Feature And Impacts of Typhoons:2008-2017--Protection System Against Typhoons

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Abstract: Heavy rainfall and strong winds brought about by typhoons often cause major loss of life and property in Taiwan. This paper sorted out 25 typhoons caused by disasters in Taiwan over the past ten years (2008-2017), and concluded that the losses caused by typhoons were positively correlated with rainfall and wind speed, and that the rainfall and casualties of typhoons were significantly related. At the same time, this paper conducted non-structural interviews and structural questionnaires on Taiwan residents, and based on the recorded results, conducted a cluster analysis to obtain the attitude of Taiwan residents towards typhoons. Finally, this paper put forward an ideal typhoon system for reference by the relevant departments, to improve the resilience of typhoon disasters on both sides of the Taiwan Strait.

1. Introduction

Taiwan suffered typhoon disasters every year with annual direct losses exceeding 16 billion NT dollars on average over 1985~2009.

The current research focuses on analyzing the generation and impact of typhoons from the fields of geography and meteorology. However, the current research on people is relatively inadequate, although the current technology makes the typhoon data more measurable, each time the typhoon transit, there will still be a greater disaster.

This study analyzed 25 typhoons caused by disasters in Taiwan over the past ten years (2008-2017), used statistical analysis, explored the factors caused by typhoons and their correlations. Through analyzed the residents' attitude towards typhoon, cluster analysis was carried out to explore the residents' response to typhoon. Finally, from the government, schools, families, the formation of a typhoon prevention system, put forward the proposal to defend against typhoon.

2. Causes of typhoons, the path of typhoons and losses in Taiwan during typhoons

The typhoon that made landfall in Taiwan came mainly from the Pacific Ocean east of the Philippines, about 10 degrees north latitude. It is the most suitable place for typhoons, and the meteorological profession is known as the "warm pool". The energy of a typhoon comes mainly from the heat released by the liquefaction of water vapor, while the "warm pool" provides sufficient warm and humid air for the formation of the typhoon. At the same time, the "warm pool" is located in the northeast wind belt, after the formation of the typhoon, follow the high pressure south edge of the clockwise ring to the west to the northwest, and sometimes to the northwest or more northerly route, depending on the direction of the guide air around the typhoon. As the typhoon gradually moves between 20 and 30 degrees north latitude, it reaches the west edge of the high pressure and turns north into the westerly wind belt, with the westerly winds moving to the northeast. Taiwan has

been hit by typhoons because of its regular path of typhoons.

A total of 187 typhoons had made landfall in Taiwan since 108 years (1911-2018). To land area, there are 23 between Peng Jiayu and Yilan, there are 41 between Yilan and Hualien, 38 between Hualien and Success, 28 between success and success, 30 between Taitung and Hengchun, 17 between Hengchun and Kaohsiung, 5 between Kaohsiung and Dongshi, 3 between Dongshi and Taichung, no typhoons landing on the northwest coast of Taiwan, and 2 typhoons. According to the above figures, the typhoon made the most landfalls between Yilan and Hualien on the eastern coast of Taiwan. Divide the typhoon paths affecting Taiwan into 9 categories, as shown in Fig.1.

Figure 1. Typhoon landfall regional statistics

Taiwan's terrain is mainly hilly, mountainous, accounting for about two-thirds of the province's total land area, low-level land accounted for about one-third. The whole island mountain system north and south, Taiwan's central mountain range is the main ridge and its location is east-east, most of the north-east to the southwest, the central east region is more high mountains, the central and western regions are sinking, the eastern region is more mountainous, in the western coastal area has a broader coastal plain. Therefore, if the typhoon makes landfall in eastern Taiwan, although it will be blocked by the central mountain range, the underlying structure will be destroyed and gradually dissipated, but the superstructure can still pass through, after the passage may still develop, or in the western part of the central mountain range to form a sub-center, this sub-center will gradually develop, replacing the original typhoon center to continue to travel, will still bring disaster to Taiwan.

On the one hand, when the typhoon strikes, it brings a lot of rain and fills the dams of the major rivers. According to statistics from The Taiwan region, there are 94 reservoirs in the island, with a total capacity of about 4 billion m3, water storage and power generation during the rainy season, and water for people's livelihood during the dry season. On the other hand, typhoons bring strong winds and heavy rain, so that a large amount of rain in a short period of time, and Taiwan's geological fragility, less plain, mountains high, rivers short, slope, can not accommodate a large amount of rain, so often cause landslides, flash floods, and plains, lower areas are flooded.

