

ANALYSIS OF GEOSPATIAL AND TEMPORAL DISTRIBUTION OF STORMS AS A NATURAL DISASTER

Vladimir M. Cvetković, MA

The Academy of Criminalistic and Police Studies, Belgrade, Cara Dušana 196,

vladimir.cvetkovic@kpa.edu.rs

Dragan Stojković

Student of PhD at the Faculty of Security in Belgrade

dragan.stojkovic@live.com

The purpose of the research - the research has been undertaken in order to determine the geospatial and temporal distribution of the number and consequences of storms in the global geospace in the period in 1900 till 2013.

Design/methodology/approach - The paper applied statistical methods. In addition, a statistical study was conducted by taking the raw data of all natural disasters (25,552) in mind, Excel "file from the international database on disasters (CRED) in Brussels, after which they were analyzed in the same program for statistical analysis of data SPSS.

Inventions - Statistical analysis of the results clearly indicate that the number of storms on the rise, as well as the severity of their consequences.

Research limitations - it cannot be said that an international database on natural disasters included absolutely everything that happens in the world, given that it was created thanks to the submitted national reports on natural disasters in the period in 1900 till 2013. So the question that arises is whether the most underdeveloped countries submitted their reports.

Practical implications - bearing in mind the increasing trend in the number and severity of natural disasters in the world's geographic space, the results are a good argument to launch a serious reform of the system of protection and rescue against natural disasters in countries around the world.

Social implications - Results of research impact on raising awareness among citizens on the severity of the consequences of meteorological disasters on people, the environment and their property.

Original value - in local Serbian literature, there are no scientific papers on this approach analyzing storms on this way. These results are original, bearing in mind the scientific method used to analyze the data obtained from the Center for Research disaster in Brussels.

Keywords - *security, emergency situations, natural disasters, statistical analysis, storms.*

INTRODUCTION

Natural disasters are events that have a large and tragic impact on society, damaging the common ways of life, hinder economic, cultural, and sometimes political conditions of life and slow the

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

development of the community and require special measures taken by first responders in disasters.¹ It can be said that natural emergencies are the consequences of mutual influence of natural events (geophysical processes and other processes in nature) and human systems (socio - economic, cultural and physical). Natural disaster increasingly endanger the safety of modern mankind. Not only that the past decades it is obvious increase in the number, but there is increase in their destructiveness.² This results in a higher loss of life, material and non-material damage. According to Mohamed, natural disasters can be classified as: natural phenomena of complex physical origin of the Earth's surface (earthquakes, tsunamis, volcanic eruptions), natural phenomena of complex physical origin of the Earth's surface (landslides, avalanches), meteorological/hydrological phenomena (storms, cyclones, typhoons, hurricanes, tornadoes, snow storms, sea surges, storms, drought, heat wave/cold wave), and biological phenomena (invasion - swarms of locusts and bugs, epidemic or infectious diseases - cholera, dengue fever, Ebola, smallpox, meningitis, malaria, yellow fever, AIDS, SARS, avian flu).³ They differ from natural hazards, which generate natural emergencies only after endanger people and their material goods.⁴ More specifically, they occur due to the impact of natural hazards on people, property, infrastructure and natural resources.

Hurricanes, typhoons, and cyclones are storms formed over tropical oceans. A single storm can cover hundreds of thousands of square miles and has interior winds of from 74 to over 155 miles per hour.⁵ Hurricanes are known as the greatest storms on earth, and destruction goes beyond wind damage, as storm surges and subsequent flooding have caused many of the greatest natural disasters in the world.⁶ A hurricane (from the Caribbean word *huraka'n*), also called a typhoon (a combination of *t'ai feng*, Chinese for "great wind," and *typhon*, Greek for "whirlwind"), requires

¹ Cvetković, V.: *Intervetno-spasilačke službe u vanrednim situacijama*. Beograd: Zadužbina Andrejević, 2013. godine; Mlađan, D., Cvetković, V.: *Classification of Emergency Situations*. Belgrade: Thematic Proceedings of International Scientific Conference "Archibald Reiss Days", Academy of criminalistic and police studies, 1-2. march 2013;

² Mijalković, S., Cvetković, V.: Vulnerability of Critical Infrastructure by Natural Disasters. Belgrade, In Procesiding „National Critical Infrastructure Protection, Regional Perspective“, 2013, str. 93

³ Mohamed, S. I.: *Disaster types. Disaster Prevention and Management*, Vol. 16, Iss: 5, 2007, str. 706.

⁴ Wisner, B.: *At Risk: Natural Hazards, People's Vulnerability and Disasters*. London: Routledge, 2004. year, str. 134. There is a significant difference between emergency, hazard and risk. The risk is the result of a combination of hazards, conditions, vulnerabilities and insufficient capacities or measures to reduce the potential negative consequences of risk. However, when hazard or threat becomes reality, ie. when it materializes, the risk becomes an emergency. For example, a river valley may be prone to flooding. The risk exists only if the affected community or assets are located in the area that is prone to storms. If the risk materializes, ie. the storms actually occurs, it will cause a loss in the affected population or property, creating an disaster. Edward, B.: *Natural Hazards*, Second Edition. Cambridge, University Press, 2005, str. 103.

