfall, which damaged high and low voltage lines. As a result, the entire city and nearby municipalities were plunged into darkness. **The estimated final cost of this failure was PLN 54.1 million.** It comprised costs incurred by companies, local governments, as well as the costs of rescue actions. Costs incurred by inhabitants and agriculture were not taken into account.[39]

On 10 August 2015, Poland came close to blackout, i.e. uncontrolled interruption to the electricity supply to a considerable area of the country. Losses for the economy would have been vast, in particular due to the threat to life and health of many people. They would also have resulted in economic costs – destroyed machinery and equipment, lost income or additional costs associated with work reorganisation.



Companies were instructed to limit energy consumption under the pain of penalty amounting to up to 15% of revenues should they fail to comply. It is estimated that in spite of this, up to 1,200 companies may have failed to reduce energy consumption. On one hand, such an attitude on the part of businesses increased the risk of the so-called blackout; on the other hand, it enabled them to reduce economic losses associated e.g. stopping manufacturing processes. As a result, data presenting the production volume in industry and construction, as well as the general mood in businesses in August 2015 do not reflect the negative impact of these events.

If a blackout lasting only one hour had taken place in Poland on 10 August 2015, its costs would have amounted to nearly PLN 500 million.

More than half of these costs would have been attributable to the processing industry and 1/10 of that amount would have been lost by farmers. The results of this simulation are based on the assumption that the failure would have started at 10 a.m., when there is high demand for electricity (most employees are already at the workplace and many people who are not working start up electrical appliances at home).

10 AUGUST 2015

1 HOUR = PLN 500 MILLION

PROCESSING INDUSTRY 50% OF BLACKOUT COSTS

AGRICULTURE 10% BLACKOUT COSTS

FIGURE 17. ESTIMATED COST OF THE FIRST HOUR OF HYPOTHETICAL BLACKOUT IN POLAND BY INDUSTRY

OUTAGE ON 10 AUGUST 2015 STARTS AT 10 A.M. AND LASTS 1 HOUR

PROCESSING INDUSTRY
PLN 284 MILLION

AGRICULTURE
PLN 52 MILLION

SERVICES RELATING TO THE REAL ESTATE MARKET AND OTHER SERVICES
PLN 44 MILLION

HOUSEHOLDS
PLN 37 MILLION

WHOLESALE AND RETAIL
PLN 29 MILLION

MINING AND POWER INDUSTRY
PLN 29 MILLION

CONSTRUCTION
PLN 19 MILLION

SERVICES RELATING TO INFORMATION AND COMMUNICATION
PLN 7 MILLION

Source: A study by Deloitte on the basis of Blackout Simulator 2.0

12 DECEMBER 2018

If extreme weather events and additional random factors (such as massive cyber attacks) had caused a blackout in Poland on 12 December 2018 (the release of this report), the cost of 8 hours of outage would have amounted to PLN 2.6 billion. This amount is comparable to the estimated costs of drought in Poland in 2018. Losses of approx. PLN 1.2 billion would have been attributable to the processing industry and households would have lost PLN 551 million.

