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STATISTICAL ASSESSMENT OF EMERGENCIES IN THE SLOVAK REPUBLIC DURING 2013-2020

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ABSTRACT

In this paper, the author identifies which emergencies occur most in the conditions of the Slovak Republic and specific parts of the country. The article's main aim is a statistical assessment of emergencies in the Slovak Republic during 2013-2020. The findings were then compared with the views of domestic authors and experts. This statistical assessment has not been processed in the literature. The content of the methodology is the creation of tables for classifying emergencies according to the established criteria and assessing the dependencies between qualitative signs. The association and contingency express the dependence between the qualitative signs.

KEYWORDS

emergency, association, contingency, statistical assessment, dependence

INTRODUCTION

Despite thorough preventive measures and extensive crisis planning, it is impossible to avoid developing crisis events, especially those of the natural character, e.g. floods, fires, earthquakes, windstorms, landslides, etc. Adequate knowledge, both in the process of prevention and reaction, affects the future development of the events and connected decision-making processes and statistical variables. Integrating the statistical elements into the management system becomes a more and more actual trend. Various statistical methods, techniques and procedures, including the modelling and simulation methods, are utilised by crisis management to support the decision-making process and make them more efficient.

1 ACTUAL STATUS OF EMERGENCIES IN SLOVAKIA

1.1 Floods

The emergencies, especially of the natural character, e.g. floods, whirlwinds, fires and landslides, occur in Slovakia, the European Union but also worldwide more and more frequently. The torrential floods due to short-lasting but intensive rains are Slovakia's most common type of floods (Neumannová, 2017). Table 1 shows an overview of the most significant floods in Slovakia.

Table 1 The most significant floods in Slovakia

Year	Locality of Flood
1965	Flood of the river Danube
1974	Extreme flood of the rivers Hron and Slaná
1997	The rivers Morava and Váh
1998	Torrential flood of the river Malá Svinka
2002	100-year flood of the river Danube
2006	Snow melting – the river Morava and the eastern territory of Slovakia
2010	1,000-year flood of the river Handlovka
2011	Torrential flood in the location Píla
2012	Ice flood in the Kysuce region
2013	Floods of the river Danube

Source: Author

Based on the website data of the Ministry of Environment of the Slovak Republic, the size of the flooded territory was 136 118 hectares from 2001 - 2018, and damages caused by the floods amounted to 750 316 872 EUR (Strategy, 2015).

1.2 Landslides

The construction of the building and engineering works with a still higher rate of urbanisation is realised in the areas endangered by the mass movements. According to Blišťanová (2017), landslides and other mass deformations are the most spread, from the social-wide point of view to the most formidable geodynamic phenomena. The total area threatened by the mass movements is 257 560 hectares in Slovakia. From the point of view of the territorial division of Slovakia, the most endangered parts are the Prešov and Žilina regions, where the area of the threatened locations exceeds 80 000 hectares (Ministry of

Environment, 2014; Ministry of Environment, 2019). Extreme downfalls in these regions have caused a lot of severe landslides since 2010. The Ministry of Environment of the Slovak Republic ensures registration of the landslides and, according to their seriousness and available data, also the geological operations to avert, mitigate or remove the consequences of the natural disaster. The record-keeping of these landslides is primarily aimed at registration, engineering and geological research and reconstruction of the landslides at selected priority localities (Blišťanová, 2015).

Table 2 The most extensive landslides in Slovakia

Year	Locality/extent
1960	Handlová (the landslide´s length was about 1 800 m, and the mass of more than 20 million m3)
1962	Riečnica in the Kysuce region (the landslide´s length was 950 m, the mass of about 900 thousand m3)
2010	Nižná Myšľa (the most severe landslide during last 50 years)
2014	Rock avalanche in Vrátna connected with torrential flood

Source: Author

1.3 Fires

The fires are another phenomenon threatening lives, health and property, including cultural and historical objects. Moreover, it is also necessary to mention their negative environmental impact (Šovčíková, 2004). In spite of the constantly improving techniques and technologies with an emphasis on monitoring the formation of fires the number of the fires is growing (Šimák, 2016). Between 2009 and 2016, 81 059 fires were registered in Slovakia, and the highest number of the fires occurred in the eastern part of Slovakia, in the Košice and Prešov regions (Statistical, 2020).