⁵ Mitchell, E. De Wayne, Steven V. Vasiloff, Gregory J. Stumpf, Arthur Witt, Michael D. Eilts, J. T. Johnson, and Kevin W. Thomas. "The national severe storms laboratory tornado detection algorithm." *Weather and forecasting* 13, no. 2 (1998): 352; Bluestein, Howard B. *Tornado alley: monster storms of the Great Plains*. Oxford University Press, 2006.

⁶ Marlene, B., Carmichael, R.: *Notable natural disaster*. New York: Salem Press, Inc, 2007, 165.

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

warm surface water, high humidity, and winds from the same direction at a constant speed in order to form. All hurricanes begin as cyclonic tropical low-pressure regions, having a circular motion that is counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.⁷

To understand geospatial and temporal distribution of storms it is important to know the basic qualitative and quantitative indicators of natural emergencies at the global level and in the long run. Namely, in the period from 1900 to 2013, there were 25,552 natural disaster. Most of them were hydrological and meteorological, geophysical, climatic and biological disasters.⁸

Since this is a really extensive matter, the subject of this work will be analysis of forms of expression, number, temporal and geospatial distribution of storms only. Phenomenology of other types of natural emergencies will be the subject of future research.

METHODS

The survey was conducted based on extensive material of the Centre for Research on the Epidemiology of Disasters (CRED). It was realized in such way, as in the first step the raw – unprocessed data in format of “excel” file with 25,552 registered events, were taken from the center (www.emdat.be).⁹ The download is made 5/6/2013. Subsequently, the data were processed by the program for statistical analysis of data, “IBM SPSS Advanced Statistics 20.0”. Frequencies and percentages of the considered variables were calculated by program operations. Also, tables and charts were made by the program made, which were further processed in, “MS Word 2013”. Results of processing of quantitative data are displayed text, tables and graphics in the form of cartographic visualization by method of thematic mapping - volume cartography.¹⁰ The results of processing these data are displayed in text, tables and graphics.

The meanings of terms that are used in the paper are: the death toll - the number of people with confirmed death and the number of missing, apparently dead people, the number of injuries - the number of people suffering from psychological injury, or trauma requiring immediate medical

⁷ Ibidem, 166.

⁸ Cvetković, V., Mijalković, S.: *Spatial and Temporal distribution of geophysical disasters*. Serbian Academy of Sciences and Arts and Geographical Institute Jovan Cvijic, Journal of the Geographical Institute “Jovan Cvijic” 63/3, pp. 346.; Cvetković, V.: Spatial and temporal distribution of floods like natural emergency situations. International scientific conference Archibald Reiss days (pp. 371-389). Belgrade: The academy of criminalistics and police studies, 2014.; Cvetković, V.: Analysis of spatial and temporal distribution of volcanic eruptions as natural disasters. NBP – Žurnal za kriminalistiku i pravo, 2014.; Cvetković, V., Milojković, B., Stojković, D.: Analiza geoprostorne i vremenske distribucije zemljotresa kao prirodnih katastrofa. Vojno delo, 2014, 275-290.

⁹ Natural event will be recorded in the database as a natural emergency situation if it the following criteria are met: there are ten or more people killed, 100 or more people affected, declared an emergency and call for international assistance.

¹⁰ Filipović, I., Milojković, B.: *Osnovi kartografije sa topografijom*, Niš: Prirodno-matematički fakultet – Departman za geografiju, 2010., str. 165.

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

attention; the number of affected - the number of people requiring immediate assistance during and after a disaster, including deployed or evacuated people, homeless - the number of people who need emergency accommodation because they ran out of his house, the affected toll - a summary of injured, homeless and affected, the total damage - a global picture of the economic impact of storms, given in U.S. dollars.

ANALYSIS OF GEOSPATIAL DISTRIBUTION OF STORMS

During the period from 1900 to 2013, the highest number of storms happened in Asia 2.946, and the smallest in Africa 447. Therefore, by the number of storm, the first Asia and America, Europe, Oceania, and eventually Africa (Table 1).

Table 1: Overview of the total number and impacts of storms to people from 1900 to 2013, sorted by continents (Source: authors' calculations)

Continent	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
Africa	447	10776	28398	28758684	3416258	32203340	7744036
America	2339	207786	120320	99561632	6883386	106565338	1282507664
Asia	2946	2529443	2478589	1585153240	94181028	1681812857	355235528
Europe	847	14672	6578	17369390	75234	17451202	187445490
Oceania	570	4182	7268	12081886	499010	12588164	39340528
Total	7149	2766859	2641153	1742924832	105054916	1850620901	1872273246

