Crisis Management and Electricity Power Distribution Network Security Zone Determination with Using GIS&RS Technology (Case Study of Neka)

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Abstract

Using geospatial information system and remote sensing with the aid of geology studies is one of the most important issues in the electricity power distribution networks. The importance of this subject in power distribution network is considerable, and it is one of the effective ways of emergencies preventing and managing. This paper is the result of collecting the location and descriptive information of Neka city in 2012. We Used the DEM and the Geoeye2 satellite image of the area accompanied by the GIS data for the electricity network. Alternatively, the data was imported to ARC GIS software to creating a 3D model. We were able to determine the security zones of Sanatyl high voltage (HV) feeder in an area of about 10km². Finally, we achieved an optimized solution of crisis management by using the map of HV line security zone based on the international code for buffering standard.

Keywords: Crisis management, GIS, RS, Electricity power distribution network

Introduction

From all 44 kinds of the natural disasters in the world, about 33 frequently occur in different parts of Iran. In the list of disaster-prone countries, Iran is the sixth in the world and fourth in Asia [10]. This country is located among the world’s greatest faults, which extended from Italy to China. This factor could be the strongest reason for creating a crisis in this region [16]. However, the existence of energies such as electricity, water, and natural gas is vital and inevitable for human life. Therefore, their damages (even for a short time) will stop not only public services but also cause greater damages. Furthermore, in a crisis, demand for services will increase. Also, a massive electricity burden will impose to the organization [9].

The primary and technical definition of crisis management represents how the rescue teams should operate in crises. In the post, the crisis team would manage the post-crisis stage and would act in that phase [6]. Those passive activities had two major problems. Firstly, the team must wait until a crisis occurs and this will cost so much and the second problem is that the crisis manager is not able to predict the crisis and then decrease its effects [1]. After it became apparent, this definition of crisis management is not sufficient. Therefore, the idea of identifying a crisis before a disaster has to be considered. These efforts led to an organized and pre-crisis planned safety system [15]. According to the developments in communities and infrastructure designing and using new technologies, surely, we will be faced with new disasters. In new definitions of crisis, the planning is done in such a way that if a disaster happens the fewer failure will be resulted [4]. Preparation and training the teams should be considered and software issues must determine the effectiveness of that action. Regarding such definition, we must use comprehensive crisis management instead of a mere crisis management, which is performed in five phases: Planning, preventing and decreasing the effects, preparedness, acting and improvement [11].

Security zone in electricity distribution network

A near construction or even below medium voltage(MV) and low voltage(LV) network cause many loss of lives and property, and compensation of these losses needs spatial legal persuasion which in many situations will end up with massive financial penalties against distribution companies[13]. For optimal using of any equipment that does not
have allowable distance, we must comply with it. This range is referred to as a security zone. In the security zone issue, we usually emphasize on overhead lines. Although the underground lines have security zone, it is very low that can be ignored [3].

At present, most electricity distribution networks are overhead lines. Regardless of increasing underground lines, overhead networks will remain at the same extent [8]. The security zone determination with GIS is to specify an area with related distances around a point or a line or a polygon [7]. There are two kinds of buffers: buffers with constant distance and variable distance buffers. Both can be used to analyze the each equipment radius effective. In fact buffering is distance analysis in GIS.

**Materials and methods**

Neka is one of the cities in Mazandaran province. It locates at 36 degrees and 40 minutes north latitude and 53 degrees and 20 minutes east longitude. The city with an area of approximately 1865 km² is located in the north of Iran and the east of Mazandaran, 21km east of Sari, 20km west of Behshahr and 280km northeast of Tehran (Figure1)[12].

![Figure1: Study area in Mazandaran Province.](image-url)
The power electricity distribution company of Neka has two 63/20kv substations and 14mv feeders. There are 6mv feeders that are in metropolitan areas of Neka and their name are sanati1, Rahahan, Neka1, Neka2, Sanati2, and Sookhtresany. sanati1 feeder is studied in this paper (Figure2).

Figure 2: 20kv network of Neka.

The conceptual model was designed based on the research questions and the objectives of the study. As for the spatial and non-spatial relationships of data definition, the modeling of data has been defined. After designing the conceptual model, the logical model was designed to create a database [18]. Then, the spatial and attribute data were extracted from city map and customer databases [5]. This data is updated and prepared based on the electricity standards of the data preparation and the database creation. We analyzed the spatial and attribute data to determine the safety zones and to classify the data. In the next step, we determined the security zones using the distribution network standard of the safety zone (table1) [19].

