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Abstract

Purpose – The purpose of this paper is to present problems related to the assessment of losses and expenditures caused by weather and climate-related events in Poland.

Design/methodology/approach – The data were collected by the direct questionnaire method from selected national and regional/local administration units.

Findings – The direct losses in 2001-2011 were estimated at more than PLN56 billion. The greatest losses were estimated in agriculture and infrastructure. The total amount of losses were estimated at PLN90 billion. In 2001-2011, more than PLN45 billion was spent in Poland on recovery and prevention of the impacts of extreme events, with a large part of it consisting of damages and benefits paid out by insurance companies.

Research limitations/implications – Given the limitations related to the method for collecting information, the results may be underestimated. It is well-advised to consider information on such a type of uncertainty in the course of the future research.

Practical implications – The results are of large importance for the building of public awareness and the making of political and investment-related decisions.

Originality/value – The estimates given in the paper are the first presentation of losses and expenditures caused by all the extreme events in the Polish territory which has been prepared on the basis of so many official information sources. The determination of "bottlenecks" related to the existing method for collecting information is a first step toward its improvement.

Keywords Disasters, Extreme events, Recovery, Climate, Losses, Expenditures

Paper type Research paper

1. Introduction

The aim of the paper is to present problems related to the assessment of losses and expenditures related to disasters ensuing from weather and climate conditions. This analysis covers three aspects: an assessment of losses caused by weather and climate-related extreme events in Poland in 2001-2011, an estimation of expenditures on recovery and prevention of their impacts, and an assessment of the manner of collecting information on the losses and expenditures in Poland in terms of their reliability and completeness. Estimates of this type were carried out for the first time in Poland.

Given the fact that the last two decades saw a substantial growth of damage caused by disasters associated to natural hazards, it becomes urgent to take measures to mitigate the risk of their impacts (European Environment Agency, 2010). The effectiveness of these measures primarily depends on reliable information enabling an assessment of the impact exerted by extreme events on the economy. It is only on this basis that the directions and scope of the adaptation of the economy to climate change can be determined.

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From this point of view, the key information includes, on the one hand, the valuation of losses caused by weather and climate-related events and, on the other, the determination of where they may occur. On this basis, it is possible to define the areas for which adaptation measures need to be taken to help reduce the risk and to mitigate the consequences of the impacts (United Nation Framework Convention on Climate Change, 2009). The benefits of adaptation measures outweigh the economic costs of not acting (Stern, 2007). In turn, the information on the necessary expenditures on recovery and prevention of extreme events can suggest the real possibilities of their being financed with private and public resources.

In this context, important issue is the organization of a consistent system for registering damage, its economic valuation and recording the expenditures. Unfortunately, such an integrated system has not been established in Poland yet. This provides a rationale for attempting to make an initial assessment of the losses and expenditures related to weather and climate-related events.

2. The key aspects of loss analysis

Altered frequencies and intensities of extreme weather are expected to have mostly adverse effects on human systems (Intergovernmental Panel on Climate Change, 2007). The negative consequences of disasters caused by natural hazard arise in the form of damage, losses and macroeconomic effects (Economic Commission for Latin America and the Caribbean, 2003; Torrente, 2012).

Damage arise as a result of a direct impact of extreme events (e.g. loss of property). Losses represent damage in monetary form (direct losses). Losses can also be of an indirect nature (indirect losses) when its effects reveal themselves with a delay and cover a much greater area that the one directly affected by the event (a drop in production and the loss of profit as a result of damage to the telecommunications infrastructure, decreased demand) (Sowiński, 2008). Macroeconomic effects are the changes caused by disasters to the expected performance of the national or regional economy (Torrente, 2012).

Both damage and losses can be valuated through the costs of the recovery of a damaged site or as the value of the site prior to the damage. A more correct approach is the latter option, since the reconstruction cost may be different, depending on the technology used, the demand level or the financial capacity of those affected (Kousky, 2012). The aggregation of damage and losses enables the assessment of the impact of a disaster on the economy (Torrente, 2012).