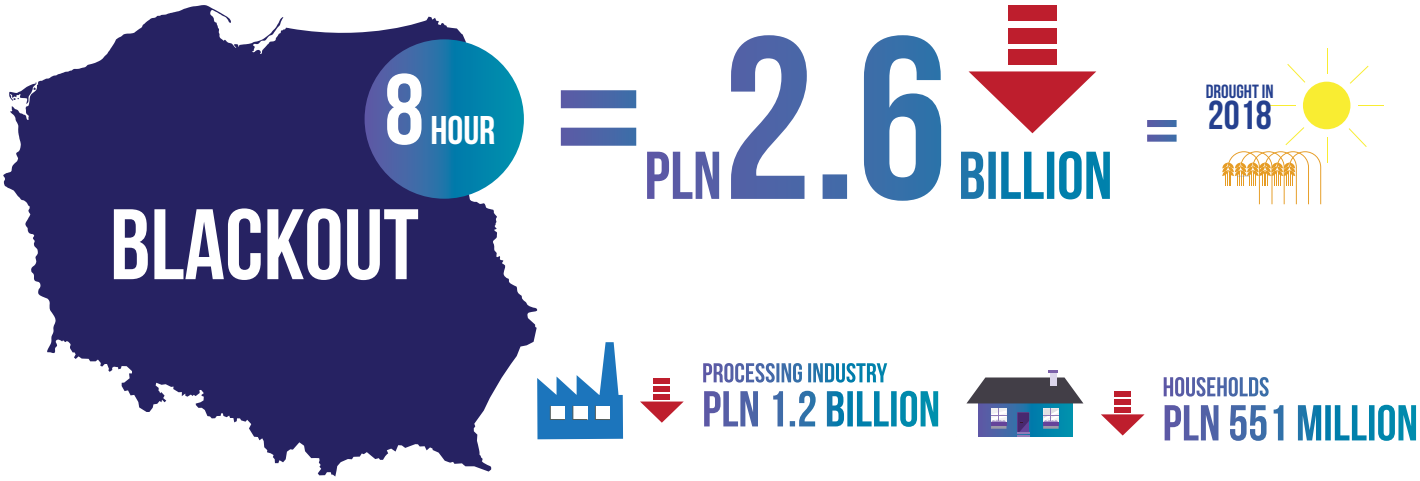


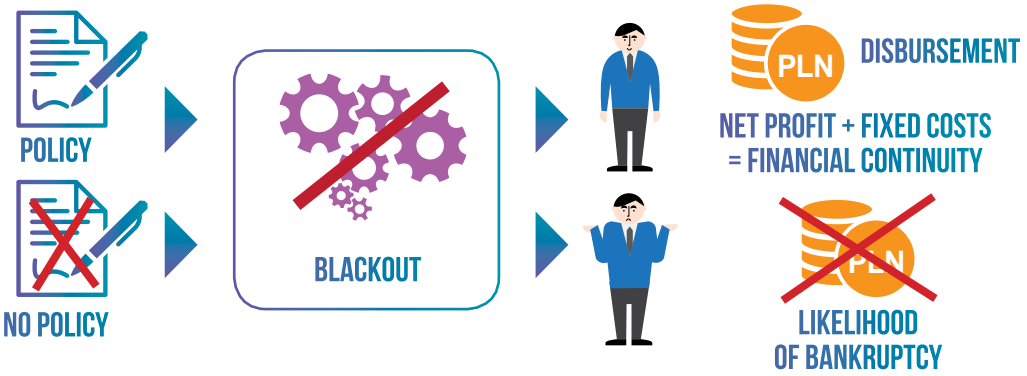
FIGURE 18. ESTIMATED COST OF A HYPOTHETICAL BLACKOUT BY PROVINCE AND KEY INDUSTRIES (PLN MILLION)

