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Original article

Identification and assessment of technical hazards in the context of national security

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INFORMATIONS

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ABSTRACT

Apart from contemporary natural and socio-economic hazards, which are sources of crises, risks associated with human activity, and therefore technical threats, also play an important role in the context of the overall level of national security. These include fires, construction disasters, transportation disasters, failures and contamination. For the article purposes the results of statistical surveys of national and international sources of information on threats and results of surveys conducted in selected local administration units (n = 101) were used. The study period covered the years 1999-2014. Due to the occurrence of technical hazards, the losses they generated were indicated as well. In addition, the ways of classifying technical threats and thus their taxonomy were specified. The cause-and-effect analysis was applied for the proper identification of technical hazards. Moreover, the main reasons for the emergence of technical hazards, their course and characteristics, as well as the effects by category of property, the environment and human life were identified.

KEYWORDS

technical hazards, national security, crisis management

Introduction

Threats of natural origin and socio-economic ones are most frequently dealt with in the area of crisis management, which is an element of national security management. Technical hazards constitute another kind of threat that has a significant impact on national security (including a state), both locally and nationally. They result from human economic activity conditioned by scientific and technological progress and the civilization development of society [Sobolewski 2011, p. 23].

Table 1 presents the basic division of technical hazards, such as fires, construction and transport (as well as mining) disasters, failures and contaminations.

A properly conducted analysis of technical hazards requires knowledge of effects of threats, both primary and secondary. Primary threats initiate a crisis situation, while the secondary ones are its result (effect). Furthermore, in parallel to the primary threats, there are leading and accompanying threats (encountered at the time of primary threats occurrence).

Table 1. Division of technical hazards

Technical hazards				
Fires	**Construction disasters**	**Transportation disasters**	**Failures**	**Contaminations**
– industrial (facilities, installations, devices, machinery) – community amenities	– industrial – installation – communal	– railway – vehicle – air – marine	– electricity grids – disruptions in the delivery of liquid fuels – disruptions in gas supply	– chemical contamination – radiation contamination – biological pollution

Source: [Ficon 2007, p. 90].

It is therefore important to carry out a cause-and-effect analysis of a given technical hazard. A useful tool for achieving this is the so-called cause-and-effect table. It points to a number of threats that simultaneously present primary and secondary hazards, e.g. a traffic or construction disaster can result in a fire, a threat posed by problems in the functioning of state administration, land contamination or communication disruptions, and a number of other social and economic risks.

1. Identification and evaluation of selected technical hazards

One of the major technical hazards that occur at various administrative levels and affect national security are construction disasters. "The Act of July 7, 1994 – Building Law defines this phenomenon as unintentional, violent destruction of a building or part thereof, as well as structural scaffolding components, molding equipment elements, sheet pile walls and trench shoring systems" [Dz. U. 1994 Nr 89, poz. 414].

Shopping malls, sports facilities, exhibition halls, industrial and mining districts and mountain areas are particularly vulnerable to this type of risk. The causes of construction disasters can be divided into technical, organizational and social. The main ones include [*Ocena ryzyka*… 2013, p. 42]:

- failure to comply with building rules and regulations,
- extreme weather conditions,
- man-made mistakes,
- structural defects of buildings,
- lack of repairs and maintenance works,
- lack of control and supervision over the technical condition of construction objects,

– improper use of objects,
– theft of transmission elements,
– terrorism or sabotage.

The effects of construction disasters are primarily human losses, substantial material losses and destruction of transport infrastructure and transmission grids, communication hindrances or local contamination of the environment.

According to EM-DAT (*The international disasters database*) data [EM-DAT n.d.] in Poland over the last fifteen years, major construction disasters took place in the years of 2002, 2006 (Silesia, Market Hall) and 2009. There were no such incidents in the 1990s. Previous events took place in 1987, 1979, and 1971. The map of historical events prepared by the Government Security Center (*Polish abbrev*. RCB) [*Ocena ryzyka*… 2013, p. 42] shows that serious construction disasters occurred in 2006 and 2009 in the Silesia Voivodship and in 2002 in the Lubuskie Voivodship. All the registered building catastrophes of category I (not caused by unforeseen reasons) and category II (as a result of the mishap) according to the source of the Central Building Supervision Authority [Glowny Urzad… n.d.] are shown in Figure 1.

