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Cartography for Emergency and Disaster Management: Research Hotspots and Trends

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Abstract:

Typical disaster events worldwide mainly include drought, earthquake, wildfire, floods, heatwave, and so on. Just at the beginning of this year, the Los Angeles fire has caused huge losses to residents, the environment, and the economy. The air pollution caused by the fire also poses a serious threat to public health. During the process of emergency handling of fire, maps came into play! As we can see, maps are an indispensable tool for visualizing disaster information. It provides a clear spatial understanding of the affected areas, helping decision-makers allocate resources efficiently and plan effective responses. From identifying vulnerable populations to mapping safe evacuation routes, maps are crucial at every stage of disaster management.

Disaster maps can be classified according to different standards. The classification standards are not fixed. Currently, they can be mainly classified according to disaster type, disaster management time, cartographical scale, technical method, expression carrier, etc. We searched and sorted the literature based on the relevant topics of CEDM, and analysed more than 140 articles and 376 keywords. Through word cloud analysis and visualization, we can find high-frequency words such as data, disaster, risk, spatial, emergency, mining, and visualization in the CEDM field. At present, CEDM research hotspots are mainly concentrated in five aspects: user-centered disaster mapping, big data-driven disaster mapping, dynamic mapping based on the geographic model, disaster scenario based on digital twin, and disaster narrative mapping.

Based on the classic map information transmission model, we put forward user-centered disaster mapping and the issues that mappers should consider: Who is the user? What does the user want? When does the user need it? How can the mapper draw it? As the indoor evacuation map, we have summarized several completed studies and proposed a user-centered design concern: 1. The hierarchical construction of indoor landmarks, 2. What are the preferences of users with different levels of spatial familiarity in landmark selection? 3. How does the spatial complexity affect the indoor navigation map design for users? 4. The adaptive design of existing indoor navigation maps does not allow for all navigation map elements, leading to inappropriate map information during the navigation process. And also, how do the map makers know the attention of different types of user groups for the emergency activities at different stages? We introduced the usability evaluation methods of flood risk map symbols from the perspectives of users' cognitive processes and influencing factors.

The second hotspot is big data-driven disaster mapping. Data is very important in disaster mapping, such as geospatial data, meteorological and environmental data, population and socioeconomic data, real-time disaster monitoring data, historical disaster data, emergency resource data, etc. We conclude the classification of big data and the characteristics of big data for disaster management. Then we introduced the study on mobile phone data, social media data, crowd-sourcing data, and video data for emergency and disaster management.

The third hotspot will introduce the dynamic mapping based on the geographic model. Dynamic maps can use the multi-dimensional visualization model and dynamic map symbols, etc., to express a continuously changing process of geographic entities or dynamic natural phenomena, social and economic phenomena. OpenGMS (https://geomodeling.njnu.edu.cn) can be employed by multi-disciplinary users through the network to solve complex geographic problems and conduct integrated simulations. We introduced the urban waterlogging application domain extension model, city waterlogging application domain extension (CTWLADE), and it is ready to be integrated into a

Web 3D Service to provide the data for 3D dynamic visualization in interactive scenes. And another method for the visualization of waterlogging information displayed under different spatial and temporal granularities will be introduced.

In the fourth part, we will introduce the scenario and narrative map construction theories and methods for disaster management. The framework and a lot of case studies of the study will be introduced.

In the conclusion, we will put forward the research trends for CEDM. First is the body of knowledge for CEDM, then is about how to visualize the Nature-Social-Memory Coupling Mechanism for EDM? And last one will be how can we combine artificial intelligence with disaster emergency mapping?

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