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Research on urban emergency capability evaluation system based on system dynamics

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Abstract

This paper expounds on the research status of the evaluation index system of urban emergency management. Based on the principle of index selection and referring to relevant literature, the evaluation system of urban emergency capability with secondary indexes is constructed, and the system dynamics method is used to simulate the indexes, which provides ideas for the improvement of urban emergency capability.

Keywords

Urban emergency management; evaluation system; system Dynamics.

1. Introduction

China's cities have the characteristics of dense space, large population, and concentrated economy. In addition, they are currently in the stage of rapid development of industrialization and urbanization[1]. All kinds of risks and hidden dangers are intertwined and superimposed. Once a disaster occurs, it will cause immeasurable losses. How to deal with sudden disasters, reduce the impact of disasters and reduce disaster losses has become an urgent problem for defending urban security.

In this paper, the urban emergency management ability is analyzed. Based on the scientific, systematic, and operational principles, an evaluation system of urban emergency management ability is constructed, which includes four aspects: preparation ability, monitoring, and early warning ability, emergency response and rescue ability, and recovery and reconstruction ability. The criterion layer and sub-standard layer contain four criteria and ten indicators respectively. Finally, the improvement path of urban emergency response capacity is proposed based on system dynamics.

2. Construction of Urban Emergency Management Capability Evaluation System

A scientific and effective urban emergency management capability evaluation system can be used to assist the healthy development of the city, and help the city to evaluate the effectiveness of emergency management capability development, identify problems, and improve them in time.

2.1. Principles for selecting indicators

Scientific principle[2]. The selection of indicators should truly and accurately meet the actual requirements of urban emergency capacity building, and each indicator should be selected on a scientific and rigorous basis. The division of indicators should comply with established standards, neither too detailed nor too simple. There should be a correlation between indicators of the same classification and no cross-cutting between indicators of different classifications.

Systematic principle[2]. The evaluation of urban emergency capacity needs to be carried out from a systematic perspective. When selecting the index factors affecting urban emergency

capacity, it is necessary to combine the local situation and comprehensively coordinate the internal relations among the indicators of urban emergency management. The selected indicators should also comprehensively reflect the emergency characteristics of the whole city.

Operational principle[2]. The selected indicators must be able to be measured and statistically analyzed in reality, so that it has strong operability. The indicators that cannot be operated on are not meaningful in the urban evaluation index system.

2.2. Construction of evaluation system

By the above principles, six non-duplicative first-level evaluation indicators and 10 second-level indicators reflecting the capacity of urban emergency management are selected among the numerous reference indicators[2][3][4], as shown in Fig. 1.