12 DECEMBER 2018 STARTS AT 9 A.M. AND LASTS 8 HOURS

ESTIMATED COST OF A HYPOTHETICAL BLACKOUT BY PROVINCE AND KEY INDUSTRIES (PLN MILLION)	AGRICULTURE	MINING AND POWER	PROCESSING	CONSTRUCTION	WHOLESALE AND RETAIL TRADE	SERVICES RELATING TO INFORMATION AND COMMUNICATION	SERVICES RELATING TO THE REAL ESTATE MARKET AND OTHER SERVICES	HOUSEHOLDS	TOTAL
DOLNOSLASKIE	9.2	4.3	103.0	10.1	15.5	3.0	27.4	43.7	216.2
KUJAWSKO--POMORSKIE	15.2	1.4	70.9	6.3	10.2	1.1	11.6	31.4	148.1
LUBELSKIE	16.3	1.8	46.0	4.9	8.5	1.1	7.6	32.5	118.7
LUBUSKIE	5.1	0.9	38.4	2.7	4.6	0.6	5.5	15.3	73.1
LODZKIE	21.6	2.3	99.3	7.2	12.9	2.1	19.5	37.9	202.8
MALOPOLSKIE	11.9	2.9	88.9	11.5	18.1	4.1	22.5	50.1	207.0
MAZOWIECKIE	47.1	3.5	136.3	20.6	46.6	18.3	70.0	79.2	421.6
OPOLSKIE	6.2	0.8	32.8	2.9	4.0	0.5	5.5	15.2	67.9
PODKARPACKIE	6.9	1.5	68.8	4.5	8.5	1.0	8.7	31.9	131.8
PODLASKIE	13.6	0.6	28.5	2.8	4.6	0.6	4.7	18.0	73.4
POMORSKIE	8.2	1.4	76.2	7.5	11.8	2.5	15.5	34.2	157.3
SLASKIE	8.1	15.6	164.8	15.7	23.8	4.5	36.1	69.3	337.9
SWIETOKRZYSKIE	8.8	1.0	35.7	4.1	5.8	0.5	5.0	19.1	80.0
WARMINSKO-MAZURSKIE	11.4	1.0	43.3	3.8	5.4	0.6	6.0	21.8	93.3
WIELKOPOLSKIE	29.9	2.4	145.7	12.1	21.7	3.6	23.6	51.8	290.8
TOTAL	219.5	41.4	1,178.6	116.7	202.0	41.1	266.2	551.4	2,616.9 | 2,198.3

Source: A study by Deloitte on the basis of Blackout Simulator 2.0

An interruption in power supply would have caused direct losses in property for only some companies, where production must take place on a continuous basis (e.g. in metallurgy). **Losses would have comprised predominantly lost profits, as well as exceptional costs, unrelated to the property of a given company** (e.g. the need to reorganise working time, implement ad hoc solutions etc.) **or losses resulting from the interruption of the supply chain**.

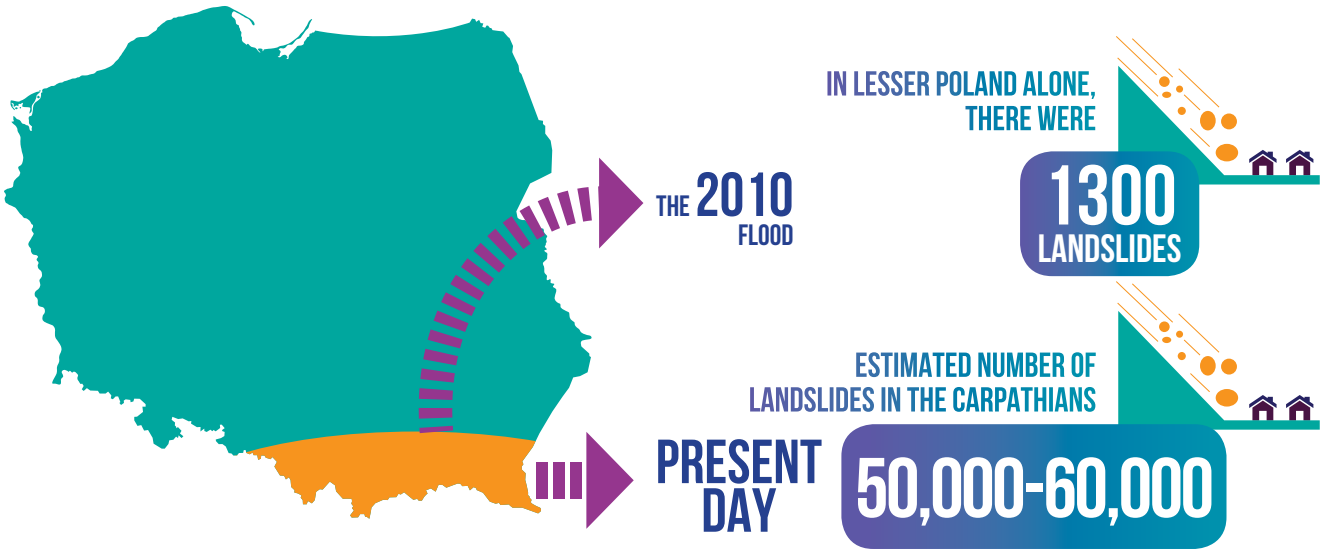


These risks can be insured using a policy against lost profits (business interruption) and its coverage may include damage caused by interruptions in the supply of utilities.[40] The benefit of having this insurance is securing financial resources for the coverage of fixed costs and recovery of lost potential net profit (the insurance amount is typically potential net profit plus fixed costs).[41]