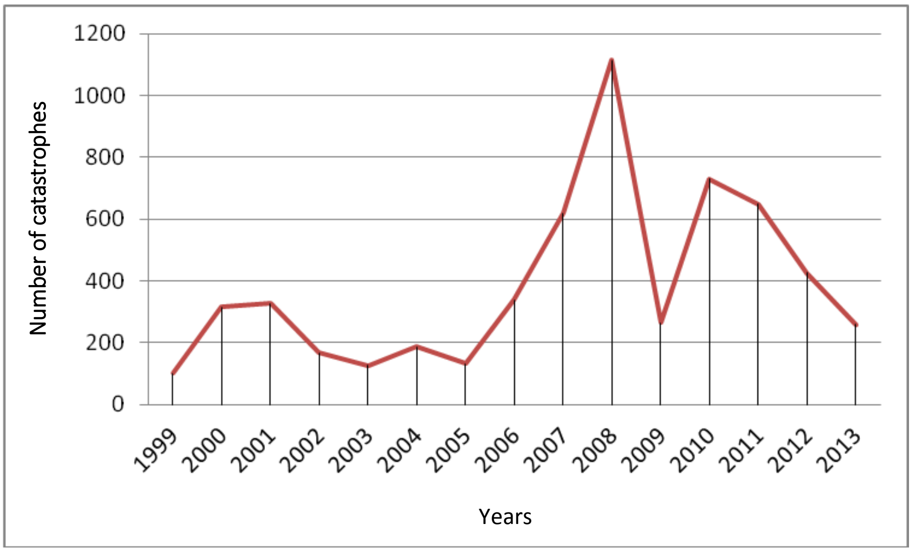

Fig. 1. The number of construction catastrophes in Poland in the years 1999-2013
Source: [Glowny Urzad… n.d.]

The data presented in Figure 1 indicates that the largest number of construction disasters falls on the years 2007, 2008, 2010 and 2011.

Communication catastrophes belong to the next discussed technical hazards. Their source lies primarily in the fact that the need for transport services increases with the economic growth. As a consequence, the development of land, air and maritime transport networks and the higher volume of passenger and freight traffic contribute to the widespread occurrence of traffic disasters [Wojtyto et al. 2014].

Road transport is the dominant mode of transport in Poland. As 'The Report of the Partnership for Road Safety Association' indicates: "(…) in Poland approximately 75%

of all cargo is transported by road. For this reason, road transport is one of the most important sectors of the economy, decisive for the pace and potential of its development (…)" [Partnerstwo… n.d.].

However, despite the fact that transport is now a driving force in the economy development, it is also the cause of many threats. These include railway, vehicle, marine, air and road crashes. These risks concern drivers, passengers, as well as residents affected indirectly. The source of the threat stems primarily from the improper action of a human – intentional or unintentional. This may be due primarily to non-compliance with traffic regulations, not properly secured carriage of chemical or radioactive materials, poor technical infrastructure and defective means of transport.

The effects of communication catastrophes, including car accidents, are varied. These include: numerous health risks or permanent health impairment, death, traffic congestion, supply problems, contamination of natural environmental, fires, public disorder and substantial material losses.

Air accidents are particularly spectacular, due to the high probability of fatalities. This results mainly from distant routes, which flying objects cover and altitudes and speeds they achieve.

Removing the effects of large-scale communications catastrophes requires a great deal of forces and measures, deployed as quickly as possible, as well as specialized rescue equipment and excellent organization of services involved. Effectiveness and efficiency of the action depend on the speed of notification and reaching the victims, despite numerous communication constraints at the time [Ficon 2007, p. 95]. On the other hand, the frequency and severity of disasters is proportional to the intensity of communication flows and the normative level of their safety.