According to Intergovernmental Panel on Climate Change (2012) changes in many weather and climate-related extreme events have been observed since about 1950. In 1980-2012, the consequences of disasters related to weather and climate (storms, floods, heat waves, droughts and forest fires) considered in this study caused more than 60 percent of fatalities and 87 percent of losses (Munich Re, 2013). The mean annual number of disasters of this type in the recent three decades has grown by almost a half, while the number of geophysical events (earthquakes, tsunami, volcanic activity) has increased slightly (European Environment Agency *et al.*, 2008; European Academies Science Advisory Council, 2013). Weather and climate-related extreme events which have occurred in the world over the last three decades have caused damage exceeding USD2,800 billion (Munich Re, 2013). A significant increase in the level of losses can be found in the North America, Asia, Australia and Oceania. In the case of Europe, their level has grown by about 60 percent compared with 1980 (European Academies Science Advisory Council, 2013).

In addition to the losses which they cause, disasters can also have a positive effect on the economy, ecosystem or technology of the affected country. According to Skidmore and Toya (2002), disasters caused by weather and climate-related extreme events lead to faster economic growth. The disasters do not only have an adverse impact on natural resources, either, e.g. a flood in floodplains leaves sediments behind which contribute to higher yields by fertilizing the soil (Abbot, 2004). Moreover, countries affected by the disasters have an opportunity for rebuilding their infrastructure, enhancing the demand for new technologies. However, a positive effect of disasters depends on the ability of a given region to recover from the disaster and on the type of disaster (Popp, 2006).

3. Financing of recovery tasks

The recovery from the impacts of weather and climate-related events exceeds the financial capacity of the victims and requires an extended system for financing the recovery tasks. The resources of insurers and those from the state budget play an important role in the building of this system (Siwiec, 2012).

The growing intensity of weather and climate-related events and expenditures on recovery and prevention of these events does not convince the Poles to become more interested in insurance. For several years the number of policies has remained at a similar level, while the share of insurers in the coverage of losses does not exceed 12-13 percent. In the UK, this share is 75 percent, while it is about 50 percent in the USA or Australia (Zwoliński, 2013). Moreover, the fact that land use plans have not been adopted for almost 70 percent of the national territory (Degórski and Degórska, 2011) is conducive to the development of floodplains. In case that an extreme event occurs those affected rely on assistance from government institutions and nongovernmental organizations. If, as a result of the growing risk in some areas, the insurance becomes too expensive or unavailable, the state authorities will be exposed not only to high costs but also to the related recovery expenditures (European Commission, 2013). In addition to the resources of insurance companies, non-returnable resources from the state budget also play an important role. Nevertheless, the government expenditures committed to the recovery from the impacts of weather and climate-related events do not fully cover the damage. Table I presents a list of losses estimated for technical infrastructure against the expenditures from the state budget for the related recovery in Poland.

The analysis of data also indicated that in Poland the resources from state budget covered part of losses only. In 2001-2010, the share of budget resources in the coverage of losses in infrastructure caused by extreme events was 58 percent on average. Despite a certain level of uncertainty, the estimates of losses and expenditures are an important element of the process of assisting the victims and minimizing the risk generated by the occurrence of disasters related to weather and climate. It would be well-advised for governments to respond to the growing value of losses by taking a larger number of preventive measures (de la Fuente, 2010).

4. Methods

4.1 Methods applied to estimate losses

Most of the methods used to estimate losses are applied in a "continuous" manner, i.e. a loss is valuated directly after it has occurred as a result of an event caused by an extreme phenomenon. This is a common feature which distinguishes these methods[1].

Table I.
Losses in technical infrastructure and resources from the target reserve allocated for the related recovery

Year	Losses (million PLN)	Target reserve found of state budget (million PLN)	As % of losses
2001	1,243	616	50
2002	168	517	308
2003	60	638	1,065
2004	383	556	145
2005	260	429	165
2006	493	213	43
2007	254	170	67
2008	461	188	41
2009	1,236	157	13
2010	4,395	1,684	38
Total	8,953	5,170	58

Note: In constant prices of capital goods in 2010
Sources: Own elaboration based on Sadowski *et al.* (2012) and Grosset *et al.* (2012)

They require the use of substantially detailed data. The best known of these methods include:

- the damage and loss assessment (DaLA) methodology; and
- the post-disaster needs assessment and recovery framework (PDNA/RF).