4.4. EXPOSURE AND COSTS OF LANDSLIDES IN THE CARPATHIANS

Landslides are sudden mass movements of soil, typically occurring in areas with interchangeable layers of permeable and impermeable rocks. They can be caused by natural phenomena, e.g. intense precipitation, flood or drought, but also by reckless human activity. Landslides are very dangerous to property (residential and farm buildings), as well as infrastructure (roads, railways, the water and sewage systems or the power grid). In the latter case, landslides can cause further indirect economic losses.

A total of 95% of landslides and areas in danger of landslides identified in Poland are located in the Outer Carpathians (Foothills, Beskids and Bieszczady). The 2010 flood demonstrated the scale of this problem. Approximately 1,300 landslides occurred at the time in Malopolskie alone. It is currently estimated that the number of landslides in the Carpathians can range from **50,000 to 60,000**.[42]



SIMULATION

During the 2010 flood, landslides in one of the counties in Małopolskie province caused the following damage:

If landslides had occurred in 2018 in the same area as in 2010, the cost of losses would have amounted to PLN 32 million. That is PLN 6.1 million (approx. 24%) more – as much as 1/3 of the annual budget of Myslenice county.[43]

The estimated increase in costs results primarily from:

increased exposure

increase in the value of private and public property in the form of real estate

increase in prices of construction services and materials, which determine the costs of reconstruction

It should be noted that with landslides, one of the possible security measures is not to build on threatened areas (securing landslides typically involves significant costs). It is especially important for all construction works in endangered areas to be preceded by geological and engineering tests which will determine explicitly whether a given area is suitable for development. Built-up areas where landslides occur should be subjected to detailed inspection in terms of drainage and performance of embankments and excavations. In order to limit subsequent landslides, spatial development plans should include the cessation of excessive deforestation.

To recapitulate:

The state

The threat of landslides requires primarily state measures for the prevention and better identification of this risk.

The insurance sector

Provides property coverage and thus reduces the costs of required social assistance and reconstruction aid on the part of the state budget and local self-governments.

In Poland, information about landslide threats is collected by the **SOPO Project** (Landslide Protection System).

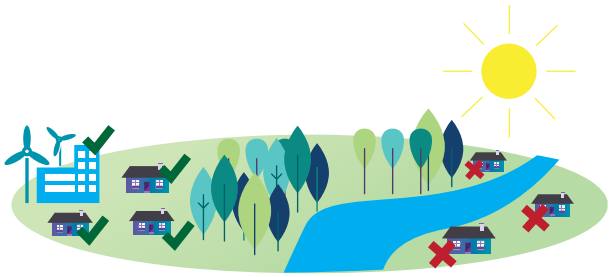
“On top of the increased risk associated with the impact of extreme weather conditions, there is the risk associated with the drainage of rainwater to open or closed sewage systems without taking into account rainwater retention systems at the place where they occur. This can create a danger of local flooding, urban floods, surges and intensified erosion in receiving bodies of water. It would therefore be good to raise social awareness and communicate the effects but also encourage landowners to retain water. Since the Water Act of 20 July 2017 entered into force, the definition of sewage has changed. Previously, rainwater from paved and contaminated areas (a significant portion of city areas) was defined as sewage, which allowed for the calculation of a tariff for its drainage to the rainwater sewage systems, pursuant to the Act on collective water supply and sewage removal. In the policy currently in operation, rainwater falls outside the sewage category, making it impossible to impose a tariff on its removal to the rainwater sewage system, creating a barrier to self-funding of rainwater sewage systems in Polish cities. However, even the most efficient rainwater sewage systems with built-in retention and common use of retention by inhabitants will not prevent flooding and overflowing of the rainwater sewage system in the event of extreme situations. In particular, in such extreme situations, it is reasonable to introduce an insurance system which would enable the coverage of losses resulting from flooding.
An interesting approach could be the division of liability between the supplier of rainwater drainage services (local self-government unit, city or a utility company acting on its behalf) and the insurer, so that the service provider would be liable for losses up to a certain magnitude of rain, while above this magnitude, when construction of an efficient rainwater sewage system is no longer cost-efficient, the insurer would be the liable party.”