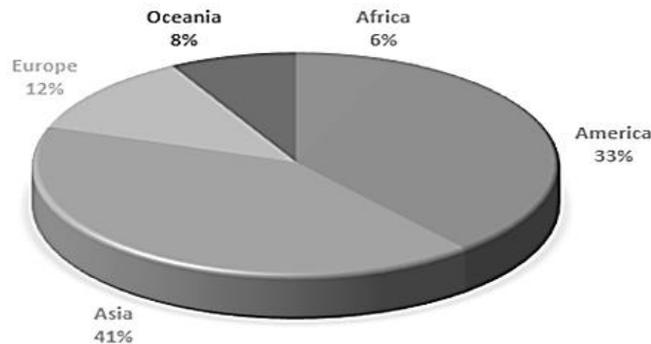
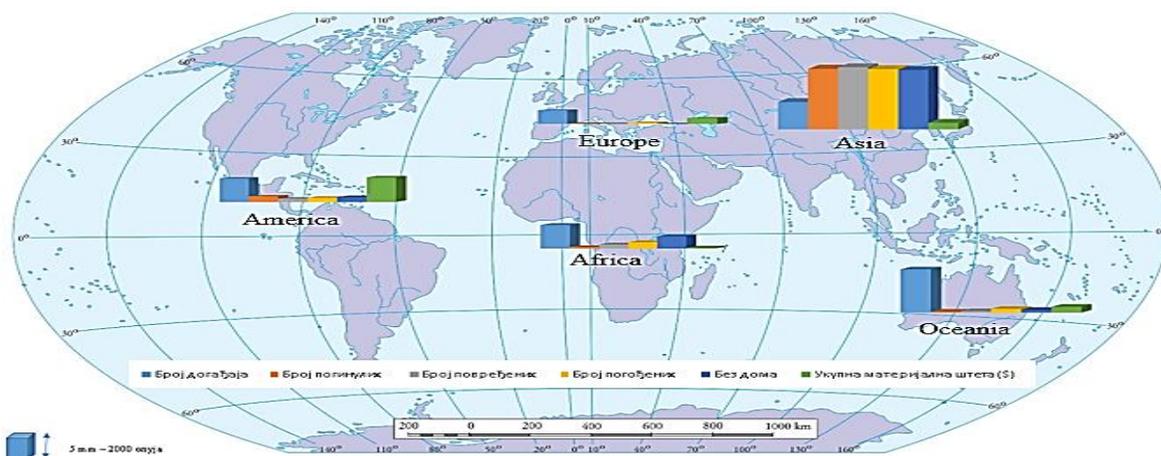


Figure 2: Percentage overview of the total number of storms in period from 1900 to 2013, sorted by continents (Source: authors' calculations)



Picture 1: The cartographic representation of the total number and impacts of storms in the world in the period from 1900 to 2013 (Source: authors' calculations)

Observed by the continents, most of the storms happened in Asia (41%), followed by the SAD (33%), Europe (12%), Oceania (8%), and finally Africa (6%) (Figure, Figure 3 and Picture 1).

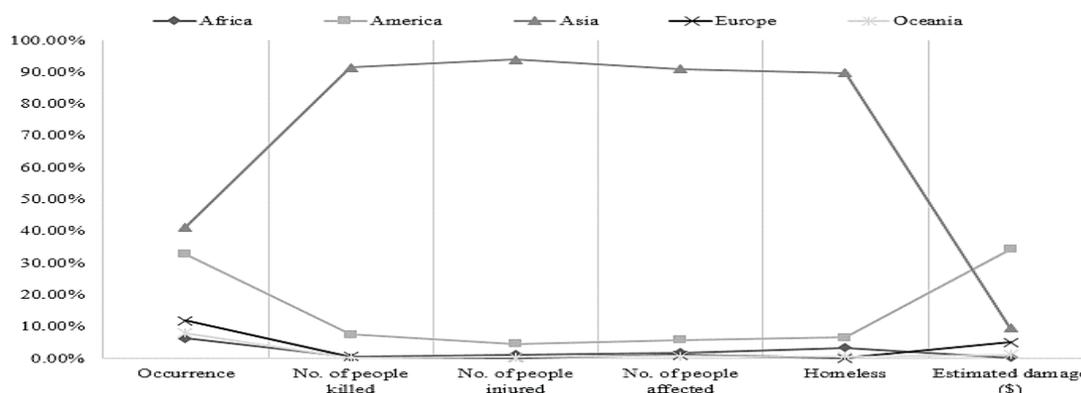


Figure 3. Percentage overview of the consequences of storms to people in the period from 1900 to 2013, classified by continent Source: authors' calculations)

During the period from 1900 to 2013, the highest number of storms happened in USA 1.096. Thus, by the number of storms in the first place is USA, Philippines 612, China 455, Bangladesh 331 and India 318 (Table 2).

Table 2: Top five states by the storms in the period from 1900 to 2013 (Source: authors' calculations)

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

Continent	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
USA	1096	60282	25526	27167892	871474	28064892	1132739020
Philippines	612	82196	79102	238481536	10844226	249404864	17844076
China	455	347435	359760	908420140	29905744	938685644	105246890
Bangladesh	331	1269046	1877527	134078624	20055136	156011287	11264760
India	318	328668	34954	167204680	19989490	187229124	22855050

During the period from 1900 to 2013, the highest number of the killed due to the impacts of storms was in Bangladesh 1.269.046. Thus, by the number of the killed due to the impacts of storms in the first place is Bangladesh, China 347.435, India 328.668, Myanmar 289.326, Philippines 82.196 (Table 3).

Table 3: Top five states by the number of the killed by storms in the period from 1900 to 2013 (Source: authors' calculations)

Continent	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
Bangladesh	331	1269046	1877527	134078624	20055136	156011287	11264760
China	455	347435	359760	908420140	29905744	938685644	105246890
India	318	328668	34954	167204680	19989490	187229124	22855050
Myanmar	34	289326	40560	7232728	598400	7871688	8158776
Philippines	612	82196	79102	238481536	10844226	249404864	17844076

During the period from 1900 to 2013, the highest number of the injured due to the impacts of storms was in Bangladesh 1.877.527. Thus, by the number of the killed due to the consequences of the storms in the first place is Bangladesh, then China 359.760, Philippines 79.102, Myanmar 40.560 and India 34.954. (Table 4).