Therefore, it is necessary to carry out a systematic analysis and study on typhoon characteristics and the typhoon awareness of Taiwan residents, and apply it to practice, so as to improve the ability of the government, society, family and so on to reduce the losses caused by typhoons.

3. Data, variables and methods

The data used in this paper are from typhoon statistics published by the China Journal of Disaster Prevention from 2009 to 2018, typhoon statistics from the Central Meteorological Administration, the Center for Disaster Prevention Research of the University of Success, and the non-structural interviews and structural questionnaires conducted by the author to 21 local residents of Taiwan.

The focus of this paper is two, one, during the typhoon, Taiwan residents casualties, economic losses and the characteristics of the specific characteristics of the specific link. The rainfall, wind speed and landfall point of typhoon are the most important characteristics of typhoon. This paper also selects the economic loss and casualties during the typhoon, two factors as the criteria for determining the impact of typhoon on Taiwan. Second, the behavior process of Taiwan residents before, during and after landfall of moderate typhoons, among which typhoon prevention knowledge reserves and specific practices of typhoon prevention, as the assessment criteria for Taiwan residents' ability to prevent typhoons.

In the analysis method, the data collected on typhoons collected for the period from 2008 to 2017 were described by means of statistics, and the maximum accumulated rainfall of 25 typhoons that caused economic losses or casualties to Taiwan, the maximum wind speed near the center (the standard for evaluating typhoon ratings), casualties, The average and standard deviation of landing path, etc., and the corresponding method of partial correlation analysis, the factors affecting economic loss and casualties: maximum accumulated rainfall, maximum wind speed near center and landing path, comparative analysis, and finally, the regression analysis, analysis of the cumulative rainfall and economic loss of the specific relationship. The results of non-structural interviews and structural questionnaires were analyzed to obtain user portraits of two groups of people, and the user journey map of Taiwan's local residents before, during and after the typhoon made landfall.

4. Results and analysis

4.1 The maximum wind speed near the center has no obvious relationship with the economic loss caused by the typhoon and the casualties

Between 2008 and 2017, typhoons issued 48 typhoon warnings, 21 of which made landfall on the island and caused damage, and four did not make landfall on the island, causing some damage (typhoon Nisa and Typhoon Haitang made landfall in2017, and the data were treated as a typhoon). In the past decade, Taiwan has issued 11 strong typhoon warnings, 8 of which made landfall in Taiwan, but the economic losses and casualties caused by no significantly higher, and even the damage caused by strong typhoons is less than the impact of some mild typhoons, as shown in Table 1 below.

Table 1. Analysis of maximum wind speed, casualties and economic loss in near-center

		Maximum wind speed near the center	Number of casualties (death, loss, injury)	Economic loss
Maximum wind speed near the center	Pearson Correlation	1.000	0.337	0.213
	Sig.（2-tailed）		0.092	0.296
	df	0	24	24
Number of casualties (death, loss, injury)	Pearson Correlation	0.337	1.000	0.675
	Sig.（2-tailed）	0.092		0.000
	df	24	0	24
Economic loss	Pearson Correlation	0.213	0.675	1.000
	Sig.（2-tailed）	0.296	0.000	
	df	24	24	0

The maximum wind speed and casualties and economic losses in the near center were 0.092and0.296 respectively, both greater than 0.05,so the intensity of the typhoon (the maximum wind speed near the center) was not significantly related to the number of casualties during the typhoon and the economic losses caused by the typhoon. Further analysis of the 11 strong typhoons issued by Taiwan in the decade from 2008 to 2017 found that: in the first week of the strong typhoon login or transit, strong typhoons will become hot events, frequently appear on mobile

phones, televisions, computers and other screens, publicity efforts in place; Compared to mild and moderate typhoons, often the public will neglect, do not pay attention to, typhoon prevention measures are not done enough, resulting in economic losses, and even loss of life and property: such as 2009 Typhoon Morakot, near the center of the maximum wind speed of 49m/s , belongs to moderate typhoons, but caused 693 deaths,76 people missing,45 injured tragedy, direct economic losses amounted to 16.4 billion Taiwan dollars.

4.3 The path of typhoon invasion, maximum accumulated rainfall and casualties and economic losses are significantly related

The terrain of Taiwan is complex, and the path of typhoons is inconsistent, the wind varies greatly from place to place, resulting in large differences between casualties and economic losses, which can generally be summarized as follows:

(1) Eastern region: Due to the typhoon's location, 57.22 percent of the 187 typhoons that made landfall in Taiwan between 1911 and 2018 made landfall in the eastern region, while the eastern region was unobstructed, resulting in the strongest winds, with the greatest impact of the storm.