The first of them, i.e. the DaLA methodology, enables the valuation of losses for the whole economy; thus, it is distinguished by its macroeconomic approach. It is used to assess the impacts of specific events on such macroeconomic variables as the growth rate, the fiscal situation of an area affected by an extreme event or the poverty levels (Jovel, 2010).

In turn, the other method, i.e. the PDNA/RF, combines the macroeconomic loss assessment used in the DaLA methodology and the identification of social needs related to recovery based on information from the public. This social component is called the human recovery needs assessment and uses the analysis of basic data from households and sets of indicators reflecting the needs for recovery. The estimates made on this basis are used to elaborate the so-called recovery framework designed to define short-, medium- and long-term needs which will emerge in the course of recovery from the impacts of extreme events (Jones, 2010).

Given the relatively long timeframe covered by the study (2001-2011) and the lack of detailed data, the choice of the method for the paper was mainly based on the availability and accessibility of information.

4.2 The questionnaire method for loss estimation in Poland

Most analyses of damage caused by the impacts of extreme events use estimates contained in databases. As indicated by the Bureau for Crisis Prevention and Recovery (2013), there are 62 such databases in the world, including five databases with global coverage and 50 country-level databases. Each of these databases collects data using different methods, criteria and assumptions; therefore, these data are often incomplete and incomparable. In some of them, such as EM-DAT, there is also information on losses and extreme phenomena in Poland; however, this database only covers events which affected more than 100 persons, in the course of which more than ten fatalities were reported, international assistance was requested or a state of

emergency was declared (Asian Disaster Reduction Center, 2012). For this reason, it was decided that an alternative method for loss estimation would be chosen, i.e. the questionnaire method.

Reliable loss estimation in Poland requires an integrated system for collecting information on both the types of extreme events and their impacts. Unfortunately, there is no such a publicly accessible and countrywide database in place; therefore, in the present study the necessary data were collected by the direct questionnaire method from selected national and regional/local administration units, and, subsequently, the collected source data were aggregated at the national scale.

The data collection process began in 2011 and lasted for more than six months. The collected data were verified and aggregated at the national level and the results were consulted with experts from the Institute for Structural Research. On the basis of experiences gained in the course of both their collection and the analysis of literature and documents, an attempt was made to assess the system in place in Poland for collecting the information on losses caused by the impacts of extreme events.

The loss and expenditure analysis was based on a questionnaire prepared by the author, which contained the following items: the year when losses occurred, the type of an extreme event, the level of losses registered and/or expenditures on recovery and prevention of the impacts of the events and the description of losses The questionnaire was sent to 87 major national and regional/local government units which take part in the loss estimation process or finance the recovery and prevention of disasters. Almost a quarter of the institutions asked to provide their data did not participate in the survey, justifying their refusal by the lack of any data. More than three-quarters of the institutions responded positively and sent back their filled in questionnaires. Filling in the questionnaire posed a certain challenge for the institutions because much information was lacking; therefore, the materials provided were not full. If an extreme event fails to cause extensive damage, the abovementioned institutions do not prepare summary compilations covering all the losses which they have estimated. Data are aggregated and analyzed only when an extreme event occurs causing a serious impact at the national level, such as the flood in 2010. This makes it difficult to monitor the effect of climate change on the economy and to assess the risk of disasters related to weather and climate. Table II provides detailed information on the data acquired. The submitted materials only cover direct losses (damage to the infrastructure, lost crops).

5. Results

The results obtained (Figure 1) are the first so detailed estimates, which have been aggregated at the national level, of losses caused by weather and climate-related events and expenditures on recovery and prevention of the impacts of these events in 2001-2011[2].

