Visualization Analysis of High-Risk Regions of Terrorist Attacks --the Case Study of Pakistan

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Abstract: In view of the geographical environment playing a vital role and influence in counterterrorism operations, the mastery of geographic information largely determines the effectiveness of operations. With the rapid advancement of informatization and intelligence of human society, the challenges and challenges of information confrontation will become much higher in the planning, organizing and deployment of further military operations. The more efficient and real-time intelligence analysis, commanding and decision-making will surely become the key to counterterrorism operations success in the future. Geographic Information System (GIS) with a complete database has become an important tool for commanding, decision-making, prevention, and preventive strike against terrorist attack. Based on the statistics of terrorist attack cases in Pakistan in 2013, this paper aims at conducting a visual analysis of the geographic features of terrorist attack cases and locate high-risk regions of attacks in order to understand counterterrorism situation in Pakistan.

1. Introduction

1.1 Understanding of Geographic Information System

Geographic information system and their associated geospatial technologies (such as global positioning systems, satellite remote sensing and digital aerial photography image processing technologies) have been widely used in various fields since the 1970s. At the beginning of the 21st century, the proliferation and destruction of terrorism affected countries around the world. The assistance of modern information technology is urgently needed to prevent and defuse terrorist attacks, operation against terrorist groups and the spread of extremist ideas. In the 1960s, the relevance of different spatial analysis content started to be considered. This kind of analysis was first called "Geo-statistics (also called *Kriging Method*)"by French geologist Matheron, a methodology for evaluating and estimating natural phenomena using variation function. In recent years, many countries have begun and strengthened the use of geographic information systems to provide comprehensive methods to maintain public security, counter-terrorism early warning and operations. GIS provides a good technical platform for spatial analysis. After the emergence of geographic information system, it quickly absorbed the available spatial analysis methods and means, integrated them into GIS software, and used various new computer technologies to efficiently use analytical geometry, logic and other operations and mathematical analysis to make complex spatial analysis tasks become much more simplified and intuitive.

1.2 The Analysis Functions of Geographic Information System

Geographical Information Systems have won praise in many respects for data structuring in a fairly complex way, and can perform unique forms of spatial analysis on data stored in GIS database. This data storage and analysis method can easily generate buffers around the elements, and then select the

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record, corresponding to other elements, in the designated buffer.

For example, the case where spatial analysis feasible and useful is delineating the distance from the location of a terrorist attack through travel time. This range includes block areas with three travel distances of 5 minutes, 10 minutes and 20 minutes, no matter what kind of transportations is. The street data used in this analysis needs to be merged into the buffer, and be linked to each block. Once these processes are completed, the travel time zone of each event can be compared with the suspicious location where the terrorist attack actually occurred (if relevant information has been coded before), and the demographic data of these areas, the travel time of the suspect can be matched in order to obtain continuous and accurate information about the suspect's possible whereabouts. It is important to note that the application of the above-discussed spatial analysis methods in counter-terrorism operations can use encrypted internal networks and national security agencies and counter-terrorism center servers for real-time data transmission and update, thereby efficiently tracking and combating potential terrorist attacks.

2. Marking the Regions with High Risk of Terrorist Attacks in Pakistan

Since the 21st century, the density and intensity of violence related to the terrorist attacks in Pakistan has been on the rise. After the war of Afghanistan outbroke in 2001, Pakistan became the forefront of the war on counterterrorism. We can include the geographic locations of violent cases that occurred in various regions in Pakistan from 2001 to 2018 into the scope of statistics, and coordinate with geographic information to mark high-risk regions. In this paper, we choose 2013 as our research year to analyze the phenomenon of terrorist attacks in Pakistan, as it recorded the largest number of attacks in that year. During the marking process, three indicators need to be evaluated.

First one, the group types that launched attacks. Second one, the correlation of attacks with location or regional characteristics. Third one, the intensity of the attack (including the number of cases and casualties). Based on these characteristics, we could map the high-risk regions with potential attacks with ARCGIS software. According to statistics on terrorist attacks in Pakistan in 2013, the attacks cases were approximately 2,300, the highest number since 1970 to 2018 (Figure 1). Even so, more than 1,800 serious attacks could not be confirmed their groups and types. In this paper, we can only analyze the 500 attack cases which the launch groups had been confirmed and Geo-tagged.