Table 4: Top five states by the number of the injured in storms in the period from 1900 to 2013. (Source: authors' calculations)

Continent	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
Bangladesh	331	1269046	1877527	134078624	20055136	156011287	11264760
China	455	347435	359760	908420140	29905744	938685644	105246890
Philippines	612	82196	79102	238481536	10844226	249404864	17844076
Myanmar	34	289326	40560	7232728	598400	7871688	8158776
India	318	328668	34954	167204680	19989490	187229124	22855050

During the period from 1900 to 2013, the highest number of the affected due to the impacts of storms was in China 908.420.140. Thus, by the number of the injured due to the consequences of the storms in the first place is China, then Philippines 238.481.536, India 167.204.680, Bangladesh 134.078.624 and Vietnam 81.846.782 (Table 5).

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

Table 5: Top five states by the number of the affected by storms in the period from 1900 to 2013

(Source: authors' calculations)

Continent	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
China	455	347435	359760	908420140	29905744	938685644	105246890
Philippines	612	82196	79102	238481536	10844226	249404864	17844076
India	318	328668	34954	167204680	19989490	187229124	22855050
Bangladesh	331	1269046	1877527	134078624	20055136	156011287	11264760
Vietnam	180	37912	23286	81846782	8730680	90600748	9465810

During the period from 1900 to 2013, the highest number of the homeless due to the impacts of storms was in China 29.905.744. Thus, by the number of the affected due to the consequences of the storms in the first place was in China, then Bangladesh 20.055.136, India 19.989.490, Philippines 10.844.226, and Vietnam 8.730.680 (Table 6).

Table 6: Top five states by the number of the homeless by storms in the period from 1900 to 2013

(Source: authors' calculations)

Continent	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
China	455	347435	359760	908420140	29905744	938685644	105246890
Bangladesh	331	1269046	1877527	134078624	20055136	156011287	11264760
India	318	328668	34954	167204680	19989490	187229124	22855050
Philippines	612	82196	79102	238481536	10844226	249404864	17844076
Vietnam	180	37912	23286	81846782	8730680	90600748	9465810

During the period from 1900 to 2013, the highest assessed value of property damage due to the impacts of storms was in USA 1.132.739.020. Thus, by assessed value of property damage due to the consequences of the storms in the first place was USA, then Japan 113.388.800, China 105.246.890, France 51.082.120 and Mexico 44.557.020 (Table 7).

Table 7: Top five states by the assessed value of property damage by storms in the period from 1900 to

2013 (Source: authors' calculations)

Continent	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
USA	1096	60282	25526	27167892	871474	28064892	1132739020
Japan	298	69296	29482	15319852	376252	15725586	113388800
China	455	347435	359760	908420140	29905744	938685644	105246890
France	102	828	676	8027080	1600	8029356	51082120
Mexico	173	10330	3958	15243222	1276500	16523680	44557020

ANALYSIS OF TEMPORAL DISTRIBUTION OF STORMS

A number of researchers every day have fear of confirming the fact that the number of natural disasters increases every year. In order to eliminate uncertainty, it is important to consider their temporal distribution. The aim of such analysis is certainly influencing certain prognostic plans. That is why it is very important to perform temporal analysis of storms. Accordingly, in the period from 1900 to 2013, 7.149 storms happened, with 2.766.859 of the killed, 2.641.153 of the injured, 1.742.924.832 of the affected and 105.054.916 of the homeless. Observed annually, it can be said there were 63,3, 5,3 storms per month, 0.2 storms per day (Table 8).

Table 8: Overview of the total number and impacts of storms in the period from 1900 to 2013, with reference to the annual, monthly and daily distribution (Source: authors' calculations)

Type	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
1900-2013	7149	2766859	2641153	1742924832	105054916	1850620901	1872273246
Yearly	63.3	24485.5	23373.0	15424113.6	929689.5	16377176.1	16568789.8
Monthlz	5.3	2040.5	1947.8	1285342.8	77474.1	1364764.7	1380732.5
Daily	0.2	68.0	64.9	42844.8	2582.5	45492.2	46024.4

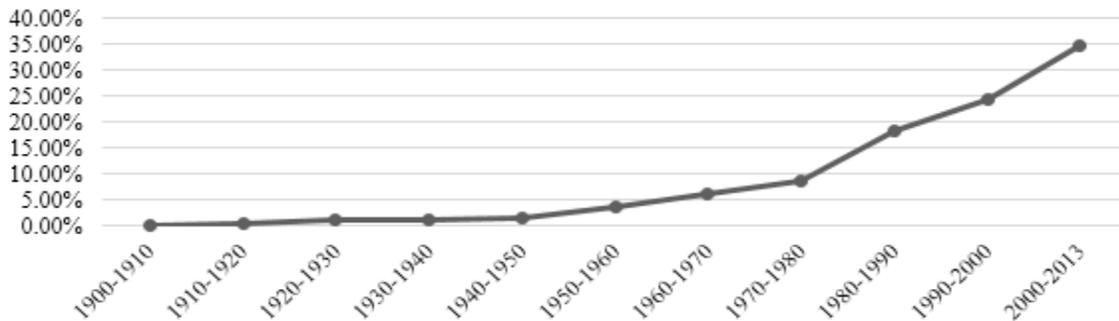


Figure 4: Percentage overview of the total number of storms in period from 1900 to 2013 year, classified by decades (Source: authors' calculations)

Up until 1980 the storms have occurred within a certain average of 10%. After this period it can be noticed a significant increase in the number of storms, and the culmination is the period since 2000 to 2013 when it happened 34,41% of the total number of storms for the period. The minimum number of storms occurred in the period from 1900 to 1910 and it is 0.42% (Figure 4).

