The Risk Assessment on Gas Pipelines Surrounding Environment

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Abstract

Gas pipeline accidents frequently happen in recent years, causing varying degrees of impact on the surrounding natural and social environment. In order to protect the safety of gas surrounding people's life and property, and maintain social economy and public order and stability. this paper through the analysis of current techniques and methods of risk assessment of gas pipeline, put forward a kind of gas pipeline surrounding environment risk assessment system based on the technology of spatial information. Offering important reference basis for government management planning, construction and investment decisions, guiding the work of disaster prevention and reduction of Science.

Keywords

Gas Pipeline Accident; Pipeline Environment; Risk Assessment; GIS.

1. Introduction

Gas accidents involving pipeline along the perimeter of the environment, and study the influence of the pipeline accidents on the surrounding environment, guides the work of disaster prevention and mitigation of science is of great significance. Risk assessment can accurately and quickly reflect the severity of the pipeline accidents and the spatial distribution of risk and risk level, for the planning and construction of the management of government department and provides an important reference for investment decisions.

This paper introduces the GIS spatial analysis and visualization technology pipeline risk evaluation system, gas pipeline and pipeline surrounding environment as the research object, the theories and methods based on spatial information, using GIS buffer analysis, superimposed analysis and the application of visual function in the pipeline risk assessment, and combining ArcGIS software tools to the pipeline data processing and analysis on the surrounding environment risk assessment research, grasp of the theory and technology based on spatial information pipeline surrounding environment risk assessment method and the basic train of thought, explore a set of convenient and apply the theory of technology, for the gas pipeline environment risk assessment provides a broad application space.

2. The application of GIS in risk evaluation

With the rapid development of GIS technology, applying GIS to the field of risk assessment has become the current development trend. Introducing GIS technology to pipeline risk assessment, the main is to use GIS strong spatial data management and analysis ability, the implementation of environmental risk assessment tools in piping. Make full use of the GIS space analysis of superposed function, make each evaluation factor of project layer, and then the corresponding evaluation factors respectively overlay layer using a function is used, and generate the accident severity and vulnerability assessment layer respectively, two superimposed operation according to certain function model, then get pipe layer surrounding environment risk assessment, risk assessment results. In this paper, the research process will be the main use of grid spatial overlay analysis of the function, which is better in current GIS spatial analysis function.

3. Risk analysis theory and method

3.1 Pipeline peripheral regional environment risk assessment system

Gas pipeline surrounding environment risk refers to the environment surrounding the pipeline under threat of risk of hazard-affected bodies. It [] (risk) of hazard-affected bodies can be said:

The risk of hazard-affected bodies= Pipeline accident severity×The vulnerability of hazard-affected body

Pipeline risk of surrounding environment, must consider the local specific circumstances, comprehensive analysis of various factors to the final evaluation. It is threatened in pipeline surrounding environment building, staff, parking and other kinds of risk of hazard-affected bodies stack. Quantitative analysis on GIS platform, the use of pipeline data accident severity and environmental vulnerability, combining the pipeline risk assessment and spatial location information, risk evaluation method of exploration based on the theory of spatial information and superposition method, space of risk, and visualization.

3.2 The severity of the accident analysis

The accident severity evaluation is an important content of the pipeline risk assessment [6], with S, said the accident severity model such as formula (1) and formula (2).

$$s = \sum_{i=1}^{n} f_i s_i \tag{1}$$

$$s_i = \sum_{i=1}^{m} p_{ij} s_{ij} \tag{2}$$

S representative accident severity; f_i represents the failure mode I failure probability; s_i represents the harm the severity of failure mode I; p_{ij} represents the probability of harm mode j; s_{ij} represents for the harm the severity of harm mode j.

3.3 Environmental vulnerability analysis

Environmental vulnerability is the environment in a variety of synthesis of the vulnerability of hazard-affected bodies of hazard-affected body, the main gas pipeline accident hazard is thermal radiation and shock wave after fire or explosion. Different thermal radiation and shock wave of hazard-affected body, can cause different degree of damage. Evaluate environmental vulnerability is the environment in the thermal radiation and shock resistance of hazard-affected bodies.

3.3.1 Thermal radiation

A fire on the environmental impact is the thermal radiation, environment under thermal damage degree of hazard-affected bodies represents its ability to thermal radiation. When the fire happened, receives the thermal radiation of hazard-affected bodies is equal to or greater than the critical thermal radiation can cause damage of hazard-affected bodies required, the body will be hurt. Below illustrate some common damage critical thermal radiation [], as shown in table 1.