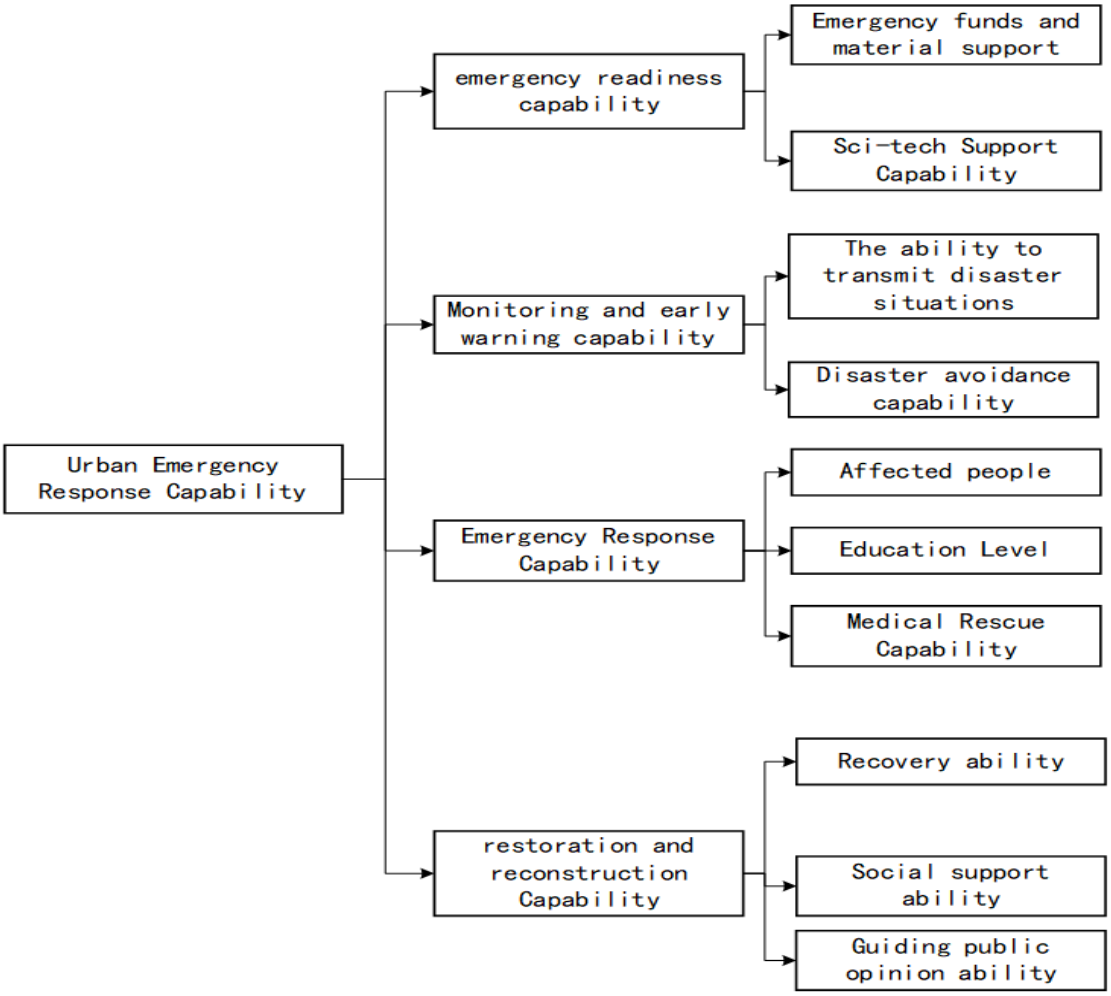

Fig. 1 Urban Emergency Management Capability Evaluation System

3. Evaluation System of Urban Emergency Response Capability Based on System Dynamics

3.1. Overview of system dynamics

System dynamics appeared in 1956 and was founded by Professor Jay. W Forrester [4]of Massachusetts Institute of Technology. System dynamics believes that the structure of the system is based on the causal loop, so the analysis of the index causal relationship is the key to the system dynamics modeling. Whether the causal analysis is comprehensive and accurate reflects the degree of understanding of the system operation and development mechanism.

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3.2. Causality diagram

The causality diagram is the basis of building SD, which is a qualitative description of the relationship between internal indicators of the system. Figure 1 summarizes the relevant indicators that affect the urban emergency response capacity and draws the causal relationship diagram of each indicator by using system dynamics, which can further analyze the correlation between the internal indicators. The causal relationship between indicators at all levels in the evaluation system is shown in Fig. 2. In the figure, the ' + ' representative indicators have a promoting effect and the ' - ' representative indicators have a weakening effect.