Serious traffic accidents classified by EM-DAT occurred in 2005, 2008, 2002 and 2012 (the railway disaster in Szczekociny) [EM-DAT n.d.]. Figure 2 shows the police statistics on the total number of traffic accidents recorded between 1999 and 2013 in Poland.

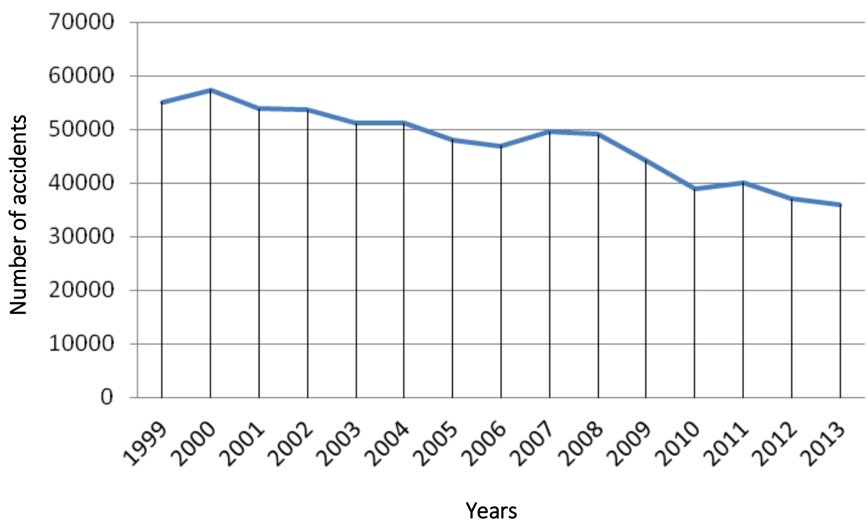

Fig. 2. The number of traffic accidents in Poland in the years 1999-2013
Source: [Own elaboration based on: [Wypadki drogowe… n.d.]].

The Reports published by the Police Headquarters [Wypadki drogowe… n.d.] provide information on the dependence of accidents on individual periods (months, days, weeks), as well as human and material losses, which enables a deeper analysis of the accident tendency. At the same time, the level of risk of traffic (road) accidents in Poland over the past several years has been characterized by a downward trend, despite the increased traffic and the growth in the number of registered vehicles (Fig. 2).

Table 2 shows examples of damage and losses caused by road transport dangers' occurrence.

Table 2. Sources of damage and losses in road transport

As a result of natural forces	As a result of criminal activity	Related to a means of transport	As a result of intentional fault	As a result of a human error
– flood – abundant precipitation – fire – extreme temperatures – volcanic eruption	– theft of goods – theft of means of transport – smuggling – robbery – burglary – acts of terrorism – fraud – extortion	– road accident – road collision – breakdown of means of transport – failure of refrigeration appliances – bad technical condition of the means of transport	– deliberate action by drivers, shippers, carriers – action of employees of companies contracting shipment – action of workers employed by recipients of goods	– delivery of goods to unauthorized persons – improper transportation of goods – inappropriately secured goods

Source: [Cyganik 2014, p. 31].

In 2013, the number of accidents was about 35% lower than in 2000. There was also a decrease in the number of fatalities and injuries. The effective construction and reconstruction of road infrastructure networks, owing to the resources gained from European funds by their administrator, have positively influenced, among others, the improvement of communication safety in recent years in Poland.

Another technical hazards that occurred in the investigated administration units include power grid failures and fuel and gas supply interruptions [Sobolewski 2011a, pp. 76-77].

Power network failure is the example of a sudden event that may be caused by a spontaneous damage to network elements, or by interference of a human (third parties) and by the effects of climatic factors (e.g. natural disasters, crisis situations). Such an event may result in local disturbances in electricity supply.

Three types of failures can be distinguished: massive failures of electricity grids, system electricity 'blackouts'[1] and power deficiencies. The effects of the breakdowns are extremely dangerous to humans, inter alia, because of the interruption in the supply of medical devices supporting human life and the possible local environmental contamination.