(2) North, Northeast region: the northern coast is mostly the Bay and rock shore, land and mountainous hills, in the north, north-east region of the typhoon, the wind is somewhat blocked, and the impact of the storm is relatively small.

(3) Central region: Due to the central mountain barrier, in addition to the typhoon struck from the central path of the wind is more strong, other types of path typhoons appear more than strong winds, but the central basin and plains suffered more severe flooding.

(4) Southern region: because of the central mountain barrier, in addition to the typhoon struck from the southern path of the wind is more strong, the other types of path typhoons will not appear too strong wind, the southern multi-plains and basins, by the floods, mudslides and other rainfall-induced disasters.

On the other hand, typhoons carry abundant moisture, so when invading Taiwan, they often bring heavy rain, which is influenced by different factors such as typhoon path, terrain, intensity, moisture content, moving speed and cloud rain distribution, and makes a big difference in rainfall. According to the path analysis, the rainfall situation can be summed up in the following situations:

(1) Routes2, 3and6, typhoon rainfall, to the north and north-east regions of the most severe, the central mountain area also has more rainfall, such as the autumn(September) after the north-east monsoon south, more likely to increase the intensity of heavy rain, often caused flooding in the north and north-east. Another Category 4 and 5 path typhoons, such as the fall invasion of Taiwan, the northern and north-eastern regions (especially mountainous areas) rainfall is also very large.

(2) Before the typhoon in the Category 3 route made landfall, heavy rain in the north and east, passing through the central region, the southern region

Southerly winds tend to lead to heavy rain, but the south-central mountains have seen the most increased rainfall.

(3) Typhoons in the Category 4 and 5 routes pass through the southern tip of Taiwan or offshore, with little rainfall in other areas except in the south-east.

(4) Typhoons along the Category 6 route are north along the east coast or the eastern sea, with the most rainfall in the east and some heavy rainfall in the north and north-east.

(5) Typhoons in routes 7and8 have a greater impact on the south-west and south-east, with the highest rainfall and little rainfall in the east, north and north-east.

(6) Typhoons in the Category 9 route are special path typhoons, the impact depending on the typhoon strength and storm range (radius), generally the south-central and Bohu areas are the most serious, followed by other areas.

By compiling data on rainfall and casualties and economic losses of typhoons affecting Taiwan over a decade from 2008 to 2017, analysis is done, such as Table 2, Table 3, and Fig. 2.

Table 2. Impact of maximum accumulated rainfall and casualties and economic losses

		Number of casualties (death, loss, injury)	Maximum cumulative rainfall	Economic loss
Number of casualties (death, loss, injury)	Pearson Correlation	1	0.465	0.675
	Sig.（2-tailed）		0.017	0.000
Maximum cumulative rainfall	Pearson Correlation	0.465	1	0.734
	Sig.（2-tailed）	0.017		0.000
Economic loss	Pearson Correlation	0.675	0.734	1
	Sig.（2-tailed）	0.000	0.000	

The significance of the maximum cumulative rainfall and economic loss and the number of casualties was 0.000 and 0.017respectively,both less than 0.05,which had a significant relationship, while the significance between the number of casualties and the economic loss was 0.000 and less than 0.05, and the number of casualties and economic losses were also significantly correlated with a correlation coefficient of 0.675. The maximum accumulated rainfall, casualties and economic loss are described and the r side of the maximum accumulated rainfall and economic loss is described, and the r side 0.522 r change after the change is 0.542 is greater than 0.5,with a strong linear relationship, corresponding to table 4 in table 4 is a linear regression model of economic loss and maximum accumulated rainfall, with a positive linear correlation.

Table 3. Summary of maximum cumulative rainfall and economic loss model

Model	R	R square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df
1	0.736	0.542	0.522	22.7541279	0.542	26.072	1

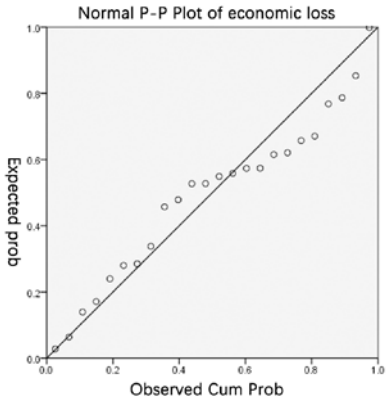

Figure 2. Normal P-P plot of regression standardization residuals

4.3 The comprehensive capacity of local residents in Taiwan is at a moderate level and the awareness of typhoon prevention is weak

These residents aged between 20 and 56, from Taipei, Taichung, Yunlin County, Tainan, Kaohsiung, Pingdong, Hualien, and they were mainly college students, graduate students, teachers, migrant workers, and restaurateurs. After the non-structured interview, the structural questionnaire is completed, the resulting statistical data entry system is obtained, and the cluster analysis is carried out, such as Table 4 and Table 5.