The direct losses in 2001-2011 were estimated at more than PLN56 billion. Because of the limited availability of data on indirect losses, attempts are made to measure indirect losses using statistical models (National Research Council, 1999) or as part of direct losses (Winter *et al.*, 2010). In general, it is assumed that their conservative value is represented by direct losses within the range of 50-80 percent of the total losses caused by extreme events. This value grows for earthquakes or tsunami. According to the Global Assessment Report on Disaster Risk Reduction, indirect losses represent 50 percent of direct losses (Serje, 2013), while Polish sources suggest 60 percent (Symonowicz, 1967; Winter *et al.*, 2010). Assuming that indirect losses represent about

Table II.
A description of selected data on losses and expenditures acquired from questionnaire surveys

Source data	Kind of extreme event	Kind of losses/expenditures	Availability to the public use	Spatial resolution
The Ministry of Internal Affairs	Not specified	Losses: damage to infrastructure of local government units	Available	National
The Ministry of Agriculture and Rural Development	Hurricane, flood, heavy rain, hail, lightning, landslide, drought, winter survival, spring freeze	Losses: damage to agriculture	Not available	Local
16 Marshal's Offices	Flood	Losses: damage to flood protection infrastructure	Not available	Local
The National Water Management Authority	Flood	Losses: damage to flood protection infrastructure	Not available	National and local
The Ministry of Finance	Not specified	Losses: damage to infrastructure of facilities administered by Ministry	Not available	Local
The Ministry of Culture and National Heritage	Not specified	Losses: damage to infrastructure of historic facilities	Not available	Local
The General Directorate of State Forests	Drought, hurricane, flood, landslides, heavy snow	Losses: damage to forest stand	Not available	Local
The Ministry of Transport, Construction and Maritime Economy	Flood	Losses: damage to road and railway	Not available	National
Maciejewski *et al.*, 2011	Flood	Losses: damage to infrastructure	Available	Regional
Chojnacki, 2003	Flood	Losses: nationwide estimate of direct losses	Available	Regional
The inter-ministerial team set up to estimate flood impacts, 2010	Flood	Losses: nationwide estimate of direct losses incl. damage to insured property	Not available	Regional
The Polish Financial Supervision Authority	Fire, storm, hail, frost and other	Expenditures: resources of insurance companies	Available	National
The Agency for Restructuring and Modernization of Agriculture	Hurricane, flood, heavy rain, hail, lightning, landslide, drought, winter survival, spring freeze	Expenditures: disaster-related credits	Not available	Regional
		Expenditures: European Union resources	Not available	Local

(*continued*)

Source data	Kind of extreme event	Kind of losses/expenditures	Availability to the public use	Spatial resolution
The National Fund for Environmental Protection and Water Management	Flood, heavy rain, tornadoes, landslide, other	Expenditures: budgets of found, own resources of affected parties, Norway Grants	Not available	Local
16 provincial funds for environmental protection and water management	Heavy rain, hurricane, flood, other	Expenditures: budgets of founds, own resources of affected parties , others	Not available	Local
The National Water Management Authority	Flood	Expenditures: budget of the National Water Management Authority, own resources of affected parties, others	Not available	Local
The Ministry of Finance	Flood, heavy rain, hurricane	Expenditures: resources from ministerial budgets and subordinated institutions	Not available	Local
The Ministry of Transport, Construction and Maritime Economy	Flood	Expenditures: resources from ministerial budgets and subordinated institutions	Not available	Regional
The Ministry of Culture and National Heritage	Flood, heavy rain, hurricane	Expenditures: resources from ministerial budgets and subordinated institutions , own resources of affected parties	Not available	Local
The Ministry of Regional Development	Flood	Expenditures: European Union resources, own resources of affected parties	Not available	Local
The Ministry of Health	Flood	Expenditures: resources from ministerial budgets	Not available	Local
Grosset *et al.* (2012)	Not specified	Expenditures: resources from the target national budget reserve	Not available	Regional

Source: Own elaboration base on collected questionnaires (2014)

Table II.