Significant losses arise from threats to the infrastructure, property and economy. First of all, they can lead to [*Ocena ryzyka*… 2013, p. 26]:

– disturbances in the functioning of hydro-technical devices, communal and communication infrastructure,
– difficulties in railway and tram (rail) transport,
– loss of radio or/and telephone communication,
– disturbances in the functioning of ICT systems,
– hindered circulation of information,
– failures of the ATM system and non-cash transactions,
– lack of power of transmission plants, which may result in production stoppage,
– disruptions of functioning of public utility facilities, including hospitals.

Failures in the supply of liquid fuels include, among others [*Ocena ryzyka*… 2013, p. 26]:

– pipeline failures within the country or abroad,
– failures of terminals for crude oil and fuels collection,
– disruptions of the distribution system's functioning throughout the country or in individual regions,
– rapid increase in fuel consumption,
– failures in the logistic system of fuels (product pipelines, fuel storage),
– unfavorable events in the international environment,
– terrorism.

The essential consequences of this type of threat are undoubtedly transport, communication, rescue and food supply problems. This can cause massive destabilization of social and economic life (potential sharp drop in GDP and limited economic activity, lack of access to basic services and goods) as well as public panic. Moreover, the need to introduce a liquid fuel regulation system for individuals and enterprises cannot be excluded [*Ocena ryzyka*… 2013, p. 26].

The registered event in the interruptions in delivery of liquid fuels in Poland took place in the Mazowieckie Voivodeship in 2007 [*Ocena ryzyka*… 2013, p. 29].

The problem of supplying the population can be also a result of a failure in gas supply, which causes general disruption of gas network functioning. This failure consists in gas pipeline unsealing, damage to equipment in gas stations, thereof accompanied by unplanned gas leak and the risk of explosion and fire [*Ocena ryzyka*… 2013, p. 30].

[1] State of the power system failure of the entire system operation or part thereof.

Oftentimes, this is an unexpected phenomenon, which results in the loss of technical efficiency of a gas network device or facility, posing a threat to people, property or the environment. Damage to transmission system elements, human error during construction and engineering work, unsealing, poor protection, meteorological factors such as corrosion and strong frost are causes of the failures.

The estimated effects of this phenomenon include distortions in the gas-dependent sectors, and therefore agro-food industry, bitumen production, electrical and chemical industries. In the most extreme cases, the consequences also apply to the emergency evacuation of the population and providing them with temporary housing, which generates additional costs and significantly destabilizes the social life. Total supply disruptions are also related to the need of the network re-filling with gas, which may close the service for up to several days [*Ocena ryzyka*… 2013, p. 42].

According to the historical events map of the *Report on National Security Threats*, the threat of gas supply disruptions occurred in the Mazowieckie Voivodship in 2009 and 2010 and in the Wielkopolska Voivodship in 2002 [*Ocena ryzyka*… 2013, p. 30].

Contaminations belong to other technical hazards that affect the safety of citizens, property and the environment. One of them is chemical contamination. This risk is posed by, inter alia, breakdowns in production facilities and those storing dangerous chemical substances, traffic accidents during transport of hazardous chemicals and illegal waste disposal. Areas of particular danger include transport routes (in particular transit areas), industrial sites, storage facilities for hazardous substances, pipelines for the transmission of raw materials, mainly crude oil and gas fuels, and places where tankers' routes cross.

The definition indicates that chemical contamination is "the pollution of air, water, soil, a human body, objects with substances harmful to humans". It can be deliberately caused, for example, by using toxic warfare agents [*Ocena ryzyka*… 2013, p. 42].

The effects of chemical contamination are both short- and long-term. They lead to the following losses: pollution of the environment, destruction of agricultural crops, soaring food prices, damage to communal and transport infrastructure

Figure 3 depicts the number of risks related to chemical contamination recorded by RCB in Poland between 1999 and 2012 in particular voivodships.

According to the information presented in Figure 3, the most threatened area in Poland in terms of the number of occurrence of chemical contamination is the Opolskie Voivodship (7 events). Furthermore, in the analyzed period, this phenomenon was observed four times in the Warmińsko-Mazurskie Voivodship and twice in the Wielkopolskie Voivodship. What is more, single events were also recorded in the districts of the Zachodniopomorskie, Małopolskie, Kujawsko-Pomorskie and Łódzkie Voivodships. In other regions such incidents were not reported. A total of 17 events were recorded in the years 1999-2012.