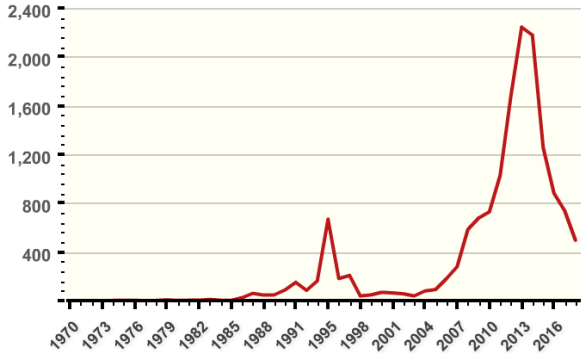

Fig.1 The Attack Cases from 1970 to 2018 Source: Global Terrorism Database

2.1 Geographical Demarcation of Attacks by Extremist Groups

The attacks in 2013 were mainly launched by four extremist groups: the Tehrik-i-Taliban Pakistan, the Lashkar-e-Jhangvi, the Islamic Army and the Mujahideen Ansar. In the process of analysis, in order to study the correlation between attacks and geographic characteristics, this section will examine cases where the number of casualties caused by related extremist groups and terrorist groups is more than zero, and the number of attacks is more than one.

2.1.1 The Geographical Label of Attack Cases by Tehrik-I-Taliban Pakistan

As the most active extremist group in Pakistan, the Pakistani Taliban (Tehrik-i-Taliban Pakistan) launched a total of 129 attack cases in 2013. The main attack regions and casualty statistics are shown in the following table (Table 1) and the Geo-labels are shown in the following Figure (Figure 2):

Table 1 the Attack Cases, Deaths and Injuries Launched by Tehrik-I-Taliban Pakistan in 2013

Place of Attack	Case number	Deaths	Injuries
Karachi	53	74	342
Peshawar	3	52	72
Khel District	3	5	2
Bannu	3	7	27
Quetta	3	52	72
Rawalpindi	2	12	45
Parachinar	1	23	70
Shamshatoo	1	16	10
Mattani	1	5	1
Swabi	2	9	6
Kohat	1	5	26
Kamar	1	9	5
Pindyali	1	3	4
Bazai	1	3	2
Yara Khel	1	3	2
Halimzai	1	3	5
Dogar	1	3	2
Hangu	1	25	55

Source: Global Terrorism Database

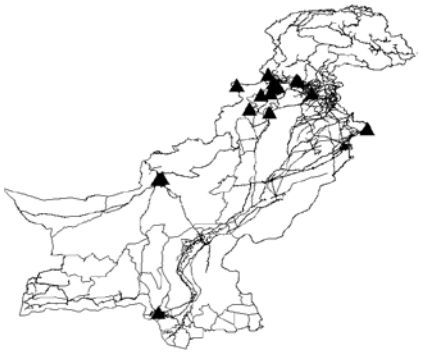

Fig.2 The Geographical Distribution of Attack Cases by Tehrik-I-Taliban Pakistan in 2013 (▲ for Place of Attack)

2.1.2 The Geographical Label of Attack Cases by Lashkar-e-Jhangvi

Lashkar-e-Jhangv was launched 18 attacks in 2013, resulting in 334 deaths. The attack in Quetta on February 15, 2013 became the worst case with 91 deaths among the 18 attacks. The main attack regions and casualty statistics are shown in the following table (Table 2) and the Geo-labels are shown in the following Figure (Figure 3):

Table 2 the Attack Cases, Deaths and Injuries Launched by Lashkar-e-Jhangv in 2013

Place of Attack	Case number	Deaths	Injuries
Karachi	6	61	172
Quetta	8	259	553
Jasooki	1	7	4
Mingora	1	37	70
Bara	9	24	31

Source: Global Terrorism Database

Fig.3 The Geographical Distribution of Attack Cases by Lashkar-e-Jhangvi in 2013 (for Place of Attack)

2.1.3 The Geographical Label of Attack Cases by Jaish-e-Islam

Jaish-e-Islam was launched 6 attacks in 2013. The worst case of attack occurred on November 1, 2013 in Machh, where 6 people were killed and 1 injured. The main attack regions and casualty statistics are shown in the following table (Table3) and the Geo-labels are shown in the following Figure (Figure 4):