Table 1. Ommon critical thermal radiation damage

Thermal radiationkw/	The damage to the human body	The damage to the equipment
1.6	Radiation is comfortable for a long time	
2.0		VC insulation cable damage
4.0	More than 20 seconds feel pain, not necessarily a bubble	
4.5	20 seconds to feel pain, once burned	
6.4	Second degree burns 8 seconds to feel pain, 20 seconds	

12.5	10 seconds, first-degree burns; A minute, 1% burns	When a flame, wood burning, the minimum energy plastic melt
25	10 seconds, major damage; A minute, 100% died	No flame, the minimum energy long wood under the radiation of the gas
37.5	10 seconds, 1% burns; A minute, 100% died	All operating equipment damage

3.3.2 Resistance to shock wave overpressure - impulse

Pact on the environment are the blast overpressure and impulse, environment under shock wave overpressure and impulse of hazard-affected bodies of damage degree represents its ability to resist shock wave overpressure and impulse. Environmental goals are being hurt, damage degree, is by the effect on the target of blast wave overpressure and explosion wave impulse decided jointly, if their different combinations can satisfy the corresponding conditions, can the same degree of damage to the target.

3.3.3 Vulnerability assessment of hazard-affected bodies

Gas accident is fire to the harm of hazard-affected body, the thermal radiation and the blast shock wave produced by the result of joint action, the vulnerability of hazard-affected bodies instead of their own resistance to shock wave overpressure and impulse and ability is proportional to the thermal radiation. Ability to resist shock wave overpressure impulse and thermal radiation of the stronger, the less the vulnerability of hazard-affected bodies. Thermal radiation of hazard-affected bodies and shock wave overpressure impulse damage vulnerability with 0 ~ 1, vulnerability is more close to 1 means more easily damaged, on the other hand, the more it is not easy to be damaged. Through analysis and study, can get type (3).

Vulnerability with A said:

$$A = ax + by \tag{3}$$

A for the thermal radiation vulnerability. b for shock wave vulnerability; x for weight of vulnerability in the vulnerability of hazard-affected bodies; y for the weight of vulnerability in the vulnerability of hazard-affected bodies.

3.4 Environmental risk assessment

Gas pipeline environment risk refers to the environment surrounding the pipeline under threat of the risk of hazard-affected bodies of the stack.

The risk of hazard-affected bodies= Pipeline accident severity×The vulnerability of hazard-affected body

Environmental risk = The risk of a of hazard-affected bodies + The risk of b of hazard-affected bodies + + The risk of c of hazard-affected bodies +…

But the risk is not simply additive, so here to monetize the risks. In this article, we admit that life has a price and has the same value, so whether people or buildings, vegetation vehicles, etc all due to the damage caused by gas accident were eventually to economic losses to show it.

Here is the calculation method of environmental risk (losses), as shown in type (4).

$$\text{R:}\quad R = \sum_{i=1}^{n} A_i S_i V_i \tag{4}$$

R is for environmental risk; A_i representative I the vulnerability of hazard-affected body; s_i represent I area of hazard-affected bodies of accident severity; V_i I monetary value of hazard-affected bodies.

4. Pipeline environmental risk assessment

4.1 The selection of hazard-affected body in area

Based on the predecessors' experience, choose pipe, population, these three parking lot around buildings for risk assessment. Although only chose three to risk evaluation, the result does not necessarily have the scientific nature and rationality, but through this research, preliminary master can use ArcGIS platform for the realization of the risk assessment method and the basic line, the significance is profound and significant.

4.2 Risk evaluation index quantification and classification of hazard-affected bodies

ArcGIS platform to get to the environmental risk classification figure, you first need to according to the practical of each evaluation index for grading.

4.3 Data preparation and processing

According to a raster image after registration will be vector map, map the vector graph, as shown in figure 1.

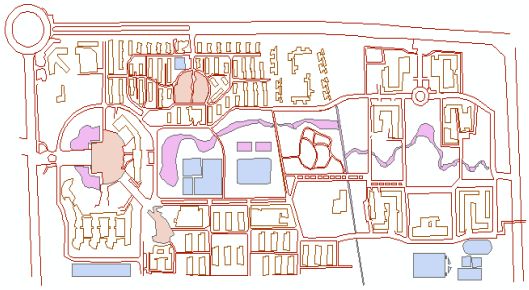

Figure 1. Image vector diagram

4.4 The study area pipeline environment risk assessment process

4.4.1 Study area pipeline accident severity buffer

Failure situations are simulated in this paper, the pipeline laying and the method to obtain and assume that all internal and external factors of the pipeline failure is the same. Only to have the area of gas pipeline were analyzed, and the part of the intercept vector diagram, the laid of the pipeline as shown in figure 2.