<table>
<thead>
<tr>
<th>Network Type</th>
<th>Equipments</th>
<th>Horizontal Distance from the edge of streets</th>
<th>Horizontal Distance form Trees</th>
<th>Vertical Distance form Building</th>
<th>Horizontal Distance form Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 KV</td>
<td></td>
<td>0/15</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>220 V</td>
<td></td>
<td>0/15</td>
<td>1</td>
<td>2/5</td>
<td>1</td>
</tr>
</tbody>
</table>

In this paper, data are prepared in three layers of points, lines, and polygons. In the point layers, there are electricity network connections and beginning & end of line equipments. These equipments include switches, transformers, jumpers, etc. In the line layers, there are MV and LV feeders. Estate and homes features are structured within the
polygon layer. Since the position of the distribution network is important, the layer of feeders is separated as shown below (Figure3).

![Figure 3: LV network of Sanati1 feeder.](image)

Buffer analysis of ArcGIS 9.3 software was used to determine the security zones [2]. Therefore, we created a field called security zone with a “double” structure for each equipment in MV layer, we entered number 3m and for LV layer we entered a number 1m (Table1). By using buffer analysis and introducing the name of the above field as the criterion for distance measurement, the security zone layer was extracted. Estates in the study area were extracted from 1:2000 cadastral maps, which was obtained from GeoEye satellite image [14]. Analyzing the security zone and estates layer, it was determined that parts of some provinces are in distribution network of the security zone. Clip analysis was used to determine this interaction. The estate layer was introduced as the imported layer and the security zone layer as the clipper.

**Results and discussion**

In this study, because there was no comprehensive map of Neka town, we were forced to use GeoEye satellite image on September 2nd 2010. Remote sensing techniques were used to extract the last residential and commercial parcels (figure4).
To prepare the 1:25000 layers and Geodatabase, we used the map produced by national cartographic center of Iran and made the desired GIS layers ready. Then we entered the layer of Sanatil MV feeder, which was extracted by GPS. In the next step, we developed DEM of the area using ENVI 4.2 software [17]. Taking the prepared layers and satellite image and using DEM processing model, the 3D model of the study area is produced (Figure 5 and 6).

Determination of the security zone of Sanati1MV feeder was done by using buffering analysis (Figure7). Approximately 456 estates of 3545 overlaps with the security zone of distribution network. Total area of each application is represented in the following chart (Figure8).

In the security zone, issues like the high-security zone have to be considered; therefore, the 3D modeling of the area can be very useful. Therefore, the 3D model of the area was prepared and is shown in Figure 9.
Figure 6: DEM Preparation of Neka.

Figure 7: Security zone Sanati1MVfeeder.

Figure 8: Total area of each application in the security zone.
HV, MV, and LV electricity network 3D models to determine high overlapping above method can be used by various organizations and therefore the model was created in model builder environment of software. Therefore, a toolset was designed in Arc toolbox and then the model was created. Then some needed analyzes were added to the model such as summarizing statistics, clip, Buffering (Figure 10). Anyone can easily define importing and exporting layers, change the parameters and analyze his data.

Conclusion

The useful application of GIS in electrical distribution networks and comprehensive crisis management with identification of high-risk centers and doing preventive actions are essential and critical because managers and specialists who are responsible can make better decisions. According to the results shown in figure 4, urban cadastral map and updated Geodatabase of distribution network of Neka city were obtained. Figure 5&6 show how to obtain a 3D model without going to the area with minimum cost and time. Modeling the 3D model structure of area and distribution network element and the study of overlapping the layer of the security zone and other layers in a three-dimensional environment are some results of this study. According to the chart (Figure 8) and figure 7, 9, most violation of security zones were related to residential areas. Due to sensitivity and importance of this issue, it is...
worthy to take appropriate process in this area through modifying the network distribution. In the second phase, it referred to the joinery and wasteland area. Finally, there are 12 percent of buildings from 3545 units in the security zone. Therefore, by considering the figures in result and development of buildings construction, it is important to observe the Rules of Construction in this area until we have the minimum of Losses in crisis times such as Earthquakes, floods and landslides that could, with comprehensive plan at the crisis time, attempt to resolve crisis. At the crises, Operational response is necessary to save lives, money and other assets. Nevertheless, it is also important to note that the foundation of the optimal response at times of crisis with minimal losses is programmed before the beginning of the plan.

Reference
[18] Ukrina j., Department of surveying and geoinformatic, Faculty of Environmental Sciences Nnamdi Azikiwe University, Awka, Anambra State, Nigeria, (2005).