Table 3 The most severe fires in Slovakia

Year	Place
1992	Forest fire due to the strong wind – an area of 1.171 hectares (Lozorno, Malacky, Bratislava)
2000	Fire of the forest cover - an area of 67 hectares (Hrabušice, district Spišská Nová Ves)
2005	Fire of salvage felling timber - area of 52.4 ha (Heľpa, Závadka)

Source: Author

The emergencies connected with the snow calamity are specific to the Slovak Republic. They test the capabilities of the crisis management bodies, especially at the level of the local state administration, to respond effectively during the reaction phase. The range of the consequences of the snow calamity depends on the growing altitude of the affected territory. The Žilina region is the most endangered territory – the areas of the Kysuce and Orava regions. From 2nd January 2019 to 17th January 2019, emergencies were declared in 77 self-government locations, including three districts. In the remaining seven regions, the emergency connected with the snow calamity was declared only in 20 self-government locations. The seriousness of the situations in some self-government units in 2019 can be proved by the fact that a helicopter of the Ministry of Interior squadron that helped remove the snow from the trees was used for the first time in Slovak history. Compared with 2014 – 2018, it means a significant growth in the number of declared emergencies connected with the snow calamity (Dritomský, 2019). According to Hollá (2010), from the point of view of the anthropogenic causes of the crisis events development or emergencies caused by human activity, industrial accidents and traffic accidents connected with leaking hazardous substances predominate. The overall number of SEVESO establishments belonging to the A and B categories is 77 in Slovakia (category A – 35; category B – 42). From the point of view of the regional division of Slovakia, the majority of the SEVESO establishments can be found in the Bratislava region, and the highest number of the B category SEVESO enterprises is in the Košice region (Enviroportal, 2019). In Slovakia, major industrial accidents occur only sporadically; however, their consequences affect the general public, lives, material values and the environment (Šovčíková, 2005). The events during 1995 – 2007 that occurred in Slovakia belong the most significant major industrial accidents. In 1995 there was a technological accident in the company VSŽ Košice. Due to the blast furnace gas leakage, 13 people died, and more than 240 people were hospitalised. In 2007 the premises of the Military Repair Company Nováky were almost destroyed by three explosions of the ammunition in the ammunition disposal hall. One of the most severe major industrial accidents claimed eight lives, and more than 30 people were injured (Hollá, 2010).

1.4 Summary

Based on the statistical data and conclusions of the investigations by several risk management experts, the occurrence of emergencies and their consequences have a growing tendency. From 1990 to 2018, the Slovak Republic registered a growing number of emergencies and their seriousness in nature and those caused by people. The increase was significant, especially in the case of natural disasters (World, 2017). According to Dritomský (2019), 2017 and 2018 are an exception. In 2018 there were 251 emergencies, while in 2017 only 124 ones. In the case of extraordinary situations, in 2018, there were 37 of them – 20 cases less than in 2017.

2 DATA AND METHODOLOGY

The main aim of this paper is to assess the emergencies that happened in Slovakia during 2013 – 2020 in a statistical way. To realise this aim, it is inevitable to fulfil the following individual partial tasks:

- creating tables for classifying the emergencies according to the type, the highest amount of emergencies (at the level of self-governments, districts and regions) and other determining criteria through descriptive statistics,
- assessing the dependence between evacuation and negative consequences, losses of lives, health, and citizens´ property, including the impacts on the environment,
- Assessing the dependence between the types of the emergency and activating the warning and information network, realising the evacuation, information about the requirements on providing aid, including the negative consequences on life, health, citizens´ property and the environment.

The association and contingency express the dependence between the qualitative signs. The dependence between the evacuation and negative consequences on life, health, citizens´ property and the environment is carried out through an association because the subject of investigation is the dependence between two verbal signs with two possibilities. The contingency was utilised in the process of assessing the dependence between the type of the emergency and the activation of the warning and information network, carrying out the evacuation, and the information about the requirements on providing aid, including consequences on life, health, citizens´ property and on the environment. The function COUNTIFS is utilised for calculating the association and contingency in the MS Excel environment. In the framework of the Chi-Square Test, it is inevitable to state the zero and alternative hypotheses. If the variables are independent, there is a zero hypothesis. If the variables are dependent, the hypothesis is an alternative. In the case of the association, we continue according to the testing formula of dependence (1), and in the case of contingency, according to the testing formula (2) of dependence (Chajdiak, 1999).

$$\chi^2 \quad = \sum_{j=1}^{4} \frac{(a_{ej} - a_{oj})^2}{a_{oj}} \tag{1}$$

$$\chi^2 = \sum_{i=1}^{m} \sum_{j=1}^{k} \frac{((a_i b_j) - (a_i b_j)_0) * (((a_i b_j) - (a_i b_j)_0)}{(a_i b_j)_0} \tag{2}$$