The next discussed threat is radiation contamination. It is defined as follows: "an event in the country or abroad, related to nuclear material, ionizing radiation source, radioactive waste or other radioactive substances, causing or threatening to cause radiation hazards, creating possibilities of exceeding the limit values of ionizing radiation doses specified in the applicable regulations, thereby requiring urgent action to protect workers or the population" [*Ocena ryzyka*… 2013, p. 49].

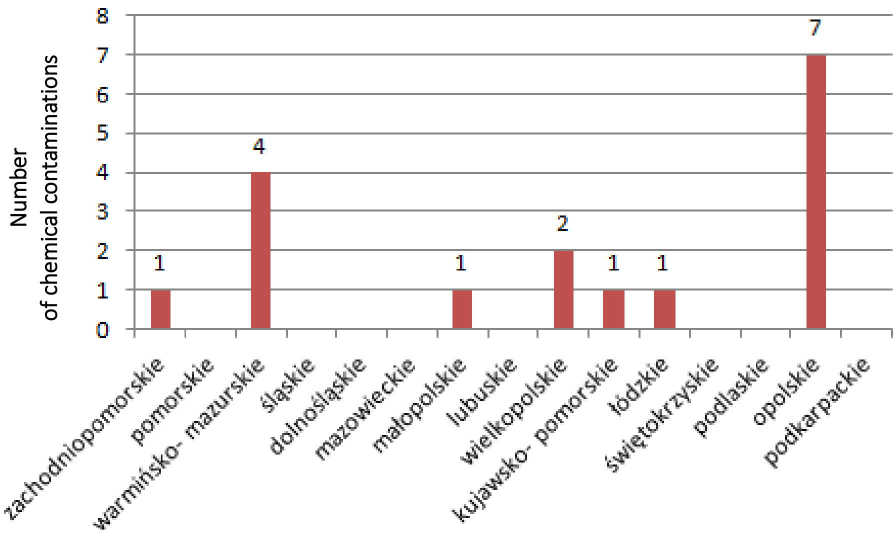

Fig. 3. The number of chemical contamination in particular voivodships in Poland in the years 1999-2012

Source: [Own elaboration based on: [Ocena ryzyka… 2013, p. 26]].

A radiation incident can be encountered during a failure of nuclear power plants, the use of radioactive sources, transport and improper storage of radioactive sources and waste. The most vulnerable areas are border crossing points and communication routes, facilities using radiation sources (science, health care, industry) and undoubtedly power plants located in neighboring countries[2]. This phenomenon can cause the total paralysis of social and economic life, from environmental contamination, isolation of endangered areas, blockade of communication routes to long-lasting human health effects, and even death [*Ocena ryzyka*… 2013, p. 42]; the most noteworthy example can be the explosion in the Chernobyl nuclear power plant in 1986.

In Poland, due to the lack of nuclear power plants this threat seems to be less prevalent. However, the risk of the occurrence of the event is posed by the proximity of neighboring power plants (there are 9 nuclear power plants located within the radius of 30 km from the borders of Poland).

Not all types of technical hazards contained in this paper are deemed relevant. Due to lack of data the study does not provide the number of potential radiation threats and the risk of failure of power grids. The overall level of technical hazards in Poland in the years 1999-2012 is presented in Figure 4.

[2] There are 9 nuclear power plants within the distance of 300 km from the Polish borders.