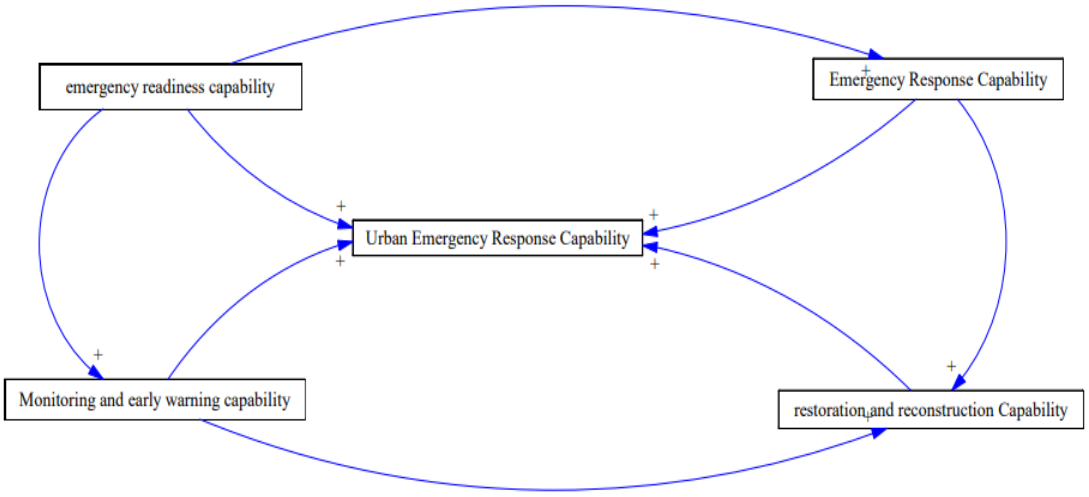

Fig. 2 Causality diagram between primary indicators and overall objectives

3.3. Construction of system flow diagram

Based on the comprehensive analysis of the relationship between the above internal variables of each system, the overall flow chart of the urban emergency capability evaluation system is drawn by using the system dynamics software, as shown in Fig. 3.

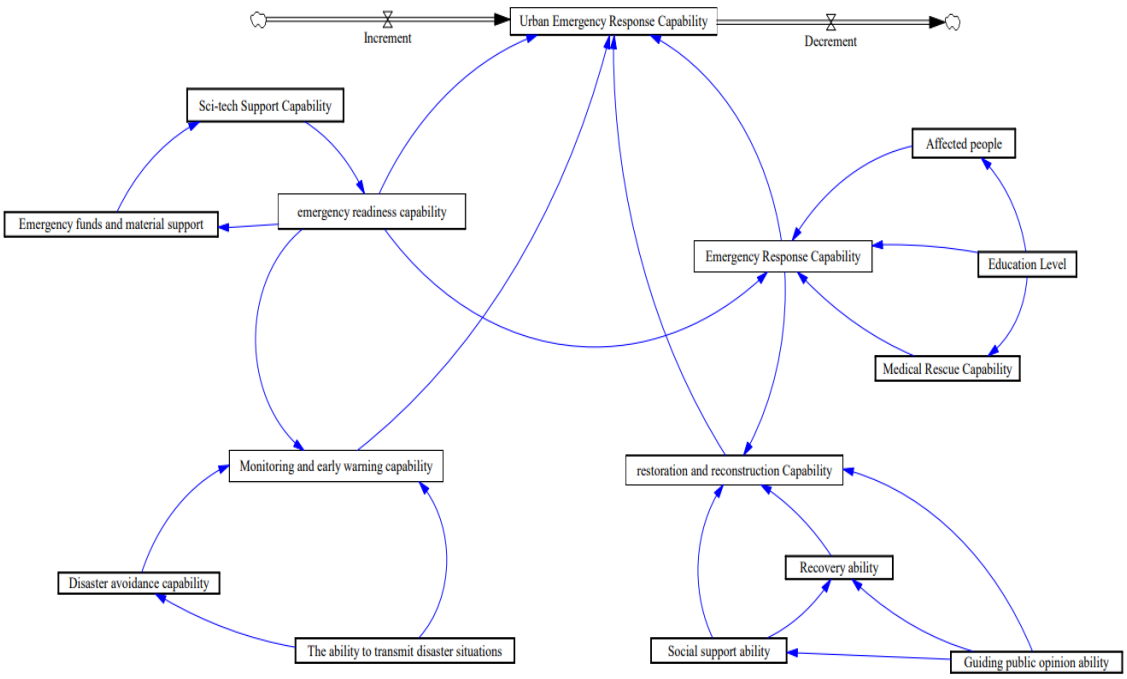

Fig. 3 System overall flow diagram

4. Conclusion

It is particularly urgent to establish a scientific and efficient evaluation index system of urban emergency response capacity. Due to the complexity of China's terrain, there are great differences in the total amount of resources, population size, and information construction in different geographical locations, which is not conducive to scholars' in-depth analysis of the dominant factors hidden behind urban emergency response capacity. In this paper, by using the method of system dynamics and using VENSIM-PLE software, the influence relationship between each index is analyzed, which points out the direction for improving urban emergency response capacity and avoids the blind waste of urban construction resources.

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