The last step is to compare the calculated values with the critical value through statistical tables for the determined level of importance. The Pearson Contingency Coefficient (r) is the most frequently utilised non-parametric gauge of the association of two random variables. The Pearson Contingency Coefficient is calculated by the formula (3) (Wang, 2012).

$$r = \sqrt{\frac{\chi^2}{n + \chi^2}} \tag{3}$$

The Pearson Contingency Coefficient determines the linear relation between two variables. Its value moves from -1 (there is a perfect negative linear relation) to +1 (there is a perfect positive linear relation). The closer this value to 0 is, the lower the level of the linear relation is. The coefficient value depends on the size of the table (the number of lines and columns). The Pearson Contingency Coefficient is only used if we compare tables of the same size (Hair et al., 2005).

Table 4 Intervals of association values and their interpretation

The measure of association value	Degree of association
0.0	Perfect independence
(0.0 - 0.1)	Trivial association
<0.1 - 0.3)	Small association
<0.3 - 0.5)	Moderate association
<0.5 -0.7)	Large association
<0.7 - 0.9)	Very large association
<0.9 - 1.0)	Nearly perfect association
1.0	Perfect association

Source: Faul (2009)

The Tschuper´s coefficient (T) is one of the indices based on which it is possible to calculate the dependence rate between two characteristics. The results have to be calculated by the contingency table r x s. The Tschuper´s coefficient (T) is calculated according to the formula (4) (Markechová, 2011).

$$T = \frac{\chi^2}{n * \sqrt{(m-1) * (k-1)}} \tag{4}$$

3 RESULTS AND DISCUSSION

The author utilised data from the statistical information provided by the Ministry of Interior of the Slovak Republic that comprehensively processed the data about all emergencies occurring in Slovakia during 2013 – 2020. At the same time, this data is also a statistical file. An emergency represents a statistical unit. The statistical signs of the given statistical unit in the area being solved are – the year when the emergency happened, the type of the emergency, its location (municipality, district, region), including the information about a warning on the radio, warning by alarm sirens, impacts on life, health, property, environment as well as information about requirements on evacuation. The reason for selecting these statistical signs is that they are the bearers of the emergencies´ attributes. The representative character of the statistical sample is emphasised by the fact that the data from the Ministry of Interior of the Slovak Republic's statistical information includes 1,882 records about emergencies occurring in Slovakia during 2013 – 2020.

The first and primary step while processing the statistical data is to detect the characteristic of the level and characteristic of the variable number of emergencies occurring in Slovakia during 2013 – 2020.

Table 5 Table of descriptive statistics – characteristics of the level and variability of the total number of emergencies

Descriptice statistics	**Value**
Mean	9.789166
Standard Error	0.575341
Median	2
Mode	1
Standard Deviation	24.96609
Sample Variance	623.3057
Kurtosis	10.81644
Skewness	3.496715
Range	108
Minimum	0
Maximum	108
Sum	18.433
Count	1.883
Largest	108
Smallest	0
Confidence Level (95 %)	1.128373