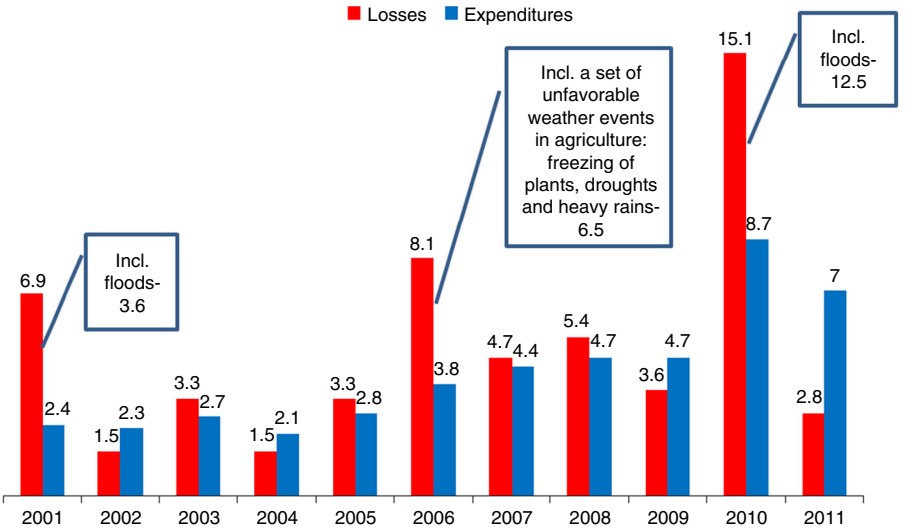


Figure 1.
Estimates of losses caused by weather and climate-related events and expenditures on recovery and prevention of these events in Poland in 2001-2011 in billion PLN

Note: In constant prices of capital goods in 2010

Source: Own elaboration (2012)

60 percent of direct losses[3], it can be calculated that the total losses caused by extreme events which occurred in Poland in 2001-2011 amounted to about PLN90 billion.

In the period from 2004 (when Poland joined the European Union) to the end of 2011 alone, the damage caused by climate-related extreme events was estimated at more than PLN71 billion, representing 78 percent of the total value of losses. The allocation of the EU financial assistance amounting to almost PLN245 billion (Ministry of Finance, 2013) which Poland received in 2004-2011 for recovery purposes would have fully met the recovery needs generated by the impacts of extreme weather events. A positive loss trend which has been growing in Poland since 2001 confirms the global analyses. Trend projections indicate that the loss level will still continue to grow (Torrente, 2012; Bouwer, 2013). One of the causes of such a trend is climate change, which, as a result of changes in the frequency, intensity and duration of extreme events makes forecasts difficult (Intergovernmental Panel on Climate Change, 2012). This causes the reducing of the efficiency of preventive measures.

However, only PLN45 billion has been spent in the period examined on the recovery from the impacts of disasters related to weather and climate and preventive measures, covering on average about 80 percent of the losses.

In order to assess the loss and expenditure levels, they were compared with the national budget revenues. The result of this is shown in the Table III. Floods are the main phenomena which cause physical capital and infrastructure losses in the Polish climate conditions (Bukowski *et al.*, 2012) and they are a problem across Europe (European Environment Agency, 2004). In 2001, a flood which occurred in the Polish territory led to losses at the level of PLN3.6 billion (Figure 1). In 2001, the losses represented more than 4 percent of the national budget revenues (Table III).

In the agriculture sector, high losses occurred in 2006, when significant crop yields were lost as a result of several adverse extreme events: spring freeze, droughts and heavy rains. Losses were accounted about 11 percent gross agricultural output

Table III.
Estimates of losses caused by weather and climate-related extreme events and expenditures on recovery and prevention of the impacts of extreme events relative to the national budget revenues and GDP

			Losses				Expenditures			
Year	National budget revenues in current prices (billion PLN)	GDP in current prices (billion PLN)	In current prices (billion PLN)	In current prices (billion EUR)	As % of national budget revenues	As % GDP	In current prices (billion PLN)	In current prices (billion EUR)	As % of national budget revenues	As % GDP
2001	141	780	6.5	1.8	4.6	0.8	2.3	0.6	1.6	0.3
2002	144	809	1.5	0.4	1.0	0.2	2.2	0.6	1.5	0.3
2003	152	843	3.1	0.7	2.0	0.4	2.6	0.6	1.7	0.3
2004	156	925	1.5	0.3	1.0	0.2	2.1	0.5	1.3	0.2
2005	180	983	3.2	0.8	1.8	0.3	2.7	0.7	1.5	0.3
2006	198	1,060	7.9	2.0	4.0	0.7	3.7	0.9	1.9	0.3
2007	236	1,177	4.8	1.3	2.0	0.4	4.4	1.2	1.9	0.4
2008	254	1,275	5.4	1.5	2.1	0.4	4.7	1.3	1.9	0.4
2009	274	1,343	3.7	0.9	1.3	0.3	4.8	1.1	1.8	0.4
2010	250	1,415	15.1	3.8	6.0	1.1	8.7	2.2	3.5	0.6
Mean	–	–	–		–	0.5	–		–	0.4

Source: Own elaboration based on data from the Central Statistical Office (2013)

(Central Statistical Office, 2007). Despite the fact that the losses in 2006 were higher than those in 2001, their level in respect of the national budget revenues fell, since the budget revenues grew from year to year (Table III).