Piotr Czarnocki
Ministry of the Environment
Head of the Sustainable Development and International Cooperation Department

CHAPTER V
RECOMMENDATIONS

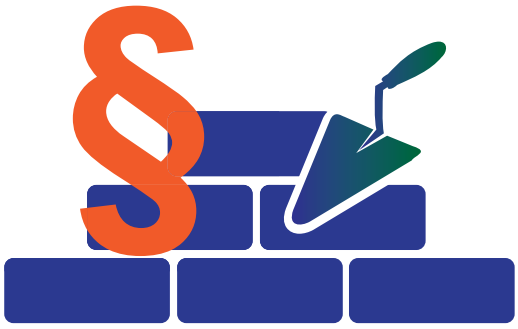
Poland will be vulnerable to the negative effects of climate change and risk exposure with increasing frequency. The simulations presented in this report prove that as a result of economic development, weather phenomena will cause increasingly substantial losses even if their magnitude remains the same.

The only effective weapon against these events is a coherent disaster risk management strategy, taking into account the role of central administration, local governments and the private sector. Such a strategy must be developed on the basis of the following assumptions:



Preventing further increase of exposure, i.e. increase in the number of inhabitants and value of property exposed to cataclysms, in particular on floodplains and areas threatened by landslides. The state must limit temporary ex post measures and place more emphasis on developing long-term solutions, effective in terms of costs and benefits, in cooperation with the insurance sector.

Local risk management plans should be created in cooperation with inhabitants, the business sector and NGOs, according to the recommendations of the Sendai Framework. More involvement on the part of stakeholders will support the transition from the reconstruction policy, which is currently dominant in Poland, to a prevention and reconstruction policy using technologies that reduce the effects of risk.



The legislator should analyse current provisions and other social and economic factors which affect the quality and reach of applicable spatial development plans. It should ensure appropriate funding of such activities. An analysis should also be carried out as to whether these factors impact the tendency to take preventive and adaptive measures at local government level. Additionally, the applicable construction law (the so-called special act on infrastructural investments), as well as effectiveness of construction supervision need to be analysed.

There needs to be an increase in expenditure on informational and educational activities which improve social awareness both in the area of threats related to natural disasters as well as possible measures for risk reduction. The current role of schools should be analysed, along with the role of employers in connection with H&S requirements.

There is a need to develop a systematic, uniform approach to statistical data collection, enabling the measurement of exposure, vulnerability and sensitivity to natural events in social, economic and structural terms. This type of data (at least at municipality level) can be collected and regularly made available by the Central Statistical Office as part of the existing Local Data Bank. As a result of the measurement infrastructure currently available in Poland and limited density of its distribution, certain events may remain undetected. A lack of local information from recording equipment for wind velocity measurements may prevent the appropriate assessment of damage by insurance companies.

State authorities should obligatorily publish cyclical and special reports containing an estimation of losses caused by natural disasters, together with a precise specification of the geographic area. For larger disasters, the report must specify the precise course of events on the basis of reports of services, the injured and other entities (e.g. entities recording a given event). Estimates of property losses and costs of interruption of continuity of state institutions and private entities should be performed using a uniform methodology, published in a regulation by the Prime Minister or the Minister in charge. Such a change will facilitate the improved planning of preventive measures and the reduction of future losses in the event of the recurrence of a given event. Such data can serve as a tool for local administrative units as an element of financial diversification of risk reducing strategies at a central level.