Figure 2. Study area vector diagram

Pipeline accident affects certain areas around the pipe, so to determine the influence of pipeline accident severity, pipe according to certain width for pipeline failure consequences severity buffer analysis.

4.4.2 Research on regional vulnerability analysis of hazard-affected bodies

A. Building vulnerability analysis

After do this, can analyze the area building vector layer, building the vulnerability of the accident is decided by two factors: the structure of the building and the number of floors of the building. For building a vector layer to add fields and rasterize assignment and distribution. According to generate the structure and building floor distribution, using the superposition of grid computer generated based

on the above two factors of the study area building vulnerability grade partition map. This paper to measure the risk of building in the form of monetization, the risk can monetize more intuitive the size of the expression of risk, so the area of the building of the value of rasterize distribution as shown in figure 3.

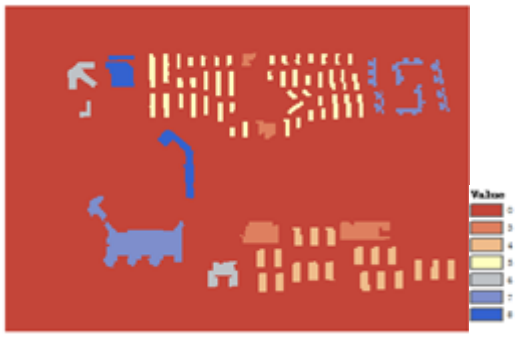

Figure 3. Rasterize building value distribution

B. The parking lot of the vulnerability analysis

The analysis of the parking lot and the analysis method of the building is the same, as shown in figure 4.

Figure 4. Rasterize parking lot value distribution

C. Human vulnerability analysis

Vulnerability in order to more intuitive expression and description of the personnel, in this paper, the study area is divided into six small regions, each region in the number of people are not the same, the number of people in the vector map is according to the research area of the grid map drawn according to the manual and add fields and assignment, and get a vector layer grid figure.

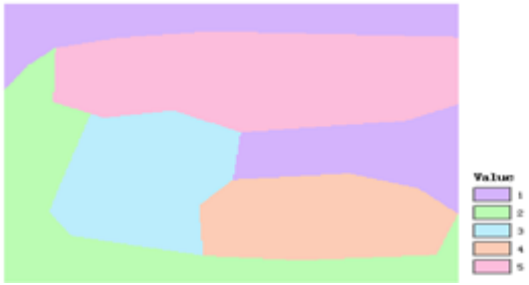

Figure 5. Rasterize population distribution

In this article we admit that life has a price and has the same value, so the value of the population spatial distribution and spatial distribution of population is the same.

4.5 Area pipeline accident risk to the environment

According to the above accident severity distribution and the vulnerability of hazard-affected bodies, value distribution. Superposition of the layer shall be carried out in accordance with the evaluation model can be generated according to the three layer risk assessment in the study area. According to the risk profile, the superposition of using raster calculator can be generated according to the three layers generated risk evaluation in the study area map for reclassification and compared with regional vector layer overlay, as shown in figure 6.

Figure 6. Pipeline accident distribution of risks to the environment

Can be seen from above 6 based on the selected three risk assessment of hazard-affected body under different risk levels in the study area in spatial distribution. Although evaluation process environment only selected the population of hazard-affected bodies, parking lot, three types of buildings, while the actual pipeline surrounding environment is complex, the selection of such does not have practical significance. But the results are in conformity with the actual, so in this paper, using the research method has practical significance.

Study of gas pipeline accident risk, the surroundings can be for the government management planning department, the engineering construction personnel decision, construction, management and investment decision makers to provide important reference basis, guides the work of disaster prevention and mitigation of science is of great significance.

5. Conclusion

This article will pipeline and pipeline surrounding environment as the research object of hazard-affected bodies and gas pipeline peripheral environment risk assessment system is established, and the gas pipeline is implemented with the help of ArcGIS platform circumjacent environment risk assessment. Based on this evaluation system, can use ArcGIS platform to realize any area based on any environmental accident risk assessment of hazard-affected bodies. The risk evaluation system to make up for the shortage of the traditional risk rating system. For the planning and construction of the management of government department and provides an important reference basis for decisions on investment in science is of great significance to guide the disaster prevention and mitigation work.

In spite of this, this article on the gas pipeline of risk evaluation on the surrounding environment still exist the following problems:

(1) For pipeline risk of hazard-affected bodies in the surrounding environment, only consider the buildings, hazard-affected body, such as population, parking lot, not to other evaluation of hazard-affected bodies.

(2) In the risk assessment of pipeline surrounding environment, only consider the immediate harm, not to evaluate the secondary disasters, only in the fourth chapter thesis some mention of a domino effect.

These problems will slowly progressive perfect will in future research.

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