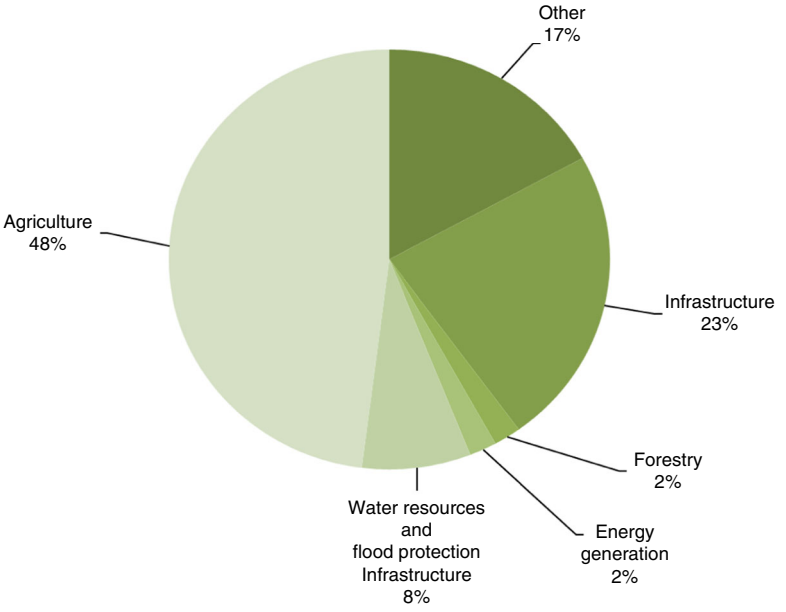
Another flood in 2010 was the most serious disaster related to weather and climate in Poland since 1997. In view of its size and the level of damage in financial terms, a decision was taken to estimate the losses in a manner which would enable the Government of the Republic of Poland to apply to the European Commission for resources from the Solidarity Fund. This was the first estimation of flood-related losses with such exactitude. There are no indications to suggest that this may become a standard procedure in the future (Rymsza, 2011). A group of experts estimated the losses at about PLN12.5 billion. Despite the fact that 2001 was characterized by relatively high-national budget revenues, the damage estimated to have occurred in the course of this disaster represented as much as 6 percent of the revenues (Table III).

The level of economic losses also depends on economic factors, such as an overall increase in wealth and possibilities for insurance and the increased amount and distribution of infrastructure vulnerable to extreme events (European Environment Agency *et al.*, 2008). For this reason, the losses caused by the impact of extreme events are greater in highly developed countries, whereas in poorly developed countries the most reliable indicator is the number of fatalities. In both cases, the severity of extreme events is well reflected by the representation of losses in relation to GDP. In well-developed counties, they represent on average 2.5 percent of their GDP, compared with more than 13 percent of the GDP in less affluent states, the economies of which are affected to a greater extent by the impacts of natural hazards (Mechler, 2004). The past extreme events have not brought about significant macroeconomic effects in Poland, as evidenced by its growing GDP. Moreover, the ratio between the losses and the GDP was on average 0.5 percent of the GDP, i.e. it was several times lower than in the case of developed countries. This ensues from the fact that analyses have failed to consider extreme geological events, such as earthquakes or volcano eruptions, which do not occur in Poland. On the other, geological events represent barely 13 percent of global losses; therefore, they do not affect significantly the value of estimates. The growing GDP and a positive trend of loss levels confirm the thesis that as a country becomes more affluent the level of losses grows.