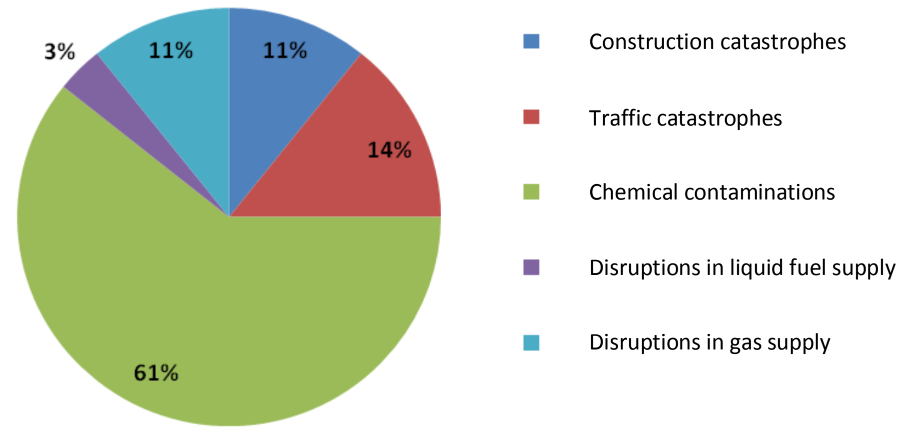

Fig. 4. The level of technical hazards in Poland in the years 1999-2012
Source: [Own elaboration based on the collected statistical data].

Summing up, it can be stated that chemical contaminations are the predominant technical hazards in the investigated period, according to available and collected statistical data. Only chemical contamination is found at a critical level in the country (high level), while the remaining ones at the low (disruption in gas supply, construction and traffic disasters) and the minor levels (disruptions in the supply of liquid fuels).

Figure 5 shows the results of the survey conducted among 101 self-government administration units (municipalities, districts and voivodships). They illustrate respondents' responses to a question on the average frequency of each state (natural, technical and social) security hazard on the 1-5 scale (where: 1 – means no; 2 – hardly ever; 3 – rarely; 4 – often; 5 – very often).

As can be seen in Figure 5 the most frequent hazards in the investigated administration units are fires and atmospheric precipitation, as well as strong winds or hurricanes. The lowest recorded value is 1 (terrorist attack), while the highest is 3.7 (atmospheric precipitation), thus Figure 5 does not depict the scale above the upper value.

The average frequency shown refers to floods and weather anomalies that are responsible for further natural hazards. According to the respondents, the least frequent occurrences are landslides, air and water disasters, radioactive contamination, epidemics and epiphytotics. No terrorist attack took place, and mining disasters concern only areas where coal-mining companies are located (mainly municipalities and districts of Upper Silesia). Therefore, the technical hazards against the remaining threats are at a low level. Among them, the most frequent were road, rail and building disasters, chemical contaminations as well as technical equipment failures and power grid failures, which is consistent with the results in Figure 4.

Conclusion

To sum up, the following conclusions regarding the identification and evaluation of selected technical hazards affecting national security can be drawn (especially in the context of crisis management):