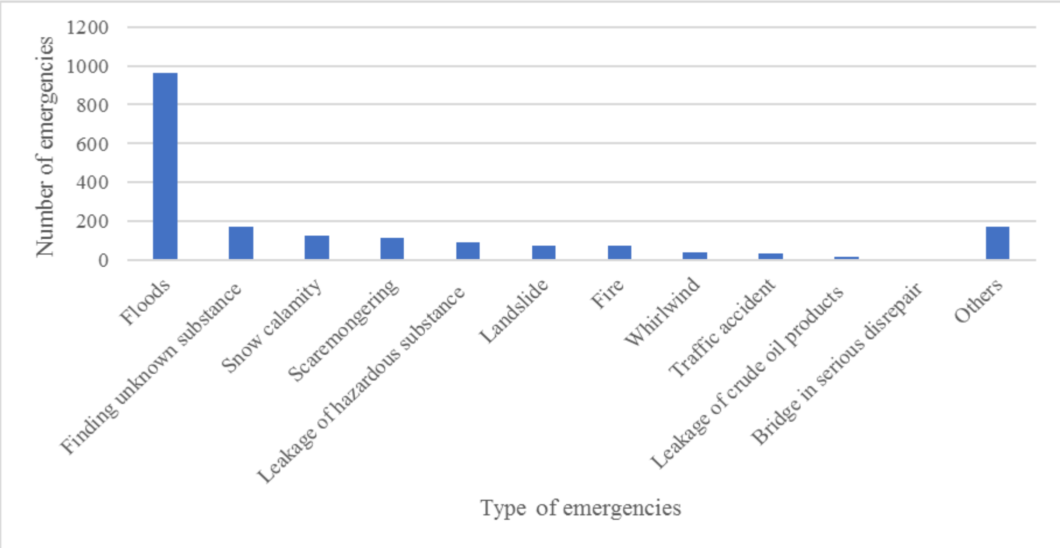
Source: Author

In this case, the selected statistical sign was the total number of emergencies in all self-governing regions of Slovakia. Table 5 shows that in a particular self-governing region, an emergency happened even 108-times during 2013 – 2020. This self-governing region is Bratislava, where the probability of developing an emergency is the greatest due to the town´s area and the number of inhabitants.

Table 6 A simple classification of the emergencies according to the type

Type of emergency	Number	Percentage share of emergencies
Floods	961	51.04
Snow calamity	124	6.59
Fire	74	3.93
Whirlwind	40	2.12
Landslide	75	3.98
Traffic accident	36	1.91
Finding unknown substance	174	9.24
Leakage of hazardous substance	90	4.78
Leakage of crude oil products	20	1.06
Scaremongering	114	6.05
Bridge in serious disrepair	1	0.05
Others	174	9.24
Total	1883	100.00

Source: Author



Graph 1 Number of emergencies according to the type – graphical depiction
Source: Author

The simple classification consists in detecting the number of values of a particular statistical sign – the type of the emergency. The simple classification according to the type of emergency is aimed at the relative number expressed in percentages.

Table 6 and graph 1 show that floods dominate the emergencies – they occurred in 961 cases from 2013 – 2020, 51.04% of the total share of the number of emergencies. Different types of emergencies occurring frequently fall into the category “Others”. A relative enormous range of emergencies belongs here, e.g. the unforeseen acoustic sounding of the sirens means of transport with an increased radioactivity level, breakdown of the water pipelines including the interruption of water supply. The emergencies “Leakage of hazardous substance” and “Others” occurred 174 times – this represents 9.24 % of the total share of the number of emergencies. The whirlwinds, traffic accidents and leakage of crude oil products are the most rarely occurring emergencies during the last seven years. The case of a bridge in serious disrepair happened only once in 2013 in the village Veľká Maňa (Nitra region, district Nové Zámky).

In the framework of the statistical assessment of the emergencies that happened in Slovakia during 2013 – 2020, the relative number of emergencies in the individual self-governing units, districts and regions has its place. The self-governing unit, district and region will be the statistical signs. Due to the extent of the criteria of the statistical signs of the self-governing units and districts, as well as to the extent of this paper, the author introduces only the essential conclusions and results of the relative number of emergencies in the individual self-governing units and districts.

Already table 5 has shown that the self-governing unit with the most frequent occurrence of emergencies is Bratislava (108 cases, i.e. 5.73 % of the total number of emergencies). Based on the results of simple classification of the emergencies according to the self-governing units, the Košice unit occupies the second place (36 cases, i.e. 1.91 % of the total number of emergencies), followed by Prešov (27 cases, i.e. 1.43 % of the total number of the emergencies). All regional towns in Slovakia registered more than ten emergencies during 2013 – 2020. The results prove that emergencies occur more frequently in the towns than in villages. The village Mútne is an exception (Žilina region, district Námestovo). It registered 14 emergencies during 2013 – 2020. In all cases, it was the snow calamity, but 2015 was the most critical one when the snow calamity hit the village nine times.

From the point of view of the relative number of emergencies in individual districts, the Prešov district is the most threatened one in Slovakia (even though the town of Bratislava registered the highest number of emergencies, territorially, it is divided into five districts). During 2013 – 2020 the district of Prešov registered 93 emergencies; it represents 4.94% of the total share of the number of emergencies. Except for 39 cases of floods, Prešov was also dominated by the number of fires (4 cases), landslides (8 cases of the total number of 75, i.e. 10.67 % of the total share of the number of landslides), scaremongering (9 cases) and other emergencies belonging to the category "Others" (13 cases). The districts of Poprad (59 cases, i.e. 3.13 % of the total number of emergencies), Námestovo (59 cases, i.e. 3.13 % of the total number of emergencies; out of which 39 cases of the snow calamity – up to 31.45 % of the total number of the snow calamities) and Žilina (58 cases, i.e. 3.08 % of the total number of the emergencies) belong to the most threatened districts in Slovakia. During 2013 – 2020 three neighbouring districts Stará Ľubovňa, Bardejov and Kežmarok in the Prešov region, were hit by the highest number of floods. During the following period, there were 133 floods in these three districts out of the total number of 961 in Slovakia (13.84 % of the total number of floods in Slovakia) and 556 floods in the Prešov region – 23.92 % of the total share of the floods in the Prešov region.