The actual response capacity is 32 points, knowledge reserve sits 8 8 points, divided into two final cluster centers, and the practical response capacity to typhoons 1 is 1 class 24 points, at 2 the upper and middle levels; In terms of knowledge reserves, Category 1 is at a high level and Class2 is at the lower and lower levels. While there are 5 people in category 1 and 16 in category 2, most local residents of Taiwan are in the lower middle of the typhoon.

The actual response capacity was largely due to the preparation of the typhoon before it passed, with 20 residents saying their homes did not have disaster prevention kits and only one respondent saying they had small medical kits in their homes. When a moderate typhoon makes landfall, residents will choose whether or not to go out according to the size of the wind, and after the typhoon passes, residents clean up their houses and around their houses, and a small number of them will do the epidemic prevention work.

In the knowledge reserve, 18 people said that there have been typhoon training, mainly through the typhoon before landfall, television, network, mobile phone and other information tips, but the typhoon knowledge of the reserve is not deep enough and system.

Table 4. Final Clustering Centre

	1	2
Practical coping ability	24	16
Knowledge Reserve	7	4

Table 5. Number of cases per cluster

Clustering	1	5.000
	2	16.000
Effective		21.000
Lack		0.000

Conclusion

Typhoons can directly cause many serious disasters because of strong winds and heavy rain. The greater the wind speed, the greater the wind pressure. The strong wind pressure brought by the typhoon can blow down houses, uproot trees, fly sand and stone, and hurt people and animals. However, typhoon due to wind casualties and economic losses are often relatively small, especially strong typhoon, residents will make good preparations in advance necessary to effectively reduce the damage caused by typhoons.

During typhoons, the disaster caused by rain is often the greatest. When a typhoon passes through, the rainfall process is affected by different factors, such as typhoon path, terrain, intensity, moisture content, moving speed and cloud rain distribution, which makes it difficult to predict. Therefore, the typhoon period of heavy rain can not get timely prevention and dredging, rainfall is too rapid, reservoir water too much, too late to flood, will trigger flash floods, river surge, resulting in low-lying flooding, destroyed houses, roads, bridges and so on, often lead to a large number of casualties and economic losses.

In typhoon prevention education, before the typhoon landfall, the government through television, network, mobile phone information and other publicity, Taiwan residents to prevent typhoon knowledge has been popularized, the overall knowledge of typhoon prevention is moderate, but non-typhoon prevention education is weakened and not systematic. In the actual response to typhoons, Taiwan residents before the typhoon made landfall, will carry out pre-checking, but most families do not have disaster prevention boxes 82% and other facilities.

Government: In infrastructure construction, the government should attach importance to the construction of disaster prevention parks, create a "sponge city" to reduce the loss caused by rainfall, and monitor and rationally regulate water levels in water conservancy projects such as reservoirs and dams. On meteorological monitoring, real-time monitoring of typhoon path, air pressure,

predicting the path of possible landfall, monitoring the distribution of cloud rain and water vapor content on land, simulation, prepared in advance. Information publicity, through television, computers, mobile phones and other electronic devices, the transmission of typhoon path information, the promotion of typhoon knowledge and countermeasures, to enhance the public's vigilance against typhoons that may cause damage, to remind the public to prepare for protection. Disaster relief, to provide the people with smooth rescue channels, improve rescue facilities, improve rescue efficiency. In post-disaster repair and epidemic prevention, statisticians damage and economic losses, search and rescue missing persons, clear the road traffic barrier, remove water, restore traffic, clean up the streets of the neighborhood, epidemic prevention, check for possible safety hazards and so on.

School: to provide systematic, vivid typhoon prevention education, improve students' knowledge of typhoons, before the typhoon landfall, the campus infrastructure to protect, check for security risks, when the typhoon landfall, master the situation of teachers and students, statistics, determine the safety of personnel, after the typhoon landfall, to carry out post-disaster repair, troubleshooting security risks and do a good job of epidemic prevention.

Family: disaster prevention education in a practical way, education of the next generation, enhance the family's ability to prevent typhoons, before the typhoon landfall, the family's security risks, procurement of adequate water and food, supplement the on the disaster prevention box items, typhoon landfall, maintain contact with the outside world, keep information open. After the typhoon transit, carry out post-disaster repair, post-disaster clean-up and epidemic prevention and so on.

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