The level of losses depends on the intensity of an extreme event, whereas the level of expenditures is characterized by a more uniform distribution, which probably ensues from the fact that recovery and the implementation of preventive measures are a long-term process. The expenditures on recovery and prevention of extreme events represented on average about 0.4 percent of the GDP. The level of expenditures has grown since 2004 when – after its accession to the European Union – Poland became able to use an additional source of financing for the implementation of recovery tasks ensuing from extreme events. An enormous surge in expenditures in 2010 and 2011 was a result of better availability of data from that period and the need to finance recovery tasks ensuing from the flood in 2010. In 2001-2009, the ratio between expenditures and the national budget revenues remained at a relatively constant level, growing in 2010 and 2011, when large financial resources were allocated for recovery from the impacts of the 2010 flood.

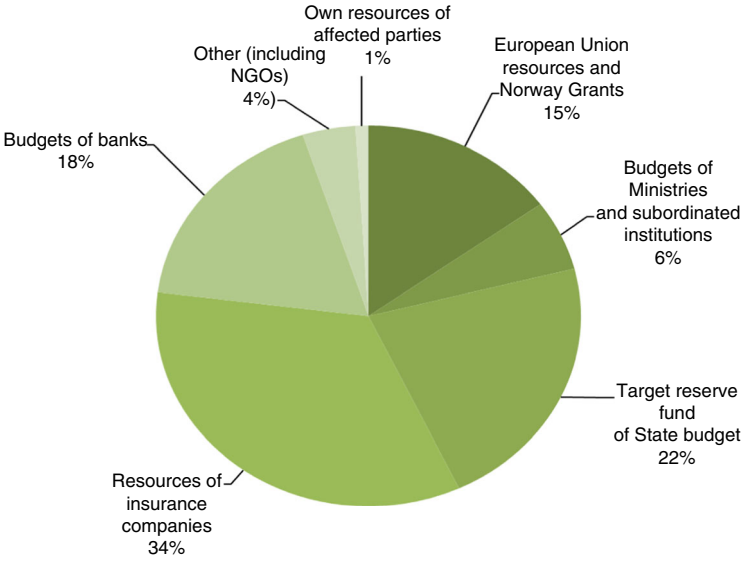
From the point of view of disasters prevention policy, apart from their total amounts, it is important to consider the structural aspect of both the losses and expenditures on recovery. Two successive Figures 2 and 3 illustrate the structure of the losses incurred and the structure of the sources used for restoration.

Analyses carried out have shown that extreme events cause the greatest losses in the agriculture sector. They represent almost 50 percent of the losses valuated. This confirms



Source: Own elaboration (2013)

Figure 2.
The structure of losses caused by weather and climate-related events by human activity sectors in 2001-2011 (in percent)



Source: Own elaboration (2013)

Figure 3.
The expenditures on restoration and prevention of the impacts of weather and climate-related events by funding sources in 2001-2011 (in percent)

that the agriculture is one of the sectors which are most vulnerable to losses. Its vulnerability ensues from its exceptional dependence on the quality and availability of climate conditions (Climate and Development Knowledge Network, 2012). The losses in technical infrastructure (roads, railway lines, water supply pipelines and wastewater

collection networks) make up about one fourth of the estimated losses. The losses in water resources and flood protection infrastructure were almost three time as low. On the one hand, this ensues from the vulnerability of these sectors, particularly agriculture, to the impacts of extreme events. On the other hand, it is only when losses emerge in the abovementioned sectors that special commissions are established to estimate them. Only such commissions carry out their calculations in a relatively complete and reliable manner. Unfortunately, given the absence of data, it is impossible to determine in which sectors 17 percent of losses called "other" have emerged. This gives some insight into the deficiencies of the system in place for collecting data of this type.

Figure 3 shows that the restoration from losses caused by extreme events is based to a greater extent on damages and benefits paid out by insurance companies than on financial assistance from the State. The resources paid out by insurance companies represented about 34 percent of the expenditures for this purpose. Their contribution to recovery was twice as a large as the amount indicated by analyses carried out by the Polish Insurance Association (Zwoliński, 2013). The budget resources represented only 22 percent of all the expenditures. Figure 3 shows that a substantial part of expenditures also consists of the resources of banks provided in the form of disaster-related credits (18 percent) and foreign funds (15 percent). A relatively low value of own funds used by the affected parties (1 percent) mainly ensues from the difficulty of collecting data of this type. Given their small share in the financing of disaster-related recovery tasks, the resources of nongovernmental organizations were included in the other group (4 percent). According to the OECD Development Aid Committee, they cover less than 10 percent of losses (Linnerooth-Bayer and Amendola, 2000; de la Fuente, 2010); this is confirmed by analyses prepared for Poland.