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

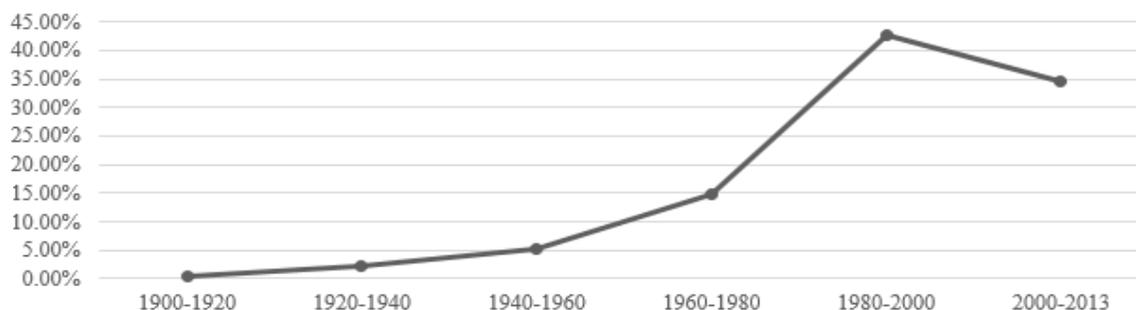


Figure 5: Percentage overview of the total number of storms in period from 1900 to 2013, classified by twenty years periods. (Source: authors' calculations)

In the periods of twenty years, the largest number of storms occurred in the period from 1980 to 2000 (42.44%) and lowest in the period from 1900 to 1920 (0.92%) (Figure 5).

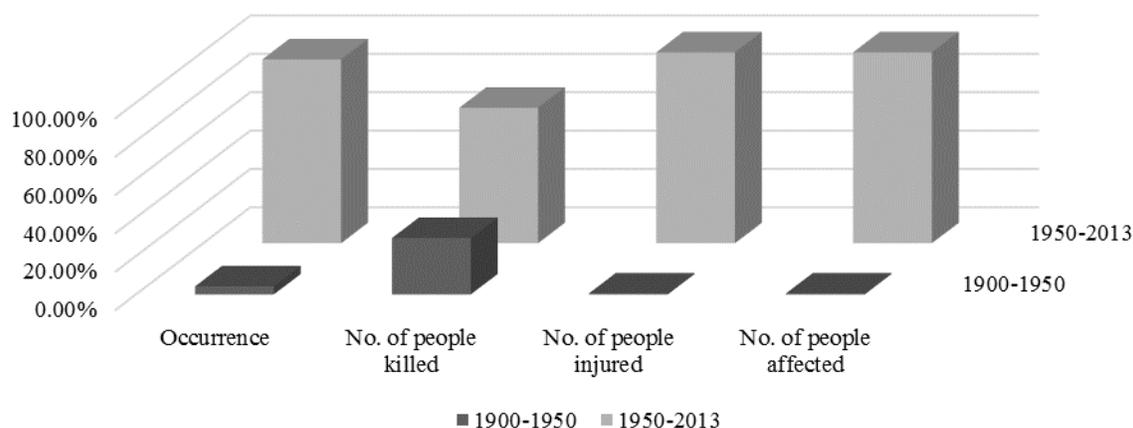


Figure 6: Percentage overview of the total number of storms in period from 1900 to 2013, classified into two periods: from 1900 to 1950 and from 1950 to 2013 (Source: authors' calculations)

Based on the graph shown above, one can clearly notice that most of the storms occurred in the period since 1950 to 2013 and it was 95.38%, in contrast to the period from 1900 to 1950 (4.62%) (Figure 6).

Table 9: Overview the total number and consequences of storms to people and property in the period from 1900 to 2013, classified by decades (Source: authors' calculations)

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
1900-1910	0	0	0	0	0	0	0
1910-1920	36	120284	400	0	194640	195040	780000
1920-1930	74	247692	12020	2092000	132600	2236620	586000
1930-1940	76	179752	1000	0	305000	306000	851000
1940-1950	114	255740	600	6323976	28000	6352576	1439000
1950-1960	266	87096	3880	11585298	752000	12341178	6338982
1960-1970	432	858524	1257976	57417210	11514340	70189526	16198366
1970-1980	620	108482	94310	111101786	20697784	131893880	38050606
1980-1990	1306	99918	146962	259765728	19632892	279545582	149347242
1990-2000	1728	415792	601782	402133520	41142152	443877454	409371878
2000-2013	2467	357491	522223	892505314	10655508	903683045	1249210172

During the period from 1900 to 2013, the largest number of 2467 storms occurred in the period since 2000 to 2013 and a minimum of 36 storms from 1910 to 1920. The largest number of the killed were from 1960 to 1970 858.524 and the lowest one, 87.096, occurred in the period from 1950 to 1960. The largest number of the injured were 1.257.976 from 1960 to 1970 858.524 and the lowest one, without consequences, occurred in the period from 1900 to 1910. By the number of the affected due to the consequences of storms in the period from 2000 to 2013 the highest number was 892.505.341 and minimum without consequences from 1900 to 1920. In the period from 1990 to 2000, there was the highest number of the homeless, 41.142.152 (Table 9 and Figure 7).