More integration of activities is required, as well as an improved flow of information between government institutions, private entities and the scientific environment. The current (silos) approach limits the ability to effectively reduce risk and remove the effects of cataclysms. In order to reduce losses caused by natural disasters in a long-term perspective, we need a more precise definition of the responsibilities of individual entities at every stage of the risk management process, according to the recommendations of the Sendai Framework.

One urgent and important task is to **develop a risk management plan at a national level**, which will contain not only a diagnosis of disaster risk, but will also define current administrative and organisational capabilities, as well as available technical and financial resources. As part of the National Risk Management Plan, priorities in the area of risk management should be selected and key tasks and indicators of objective achievement should be specified. The current operating plans are not strategic in nature and quickly become obsolete.

"Comprehensive risk management is more than its limitation according to plan and simultaneous readiness to respond in the event of a threat. It also entails a society that is adequately prepared to take measures to protect it from the potential threat. The Government Security Centre has just commenced actions aimed at the comprehensive preparation of the population for such events. These preparations comprise the RCB ALERT warning system, the accompanying educational programme for children, as well as a number of guides published online. It is assumed that a warning message will only be sent if there are at least 6 hours left until the anticipated threat occurs. Preparing the message and sending it to several million recipients requires approx. 4 hours. The remaining time is for the interested parties themselves, who should know how to protect themselves, their families and limit property losses. Even if they have not participated in educational projects before, easily available, short and understandable guides should point them to behaviour which is appropriate in a given situation."

Witold Skomra
Advisor at the Government Security Centre

Methodological annex

Property

The value of human capital is estimated as the sum of predicted earnings for individuals aged 15-64 (throughout the period of their professional activity).[44] As a result, the volume of human capital depends on the opportunities created by the economy for the society, as well as decisions concerning education and work. The rapid increase of the value of human capital after 1995 resulted primarily from the high dynamics of average salary and an increase in the number of people with tertiary education. The average gross monthly remuneration in 1995 in Poland amounted to merely PLN 702.62 (nominally), whereas in 2014, it already stood at PLN 3,783.46.[45] During this period, pursuit of tertiary education also became common – 43.5% of Polish citizens aged 25-34 graduated from university, compared to only 15.1% for people aged 55-64.[46]

Human capital is one of the key factors of development, which is why **reducing the number of fatalities and people with permanent injuries resulting from extreme events is so important**.

Drought

Simulation methodology

We used the Input-Output model based on the table of inter-sectoral flows for 2010, developed by the Central Statistical Office (it is the latest available table; the next one should be published in 2019). The input impulse for the model was adopted on the basis of estimates by the Ministry of Agriculture and Rural Development as at the end of September 2018. According to these estimates, direct losses caused by 2018 drought amounted to PLN 3.6 billion. This is the value of lost agricultural output, resulting from lower harvest volume throughout the country. However, this amount cannot be directly compared to GDP since GDP is the sum of value added in all sectors, increased by net tax on goods and services (primarily VAT and excise duty).

For the purpose of the simulation, it was assumed that the ratio of gross value added to the value of global output in agriculture was 43% (according to the last available table of inter-sectoral flows of the Central Statistical Office from 2010).

Multipliers resulting from industry demand for goods and services of other industries were calculated (purchasing multipliers, so-called backward multipliers or backward linkages). The indirect and induced impact was calculated.

Flooding

The following steps provided an estimation of the cost of a hypothetical flood in 2018, broken down by provinces and types of property, while recreating the characteristics of the 2010 flood as faithfully as possible. Above all, the impact of increased exposure on potential losses was demonstrated.

Simulation methodology

- We used coefficients specifying the value (in PLN/m^2) of property located in the areas according to different types of economic exploitation, pursuant to the 2012 regulation setting rates for provinces.[47]

- We performed a forecast of coefficient values (PLN/m^2) from the regulation for main types of area use: residential housing, industrial development, forests, arable land and grasslands. The forecast was performed for the years 2013-2018.
- The values of the coefficients were forecast at the level of provinces, based on variables and economic and structural parameters:
  - values of gross fixed assets in the business sector;
  - investments in fixed assets in the private sector;
  - average depreciation rate for fixed assets;
  - prices of construction and assembly output;
  - volume of wood obtained from 100 ha of forest;
  - gross remuneration in the national economy;
  - value of global output in agriculture;
  - increase in costs associated with dwellings (part of the inflation basket);
  - area of land used for residential, industrial and other purposes.