Due to the relative number of emergencies in individual regions, the statistic sign is the region through a simple classification.

Table 7 A simple classification of emergencies according to the region

Region	Number of emergencies in the given region	Percentage share of number of emergencies in the given region
Bratislava	196	10.44
Trnava	142	7.57
Nitra	113	6.02
Trenčín	115	6.13
Žilina	287	15.29
Banská Bystrica	233	12.41
Prešov	556	29.62
Košice	235	12.52
Total	1,877	100.00

Source: Author

Table 7 shows that from the relative number of emergencies in individual regions, the region of Prešov was the most impacted one during 2013 – 2020 – 556 emergencies, i.e. 29.62 % of the total share of the number of emergencies. From the point of view of the occurrence of emergencies, the Žilina region is in second place (287 cases, i.e. 15.29 % of the total share of the number of emergencies). The Nitra (113 cases, i.e. 6.02 % of the total number of emergencies) and Trenčín (115 cases, i.e. 6.13 % of the total number of emergencies) regions are the least endangered ones.

The author aimed at the statistical assessment of activating the warning and information network (through sirens or radio), at realising the evacuation, requirements on providing aid including the negative consequences of emergencies between the years 2013 – 2020, i.e. the impacts on life, health, property and environment. According to the verbal signs, the simple classification method was implemented in the case of three natural disasters that threatened the Slovak territory during the following period (flood, snow calamity, and fire).

Table 8 Simple classification of selected emergencies according to stated criteria

Type of emergency / Criteria		**Floods**	**Snow calamity**	**Fire**
Warning by radio	yes	143.00	8.00	12.00
	no	746.00	116.00	50.00
	Total	**889.00**	**124.00**	**62.00**
Warning by siren	yes	5.00	3.00	0.00
	no	862.00	121.00	62.00
	Total	**867.00**	**124.00**	**62.00**
Evacuation	yes	50.00	0.00	3.00
	no	812.00	124.00	59.00
	Total	**862.00**	**124.00**	**62.00**
Requests on providing aid	yes	91.00	4.00	8.00
	no	787.00	120.00	51.00
	Total	**878.00**	**124.00**	**59.00**
Impacts on life	yes	14.00	0.00	3.00
	no	832.00	124.00	56.00
	Total	**846.00**	**124.00**	**59.00**
Impacts on health	yes	28.00	2.00	3.00
	no	815.00	122.00	56.00
	Total	**843.00**	**124.00**	**59.00**
Impacts on property	yes	135.00	2.00	10.00
	no	70.00	122.00	49.00
	Total	**840.00**	**124.00**	**59.00**
Impacts on environment	yes	22.00	4.00	3.00
	no	780.00	120.00	56.00
	Total	**802.00**	**124.00**	**59.00**

Source: Author

We determined eight criteria for three selected emergencies (flood, snow calamity, fire) as follows: warning by the radio, warning by sirens, evacuation, requirements on providing the aid, consequences on life, consequences on health, and consequences on the property and the environment. Table 8 clearly shows that warning the citizens by the radio is realised more frequently than warning the inhabitants by sirens. From the point of view of warning on the radio, requirements for providing aid and consequences on life, health, property and environment, the fire seems to be the most severe emergency. 5 % of the fires caused consequences on the life and health of the inhabitants. During 2013 – 2020 there was not a single case when the warning network had to be activated through the sirens during a fire. The evacuation had to be realised even in 50 % of the cases out of 812 floods (5.8 % of the total share of the number of floods). The consequences on the property caused by the floods developed in 135 cases out of 705 (16.07 % of the total share of the number of floods). Based on the results from table 8, the snow calamity represents the type of natural disaster of the least serious character (according to the stated criteria). During the following period, there was no case of the snow calamity when evacuation occurred, or it would have claimed any lives. Only two calamities (out of 122) claimed consequences on health or property (1.61 % of the total share of the number of the snow calamity).