In conclusion, it can be said that the losses estimated in 2001-2011 are higher by more than PLN10 billion than the expenditures incurred. The extreme events which occurred then had a seriously adverse effect on the condition of the economy and it will take many years to repair the damage, in spite of an extensive scheme in place for funding tasks related to recovery from the impacts of extreme events.

To a certain extent, the reliability of the data used for estimation is limited. There are three reasons for this limitation.

The first reason is the estimation method adopted at the national level. Losses in infrastructure and agriculture are estimated by purpose-appointed commissions which follow guidelines laid down by the national government administration authorities. The guidelines provide that losses below specific thresholds will not be estimated and that compilations will not cover certain types of costs. This means that a large part of losses caused by disasters cannot be classified as eligible for co-financing and is not covered by any statistics (Rymsza, 2012).

The second reason is that the estimates presented here do not include the losses and expenditures incurred by enterprises and individuals uncovered by insurance. It is difficult to acquire data of this type for Poland's territory; therefore, the estimates presented here are different from the real status by the level of losses suffered by the private sector.

The third reason is the incompleteness of the materials submitted. As already mentioned, this results from the fact that there is no national system in place to ensure a systematic collection of data losses caused by the impacts of extreme events and expenditures on recovery and prevention of the effects of these events.

Because of the many limitations related to the system for collecting information (Zolala, 2010), estimated value of losses does not coincide with the real losses and costs incurred to recover from them. In order to improve the manner of calculating

information on losses and expenditures generated by extreme events, a countrywide system has to be established to enable the collection and analysis of data of this type. It would be well-advised to assign the responsibility for its functioning to a separate national administration unit. An in-depth analysis of data collected should indicate national sectors and areas which are particularly vulnerable to the impacts of weather and climate-related extreme events.

6. Conclusions

Data on damage and losses constitute a starting point for the efficient management of the risk of disasters. Moreover, they provide a basis for an assessment of the adverse impact of the climate and can be used in the process of adaptation to climate change. In particular, information on damage and losses enables an assessment of the results of risk management and adaptation strategies, documentation of an adverse impact of disasters and climate change on communities, the economy and the environment and monitoring of disasters and the impact of climate change, preparation of scenarios of damage and losses, with the determination of the probability of the occurrence of a disaster (Gall and Kreft, 2013).

Moreover, the provision of information on damage and losses can encourage residents and local authorities to take informed decisions to site investment projects and help determine the principles of insuring people and fixed assets in areas vulnerable to disasters. The international community has discerned the problem related to the collection of data on damage and losses.

The direct losses caused by weather and climate-related events in Poland in 2001-2011 were estimated at more than PLN56 billion. Assuming that indirect losses represent about 60 percent of direct losses, it can be calculated that the total losses caused by climate-related extreme events which occurred in Poland in 2001-2011 amounted to about PLN90 billion. The greatest losses were estimated in agriculture and infrastructure.

In 2001-2011, more than PLN45 billion was spent in Poland on recovery and prevention of the impacts of extreme events, with a large part of it consisting of damages and benefits paid out by insurance companies.

Despite their limited reliability, the estimates presented here have a certain cognitive value, as they are the first compilations of losses and expenditures caused by the impacts of all the extreme events, based on source data aggregated at the national level.

In Poland, there is no national system in place for collecting information on losses and caused by the impacts of all the extreme events. This makes it difficult to monitor the effect of climate change on the economy, to assess the risk of extreme events and to implement adaptation measures.

The manner of calculating information on losses caused by the impacts of extreme events can be improved by establishing a system which would enable a systematic collection and analysis of data of this type.

Notes

1. Another approach involves a one-off estimation of long-term losses which occurred in the past.
2. The assumption adopted in the Flood Protection Programme for the Upper Vistula River Basin for indirect damage applied to the damage caused by all the extreme events.
3. The data on expenditures was submitted in aggregated form and for this reason they cannot be broken down into those related to recovery and those related to prevention.

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