- The above variables allowed us to forecast the numerator (PLN) or the denominator (m^2) of the coefficients used for loss valuation.

- It was assumed that the 2018 flood would cover the same areas as in 2010, with water depth amounting to 0.5-2 m. According to the regulation, for this depth, the adopted coefficient for losses in residential property was 35%, and in property of businesses, it was 40%.

- It was assumed that the direct costs of the 2010 flood amounted to PLN 12.8 billion. The distribution of costs among provinces was estimated on the basis of the Supreme Audit Office report and the Institute of Meteorology and Water Management reports.[48]

- Based on the analysis of the Institute of Geodesy and Cartography using satellite photographs, we adopted assumptions concerning the share (%) of individual types of areas (industrial, agricultural, residential, etc.).[49]

- The source of the remaining data was the Local Data Bank of the Central Statistical Office.

Blackout

Simulation methodology

In the analysis, we used Blackout Simulator 2.0, a tool available at www.blackout-simulator.com, which was co-funded by the European Commission. The model provides an estimation of costs at the level of NUTS 2 regions in the EU, broken down by selected industries according to NACE classification. The model estimates the costs of a blackout on the basis of economic and structural data for a given region, the date, starting time and duration of the outage.

Landslides

We used data from the inventory of losses in the affected county. Next, on the basis of costs of reconstruction and renovation of infrastructure in 2010, destruction losses were estimated. In order to calculate losses resulting from the same event in 2010, we used coefficients of exposure growth in this area, resulting from changes in prices of real estate as well as construction materials and services since 2010.

Simulation methodology

We used data from the inventory of losses in the affected county. Next, on the basis of costs of reconstruction and renovation of infrastructure in 2010, destruction losses were estimated. In order to calculate losses resulting from the same event in 2010, we used coefficients of exposure growth in this area, resulting from changes in prices of real estate as well as construction materials and services since 2010.

Exposure and socio-economic vulnerability in Poland – spatial diversity

Analysis methodology

1. A **Social vulnerability index** was constructed using the following variables from the local database of the Central Statistical Office:
    - individuals unemployed for more than a year as a percentage of the professionally active population;
    - total remuneration;
    - nurses per 10,000 inhabitants;
    - population of a non-productive age per 100 people of a productive age;
    - gross enrolment coefficient – primary schools;
    - ratio of crimes determined by the police in completed preparatory proceedings to subregion population.

2. Rationale for variable selection

- The percentage of long-term unemployed individuals may indicate problems with structural unemployment of the subregion and, as a result, worse economic standing of a part of the population. The picture of wealth of the region is supplemented by average remuneration.
- Population of a non-productive age (children, youth and pensioners) is also important to estimate the region's vulnerability. Not only due to economic burden (being supported by the rest of the population), but also due to the need of special assistance and care in the event of a natural disaster.
- Moreover, the analysis additionally used the enrolment coefficient (a highly educated society translates into improved welfare), the number of crimes as well as the number of nurses per 10,000 inhabitants, which ensures better medical aid in a given county.
- It should be noted that the 'total remuneration', 'number of nurses per 10,000 inhabitants' and the 'enrolment coefficient' variables were reversed in the analysis, so that higher values mean a lower coefficient.

3. In the end, the following variables were used to construct the **exposure index**:
    - number of inhabitants of the subregion;
    - population density per 1 km^2;
    - total residential buildings;

- gross value of fixed assets in companies;
- area of illegal landfills;
- motor vehicles and tractors.

4. The foregoing variables were standardised to fit within the <0.1> interval. Furthermore, the number of nurses, remuneration and enrolment coefficient were reversed (the higher the value, the closer the coefficient is to 0). Next, the variables were added while retaining identical weights so as to create the exposure and vulnerability index, which was later standardised again.

FIGURES AND SOURCES

Figures:

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