Figure 7: Percentage overview of the consequences of storms to people and property in the period from 1900 to 2013, classified by decades (Source: authors' calculations)

In percentage terms, most people were killed in the period from 1960 to 1970 (31.03%) and the lowest percentage from 1900 to 1910 (1.30%). In the period from 1960 to 1970 there

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

was the highest number of the injured (47.63%) and the lowest percentage from 1900 to 1910 (0%). In the period from 2000 to 2013 there was the highest number of the affected (51.21%) and the lowest percentage from 1900 to 1920 (0.00%). In the period from 1990 to 2000 there was the highest number of the affected (39.16%) and the lowest percentage from 1900 to 1920 (0%) (Figure 7).

Table 10: Overview of the total number and impacts of storms to people in the period from 1900 to 2013, classified by twenty years periods (Source: authors' calculations)

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
1900-1920	36	120284	400	0	194640	195040	780000
1920-1940	150	427444	13020	2092000	437600	2542620	1437000
1940-1960	380	342836	4480	17909274	780000	18693754	7777982
1960-1980	1052	967006	1352286	168518996	32212124	202083406	54248972
1980-2000	3034	515710	748744	661899248	60775044	723423036	558719120
2000-2013	2467	357491	522223	892505314	10655508	903683045	1249210172

During the period from 1900 to 2013, the largest number of 3.034 storms occurred in the period since 1980 to 2000 and a minimum of 36 storms from 1900 to 1920. The largest number of the killed was from 1960 to 1980 967.006 and the lowest one, 120.284, occurred in the period from 1900 to 1920. The largest number of the injured 1.352.286 was from 1960 to 1980 and the lowest one, 400, occurred in the period from 2000 to 2013. The highest number of affected 892.505.314 was in the period from 2000 to 2013 and the lowest number without consequences was from 1900 to 1920. In the period from 1980 to 2000, there was the highest number of the homeless, 60.775.044 (Table 10).

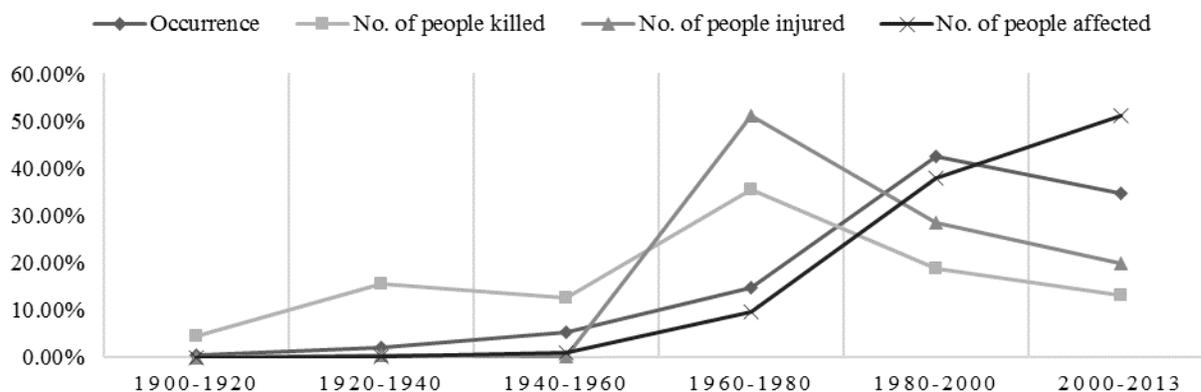


Figure 8: Percentage overview of the consequences of storms to people in the period from 1900 to 2013, classified by period of twenty years (Source: authors' calculations)

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

In percentage terms, most people were killed in the period from 1960 to 1980 (34.95%) and the lowest percentage from 1900 to 1920 (5.65%). In the period from 1960 to 1980 there was the highest number of the injured (51.20%) and the lowest percentage from 1900 to 1920 (0.02%). In the period from 1960 to 1980 there was the highest number of the affected (51.21%) and the lowest percentage from 1900 to 1920 (0.00%). In the period from 1980 to 2000 there was the highest number of the affected (57.85%) and the lowest percentage from 1900 to 1920 (0.01%) (Figure 8).

Table 11: Overview of the total number and impacts of storms to people in the period from 1900 to 2013, classified into two periods from 1900 to 1950 and from 1950 and 2013 (Source: authors' calculations)

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
1900-1950	300	803468	14020	8415976	660240	9090236	3656000
1950-2013	6819	1927303	2627133	1734508856	104394676	1841530665	1868517246

Looking at a period of fifty years, it is noted that after 1950, there was a significantly higher number of storms. Thus, the total number of storms from 1900 to 1950 amounted to 8.415.976, and from 1950 to 2013 1.734.508.856 (Table 11).

