Research of Road Accessibility under Emergency Coupling in Tibet

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Abstract. With the improvement of living conditions and booming tourism in Tibet, more and more people choose Tibet as a tourism destination. More emergency events may happen when lots of people swarm into Tibet. This paper focuses on the accessibility of road network near Jokhang Temple in Lhasa at a peak tourist season with different events coupling. Some data about path lane, path width and trips of road has been collected and accessibility of road near Jokhang Temple has been computed with two disparate events. The result shows different emergencies coupling may cause different consequences to road network. So highway management department can set up various strategies to speed up traffic flow based on the degree of events coupling and make relevant measurements.

Introduction

With the development of global economy and industry, environmental problems have become more and more seriously. One event occurring caused by another event has been popular. Some research has been studied under the condition of emergencies coupling. Paper [1] studies the coupling of landslide and rainfall. Li Jie et al. proposes the traffic early-warning index in the situation of explosion and fire disaster coupling by using multi-algorithm with cluster analysis and Analytic Hierarchy Process [2]. Luo Yonggang et al. study the accessibility under multi-emergencies [3]. The coupling degrees of different events usually are different. For example, mass shootings events may cause more serious panic than single killing. So the degree of emergency coupling provides us a way to research accessibility of road network.

Tibet locates at southwestern region of China with the highest region about average elevation of 4,900 meters on earth [4]. Jokhang Temple was founded in 647 by King Songtsen Gampo (r. 617-49), the first ruler of a unified Tibet, and his two foreign wives who are credited with bringing Buddhism to Tibet [5]. With the development of economy and operation of QingZang Railway, many tourists by railway or cars come to Tibet to travel or make business. It makes road become more and more congested and kinds of accidents happen easily. This gives the road administrator new challenge about how to manage the city safety and efficiently especially when emergencies happened. The article mainly talk about the accessibility of road network near Jokhang Temple with emergency occurring. It uses the degree of emergency coupling and statistic data of road to compute the accessibility of location of emergency.

Mathematical Modeling

Emergencies refer to the important events that occur suddenly and can be divided into four categories: public health events, nature disaster, social safety accidents and accident calamity.
It can distribute into four levels: specially serious events, serious events, major events and common events. Events coupling means two or more events coupling which can happen at the same time or different time. Emergencies coupling can bring severe effects which cause vehicle jam, people gather and have a strong impact on delivering relief goods successfully. This paper mainly talks about the coupling between events and traffic.

The degree of coupling can be represented as $\omega_{ij}$ which can also be called weight factor, i and j mean the ith and the jth event. Larger weight indicates the coupling of event and traffic more close and the probability of one event occurring caused by another event is greater.

Emergency resource scheduling is related with transportation efficiency which is also known as accessibility. Accessibility of math equation [6] can be written as,

$$ A_i = \sum_{\substack{j=1 \\ j \neq i \}}^{n} s_{ij} i, j = 1, 2, 3...n $$

(1)

where $A_i$ is the accessibility of location i, defined as the sum of the spatial separations from all other locations j to that location, and $s_{ij}$ is the containable trips per hour from node i to node j. It is related to lane count, path width and trips unit time.

If emergency happens at location $A_i$, we can get another equation with the weight $\omega_{ij}$,

$$ W_i = \sum_{\substack{j=1 \\ j \neq i \}}^{n} w_{ij}^{-1} s_{ij} i, j = 1, 2, 3...n $$

(2)

Eq. 2 means that larger weight leads to smaller accessibility.

Case Analysis

This paper uses road network near Jokhang Temple in Tibet as a case to study the traffic accessibility with two events coupling. We list value of event’s levels and the type of event. These values can be obtained by experts questionnaire or Analytic Hierarchy Process method. In this paper, we give the values of table by experts. The relevant values are shown in Table 1 and Table 2, respectively. These values are used to calculate the weight of coupling by multiplying them simply.

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Specially serious events</th>
<th>Serious events</th>
<th>Major events</th>
<th>Common events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value(L)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1. The Four Levels of Event.

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Bomb attack</th>
<th>Earthquake</th>
<th>Fire</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value(T)</td>
<td>3</td>
<td>2</td>
<td>0.8</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Table 2. The Degree of Different Event with Traffic Coupling.

Study on Accessibility of Road Network Near Jokhang Temple with Lower Degree of Coupling

Fig. 1 shows the overall map of Tibet. It locates near Sichuan Province. First step, we simple the road network and number the traffic node according to the map of Jokhang Temple.
The simplified road nodes make our analysis easily and clearly. Road network are divided into 12 nodes and each node can be marked with a significant building. The result is shown in Fig. 2. From Fig. 2, we can see the conditions of road network clearly and some data about road condition survey have been obtained.

![The Tibet Map](image1)

**Figure 1. The Tibet Map.**

![The Sketch of Road Network Near Jokhang Temple](image2)

**Figure 2. The Sketch of Road Network Near Jokhang Temple.**

Second step, road condition survey is given, shown as Table 3. These data include path lane count, path width and trips (per hour) of all node shown in Fig. 1. We only select partial data records.

<table>
<thead>
<tr>
<th>Number</th>
<th>Start Node</th>
<th>End Node</th>
<th>Lane Count</th>
<th>Path Width</th>
<th>Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>1260</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>950</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>3.5</td>
<td>160</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>3.5</td>
<td>110</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>7</td>
<td>1300</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>8</td>
<td>900</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>9</td>
<td>2</td>
<td>8</td>
<td>300</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>11</td>
<td>2</td>
<td>7</td>
<td>1000</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>1862</td>
</tr>
</tbody>
</table>

According to Eq. 1, Eq. 2 and data from Table 1, Table 2 and Table 3, we can calculate Jokhang Temple’ accessibility is 78% with lower weight.
Study on Accessibility of Road Network Near Jokhang Temple with Two Important Emergency Coupling

When emergency events happen, lots of evacuation and rescue must be done to make sure people and supplies safety. In this situation, the degree of coupling becomes bigger and the weight is smaller. With equation and above data, we can calculate the accessibility is 5.9%. From above data we can conclude that the different degree of emergencies coupling can lead to different result.

Conclusions

The paper mainly talks about the road accessibility of Jokhang Temple in Tibet which uses different degree of emergencies coupling. We record the traffic data near Jokhang Temple and calculate the accessibility based on different degree. From the result different degree can lead to different road accessibility.

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References