Due to the limited extent of the paper, the author introduces only results in the area of association and contingency. The association was utilised to assess the dependence between the evacuation and negative consequences on life, health, and citizens' property, including environmental impacts. After substituting the data from four association tables for assessing the dependence into equation (1) and comparing it with table 4, the dependence between evacuation and negative consequences on life, health, and citizens' property, including the impacts on the environment, is shown in table 9.

Table 9 A simple classification of emergencies according to the region

Type of association	Value	Assessment of dependence
Dependence between evacuation and impacts on life	0.38	Moderate association
Dependence between evacuation and impacts on health	0.13	Small association
Dependence between evacuation and impacts on property	0.39	Moderate association
Dependence between evacuation and impacts on environment	0.03	Trivial association

Source: Author

We can conclude that there is a moderate association between evacuation and negative consequences on life and property. Dependence between evacuation and impacts on health is a small association. Dependence between evacuation and impacts on the environment is a trivial association.

Contingency was utilised to assess the type of emergency type and activate the warning and information network, realising evacuation, information about requirements on providing aid including negative consequences on life, health, citizens property including the impacts on the environment. After substituting the data from 8 contingency tables for assessing the dependence into the equations (2), (3), (4) and comparing with table 4, the comparison of the dependence between the type of emergency and activating the warning and information network, realising evacuation, information about providing aid including the negative consequences on life, health, citizens property involving the impacts on the environment is shown in table 10.

Table 10 A simple classification of emergencies according to the region

Type of contingency	**Value of Pearson contingency coefficient**	**Assessment of dependence**	**Value of Tschuper´s coefficient**	**Assessment of dependence**
Dependence between the type of emergency and warning by radio	2.2692	No dependence	0.06904	No dependence
Dependence between the type of emergency and warning by sirens	0.03214	No dependence	0.00099	No dependence
Dependence between the type of emergency and realising evacuation	1.6173	No dependence	0.0499	No dependence
Dependence between the type of emergency and requirements on providing aid	6.06959	No dependence	0.18318	No dependence
Dependence between the type of emergency and consequences on life	0.35594	No dependence	0.0111	No dependence
Dependence between the type of emergency and consequences on health	0.68951	No dependence	0.0215	No dependence
Dependence between the type of emergency and consequences on property	2.1228	No dependence	0.06621	No dependence
Dependence between the type of emergency and consequences on the environment	0.46763	No dependence	0.0149	No dependence

Source: Author

We can conclude there is no dependence between the type of emergency and activating the warning and information network, realising evacuation, information about requirements on providing aid including negative consequences on life, health, citizens, property including the impacts on the environment.

CONCLUSION

The statistical assessment results of the emergencies in Slovakia during 2013 – 2020 show the importance of integrating the statistical elements into the crisis management system. The chapter Actual Status of emergencies in Slovakia is created based on selected professional bibliography by various authors dealing with the area of crisis management in Slovakia. The chapter Results of Discussion introduces the results and conclusions of the statistical assessment of emergencies in Slovakia from 2013 – 2020. The author finds specific penetrations between these chapters. According to Reitpís (2004) and based on table 6 and graph 1, floods dominate the emergencies in Slovakia. According to Titko (2016) and based on table 6 and graph 1, the occurrence of the whirlwinds is rare in Slovakia. According to Šovčíková (2005) and based on table 6 and graph 1, major industrial accidents occur only sporadically in Slovakia. According to the data from the websites of the Ministry of Environment of the Slovak Republic (Ministry of Environment, 2014; Ministry of Environment, 2019) and the results from table 7, the most affected regions are the Prešov and Žilina regions. From the point of view of the relative number of emergencies in individual districts, the Prešov district is the most threatened in Slovakia. According to Dritomský (2019) and the relative number of emergencies in individual regions, the Žilina region is the most endangered, particularly in Kysuce and Orava. The results of the statistical assessment of the emergencies that happened in Slovakia during the years 2013 – 2020 show that emergencies occur more frequently in the towns than in the villages. Table 8 enables us to say the individual facts. The author considers the most severe facts to be: warning by the radio is carried out more frequently than a warning by sirens, during floods, evacuation is often carried out, and there are significant consequences on the property, in the framework of the fires, the crisis management bodies and inhabitants have to cope with a relatively frequent occurrence of impacts on life and property. The conclusions from table 9 show a moderate association between evacuation and negative consequences on life and property, including a small association between evacuation and impacts on health. The conclusions from table 10 show no contingency between the type of the emergencies and activating the warning and information network, realising evacuation, information about the requirements on providing the aid including negative consequences on life, health, citizens´ property including the impacts on the environment.

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