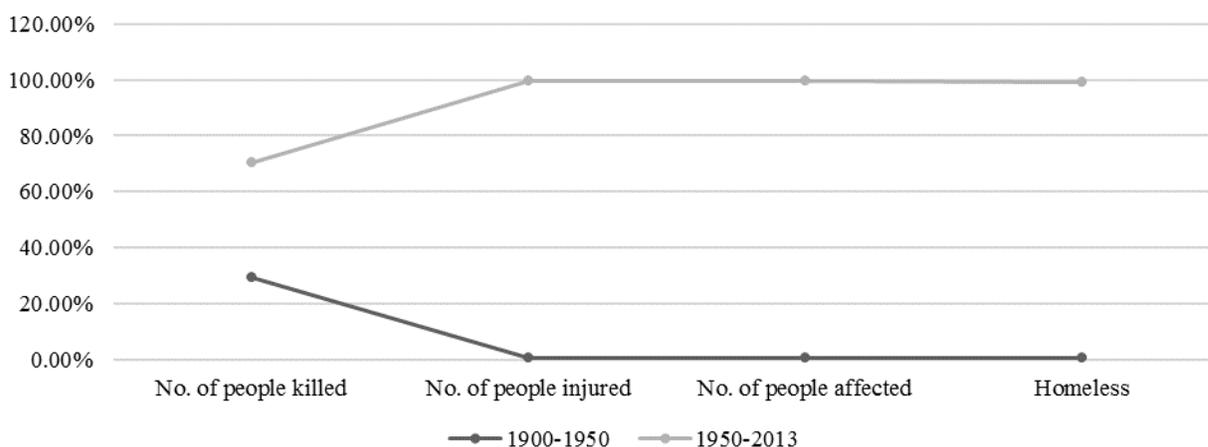


Figure 9: Percentage overview of the consequences of storms to people in the period from 1900 to 2013, classified into two periods: from 1900 until 1950 and since 1950 to 2013 (Source: authors' calculations)

In percentage terms, the highest number of the killed (69.66%) injured (99.47%) and affected (99.52%), as the number of people left homeless (99.37%) was in the period from 1950 to 2013, and the lowest number in the period before 1950 (Figure 9).

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

Table 12: Top five years by storms in the period from 1900 to 2013 (Source: authors' calculations)

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
1990	274	9246	5226	31822536	2710434	34538196	53195870
2005	260	10500	13814	97396218	824536	98234568	369586922
2004	256	13306	37606	40846698	1881790	42766094	168378730
2002	246	2770	7994	222223760	93640	222325394	29491704
2008	222	281970	46920	30709882	546746	31303548	121346206

During the period from 1900 to 2013, in 1990 most storms happened, 274. So, in the first place by storms is 1990, then 2005, 2004, 2002 and 2008 in the end (Table 12).

Table 13: Top five years by the number of deaths due to the consequences of storms in the period from 1900 to 2013 (Source: authors' calculations)

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
1970	48	608990	10064	10824490	154160	10988714	2129948
1991	132	292594	302284	44234490	2070960	46607734	35073446
2008	222	281970	46920	30709882	546746	31303548	121346206
1942	6	202000	0	0	0	0	0
1922	4	200000	0	0	0	0	0

During the period from 1900 to 2013, in 1970 most people were killed due to the consequences of storms and the number was 608.990. In the first place by the number of deaths due to the consequences of the storms is 1970 then 1991, 2008, 1942 and 1922 in the end (Table 13).

Table 14: Top five years by the number of the injured due to the impacts of storms in the period from 1900 to 2013 (Source: authors' calculations)

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
1965	38	119864	1203878	21202400	10000400	32406678	3338800
1991	132	292594	302284	44234490	2070960	46607734	35073446
2001	216	3828	184016	62783776	1013750	63981542	29040024
2007	210	12070	114006	47622066	212418	47948490	59117472
1996	154	9162	85342	55271150	201720	55558212	21515286

During the period from 1900 to 2013, in 1965 most people were injured due to the consequences of storms and the number was 1.203.878. In the first place by the number of the injured due to the consequences of the storms is 1965 then 1991, 2001, 2007 and 1996 in the end (Table 16).

Table 15: Top five years by the number of the affected due to the impacts of storms in the period from 1900 to 2013 (Source: authors' calculations)

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
2002	246	2770	7994	222223760	93640	222325394	29491704
2006	152	8658	28496	132949002	1240966	134218464	35405670
2009	174	6574	20908	100652904	491744	101165556	52269310
1989	146	8512	36552	99523896	2092342	101652790	20706598
2005	260	10500	13814	97396218	824536	98234568	369586922

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

During the period from 1900 to 2013, in 2002 most people were affected due to the consequences of storms and the number was 222.223.760. In the first place by the number of the affected due to the consequences of the storms is 2002 then 2006, 2009, 1989 and 2005 in the end (Table 17).

Table 16: Top five years by the number of the homeless due to the impacts of storms in the period from 1900 to 2013. (Source: authors' calculations)

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
1998	176	49870	42386	39658152	22342330	62042868	61317362
1977	64	30596	23480	18609684	10948900	29582064	2419618
1965	38	119864	1203878	21202400	10000400	32406678	3338800
1988	120	6760	18928	37632090	4416842	42067860	6847752
1980	86	2794	2210	33670280	4130758	37803248	3779770

During the period from 1900 to 2013, in 1998 most people were homeless due to the consequences of storms and the number was 223.342.330. In the first place by the number of the homeless due to the consequences of the storms is 1998 then 1977, 1965, 1988 and 1980 in the end (Table 16).