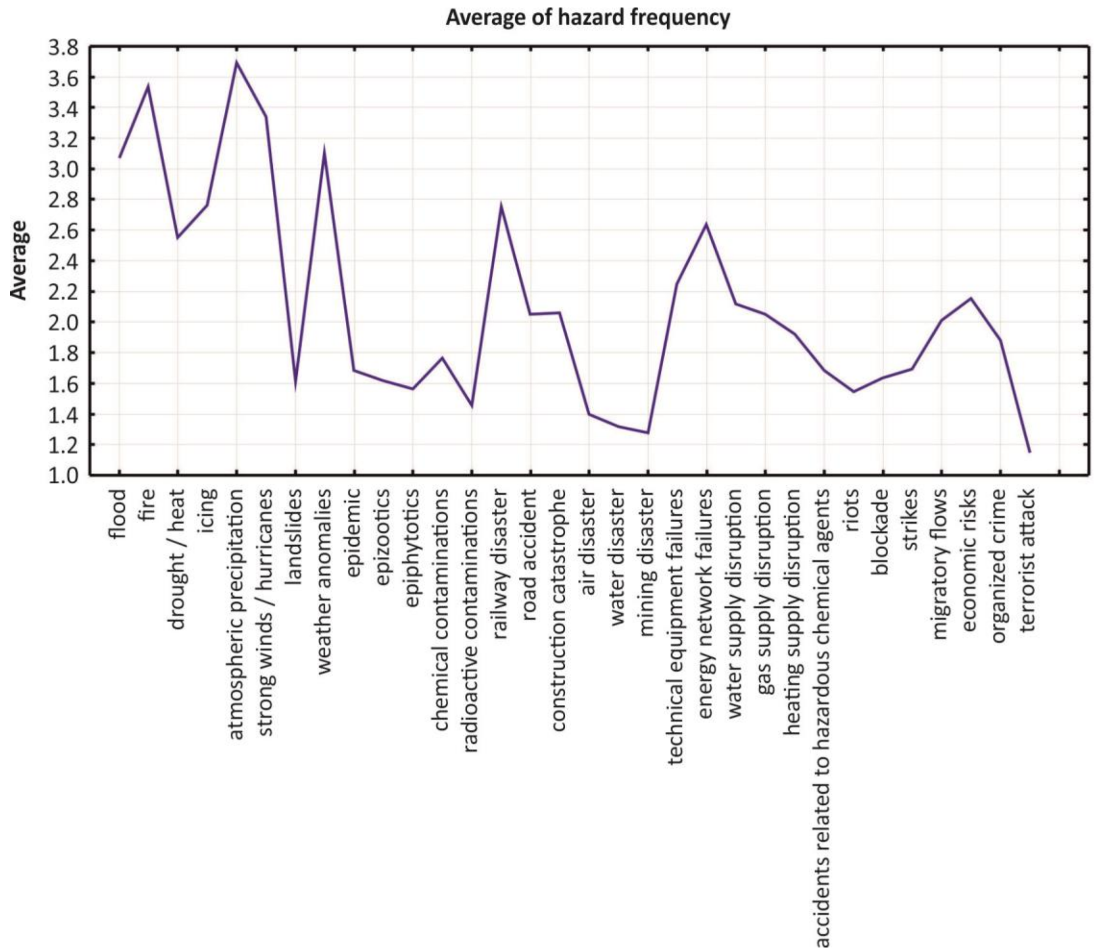

Fig. 5. The average frequency of occurrence of emergency threats in the investigated administration units, n = 101

Source: [Own elaboration based on the survey conducted in local government administration units].

– there is great diversity in the identification of technical hazards. This is due to the fact that it is not possible to clearly state their causes and effects. These are both primary and secondary hazards. They may therefore be the reason for other technical, natural or socio-economic threats. Thus, it is important to use the cause-and-effect analysis,

– the development of civilization and, consequently, technological evolution, trigger escalation of technical hazards. Due to the fact that human activity determines their appearance and course, it is necessary to reduce human errors and apply appropriate technical protections in order to minimize / their occurrence,

– according to the available statistical data, the dominant technical hazards in the analyzed period 1999-2014 in Poland were in the declining order: chemical contaminations, communication and construction catastrophes, gas supply disruptions and occasional interruptions in the supply of liquid fuels,

– against the background of the remaining non-military threats to national security, technical hazards are in the second place, following natural threats (mainly climatic, hydrological and meteorological),
– over the past fifteen years until the end of 2014 in Poland, according to EM-DAT data, the losses resulting from technical hazards, identified as crisis situations, amounted to $ 314 million and claimed 205 fatalities,
– countering technical hazards is relatively easier than tackling natural threats. There are greater possibilities for predicting the phenomena in question than for other risks, which are often characterized by randomness, large scale and lack of real preventive measures. However, activities aimed at reducing technical hazards require co-operation between owners of objects that may be exposed to them, together with the state administration and services. Critical infrastructure objects are particularly important from this point of view, since they are sensitive to the functioning of the society and the state as a whole. Hence, it is imperative that appropriate preventive actions involve appropriate contingency plans drawn up for the eventuality of an emergency situation, which may prevent the threat or minimize potential damage.

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Conflict of interests

The author declared no conflict of interests.

Author contributions

Author contributed to the interpretation of results and writing of the paper. Author read and approved the final manuscript.

Ethical statement

The research complies with all national and international ethical requirements.

ORCID

Dorota Wojtyto – The author declared that she has no ORCID ID's

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Biographical notes

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