Table 3 the Attack Cases, Deaths and Injuries Launched by Jaish-e-Islam in 2013

Place of Attack	Case number	Deaths	Injuries
Quetta	4	8	0
Ganji	1	0	0
Machh	1	6	1

Source: Global Terrorism Database

Fig.4 The Geographical Distribution of Attack Cases by Jaish-e-Islam in 2013 (for Place of Attack)

2.1.4 The Geographical Label of Attack Cases by Mujahideen Ansar

Mujahideen Ansar, later incorporated into the Pakistani Taliban, was launched a total of 12 attacks in 2013, the most serious of which occurred in Parachinar, which killed approximately 61 people. The main attack regions and casualty statistics are shown in the following table (Table 4) and the Geo-labels are shown in the following Figure (Figure 5):

Table 4 the Attack Cases, Deaths and Injuries Launched by Mujahideen Ansar in 2013

Place of Attack	Case number	Deaths	Injuries
Parachinar	2	61	151
Spinwam	1	4	5
Shawa	1	5	12
Kulachi	1	9	31

Wana	1	3	2
Bannu	1	1	8
Khel District	1	3	8
Boya	1	9	20

Source: Global Terrorism Database

Fig.5 The Geographical Distribution of Attack Cases by Mujahideen Ansar in 2013(■ for Place of Attack)

3. The Correlation of Attacks with Geographical Distribution of Population

In 2013, Pakistan had a population of approximately 191.3 million. Its population is mainly distributed in the eastern part adjacent to border of India and the north-central area along the Indus River. The geographical distribution of population is correlated with the attacks.

For Tehrik-i-Taliban Pakistan, Lashkar-e-Jhangvi, Jaish-e-Islam and Mujahideen Ansar, the main attack regions are as follow figure with population density (Figure 6).

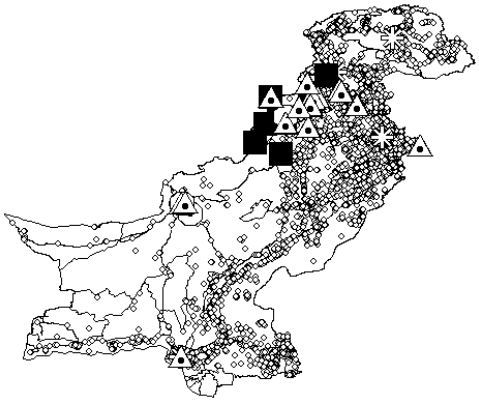

Fig.6 Correlation Analysis of Attack Cases by the Four Groups with the Geographical Distribution of Population (the More Babbles Scatter, the More Density the Population is)

From the perspective of population distribution, the high-risk regions of attacks are mainly concentrated in the north and northwest of Pakistan, especially along the border between Khyber Pakhtunkhwa and Federally Administered Tribal Areas, Federally Administered Tribal Areas and Afghanistan.

4. Conclusion

The risk of extremism and terrorist attacks along the border area between Afghanistan and Pakistan are comparatively high through the GIS analysis. Based on statistics on the amount of news reports related to terrorist attacks, combined with the characteristics of the GIS data distribution map, we launched a discussion on Pakistan's high-risk regions of terrorist attack.

Improving early warning system and increasing operation efficiency are crucial parts of counterterrorism. To achieve these two goals, analyzing the regularities of related attacks in the past is the key process. From the perspective of geographic information analysis, significant information flows around the planning, preparation, and deployment of the attack will definitely be formed before and after attacks. The hidden correlations among these information flows composed of a large amount of changing datum would be analyzed and explored by GIS. It is of great significance for improving the accuracy and real-time of counter-terrorism intelligence collection, strengthening the role of artificial intelligence in analyzing suspicious intelligence, and building a counter-terrorism early warning platform with help of Spatial Analysis.

Currently, the mainstream analysis methods include classification, cluster analysis, association analysis, anomaly detection, frequent subgraph mining, infrequent pattern mining, spatial pattern mining, etc. These methods above can effectively discover the tendency and structural characteristics of a large number of terrorism-related data streams. The structural characteristics of elements of terrorism could provide a useful reference for early warning and precision strikes against potential or ongoing terrorist attacks. The combination of geographic information system (GIS) and Geospatial Data Mining has become the most effective and non-substitutable method for monitoring, analysis, early warning and combating terrorism.

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