Table 17: Top five years by estimated value of property damage due to the impacts of storms in the period from 1900 to 2013 (Source: authors' calculations)

Year	Occurrence	No. of people killed	No. of people injured	No. of people affected	Homeless	Total affected	Estimated damage (\$)
2005	260	10500	13814	97396218	824536	98234568	369586922
2012	180	6173	13543	39167478	1213084	40394105	172961292
2004	256	13306	37606	40846698	1881790	42766094	168378730
2008	222	281970	46920	30709882	546746	31303548	121346206
2011	168	6206	24612	76469648	595504	77089764	101744296

During the period from 1900 to 2013, the highest estimated property damage due to the consequences of storms was in 2005 and the number was 369.586.922. Thus, by estimated property damage due to the consequences of the storms in the first place is 2005 then 2012, 2004, 2008 and 2011 in the end (Table 17).

CONCLUSION

Analyzing numbers, trends, impacts and temporal and geospatial distribution in the storms period from 1900 to 2013, we came to the following conclusions in relation to the total number of storms events by continent, in this period, the highest number of storms happened in Asia 2.946, and the smallest in Africa 447. Thus, by the number of storms in the first place is USA, Philippines, China, Bangladesh and India. By the number of the killed due to the impacts of storms in the first place is Bangladesh, China, India, Myanmar and Philippines. By the number of the killed due to the consequences of the storms in the first place is Bangladesh, then China, Philippines, Myanmar and

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

India. By the number of the injured due to the consequences of the storms in the first place is China, then Philippines, India, Bangladesh and Vietnam. By the number of the affected due to the consequences of the storms in the first place was in China, then Bangladesh, India, Philippines, and Vietnam. By the number of the affected due to the consequences of the storms in the first place was in China, then Bangladesh, India, Philippines, and Vietnam.

Accordingly, in the period from 1900 to 2013, 7.149 storms happened, with 2.766.859 of the killed, 2.641.153 of the injured, 1.742.924.832 of the affected and 105.054.916 of the homeless. During the period from 1900 to 2013, the largest number of storms occurred in the period since 2000 to 2013 and a minimum storms from 1910 to 1920. The largest number of the killed were from 1960 to 1970 and the lowest one, occurred in the period from 1950 to 1960. The largest number of the injured were from 1960 to 1970 and the lowest one, without consequences, occurred in the period from 1900 to 1910. By the number of the affected due to the consequences of storms in the period from 2000 to 2013 the highest number was and minimum without consequences from 1900 to 1920. In the period from 1990 to 2000, there was the highest number of the homeless.

From the above, it is necessary to continue ongoing research phenomenology and monitoring methodology and forecasting storms as a kind of natural disaster, to normatively improve the system of preventive care especially in the area of more consistent compliance with urban planning standards of construction of buildings according to the risk assessment of vulnerability by storms. Finally, special emphasis should be placed on improving the monitoring system and promoting international cooperation and action of national rescue forces outside of national geographic space, from the regional to the global level.

References

1. Bluestein, Howard B. *Tornado alley: monster storms of the Great Plains*. Oxford University Press, 2006.
2. Cvetković, V., Mijalković, S.: *Spatial and Temporal distribution of geophysical disasters*. Serbian Academy of Sciences and Arts and Geographical Institute Jovan Cvijic, Journal of the Geographical Institute "Jovan Cvijic" 63/3, pp. 346.;
3. Cvetković, V., Milojković, B., Stojković, D.: *Analiza geoprostorne i vremenske distribucije zemljotresa kao prirodnih katastrofa*. Vojno delo, 2014, 275-290.
4. Cvetković, V.: *Analysis of spatial and temporal distribution of volcanic eruptions as natural disasters*. NBP – Žurnal za kriminalistiku i pravo, 2014.
5. Cvetković, V.: *Intervetno-spasilačke službe u vanrednim situacijama*. Beograd: Zadužbina Andrejević, 2013. godine;

INTERNATIONAL SCIENTIFIC CONFERENCE - Criminalistic education, situation and perspectives - 20 years after Vodinelic

6. Cvetković, V.: Spatial and temporal distribution of storms like natural emergency situations. International scientific conference Archibald Reiss days (pp. 371-389). Belgrade: The academy of criminalistics and police studies, 2014.
7. Edward, B.: Natural Hazards, Second Edition. Cambridge, University Press, 2005.
8. Marlene, B., Carmichael, R.: Notable natural disaster. New York: Salem Press, Inc, 2007, 165.
9. Mitchell, E. De Wayne, Steven V. Vasiloff, Gregory J. Stumpf, Arthur Witt, Michael D. Eilts, J. T. Johnson, and Kevin W. Thomas. "The national severe storms laboratory tornado detection algorithm." *Weather and forecasting* 13, no. 2 (1998): 352-366.
10. Mladan, D., Cvetković, V.: *Classification of Emergency Situations*. Belgrade: Thematic Proceedings of International Scientific Conference "Archibald Reiss Days", Academy of criminalistic and police studies, 1-2. march 2013;
11. Mohamed, S. I.: *Disaster types. Disaster Prevention and Management*, Vol. 16, Iss: 5, 2007, str. 706.
12. Wisner, B.: *At Risk: Natural Hazards, People's Vulnerability and Disasters*. London: Routledge, 2004. year, str. 134.