LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

Le Ministre de l'Économie,

Vu la loi du 20 juillet 1992 portant modification du régime des brevets d'invention, telle que modifiée ;

Vu le règlement grand-ducal du 17 novembre 1997 concernant la procédure et les formalités administratives en matière de brevets d'invention ;

Vu le dépôt de la demande de brevet luxembourgeois daté du : **03/12/2021 ;**

Arrête :

Art. 1er.- Il est délivré à la (aux) personne(s) mentionnée(s) sur le tableau des données bibliographiques attaché au présent arrêté, sous le numéro de code 73, un

BREVET D'INVENTION N° LU500953

pour : Rainstorm disaster risk assessment method and system
tel que décrit dans les duplicata des pièces techniques joints en annexe.

Art. 2.- Le brevet est délivré sans examen préalable de la brevetabilité de l'invention, sans garantie de l'exactitude de la description et aux risques et périls des demandeurs.

Art. 3.- Le présent arrêté, qui constitue le titre de protection, est expédié au(x) mandataire(s) agréé(s), mentionné(s) sur le tableau des données bibliographiques attaché au présent arrêté, sous le numéro de code 74 ou, à défaut, à la (aux) personne(s) visées(s) à l'article 1er, pour servir de document probant à celle(s)-ci.

Luxembourg, le **03/06/2022**

Pour le Ministre de l'Économie,

Corinne Müller
Attachée
Office de la propriété intellectuelle

(19) LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

(11) N° de publication : **LU500953**

(12) **BREVET D'INVENTION** **B1**

(21) N° de dépôt: LU500953

(22) Date de dépôt: 03/12/2021

(51) Int. Cl.:
G06Q 10/04, G06Q 10/06, G01W 1/02

(30) Priorité:

(43) Date de mise à disposition du public: 03/06/2022

(47) Date de délivrance: 03/06/2022

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(54) **Rainstorm disaster risk assessment method and system.**

(57) The invention discloses a rainstorm disaster risk assessment method and system, which comprises the following steps: S1, collecting and sorting out data and building a risk database; S2, calculating area rainfall through forecast data, radar estimation and rainfall station data; S3, determining disaster-causing critical precipitation; S4, analyzing the exposure and vulnerability of the carrier; S5, combining the risk database, the determination of disaster-causing rainfall and the exposure and vulnerability of the carrier, building a risk assessment model, and obtaining the scope and distribution map of disaster risk and the quantitative estimation of disaster risk. The application realizes the uniform distribution of automatic stations, accurate range control and better response to the distribution of precipitation. In this application, the discrete site distribution is used to interpolate data into a mesh data structure, which realizes the accurate monitoring and evaluation of rainstorm and improves the ability of rainstorm monitoring and forecasting.

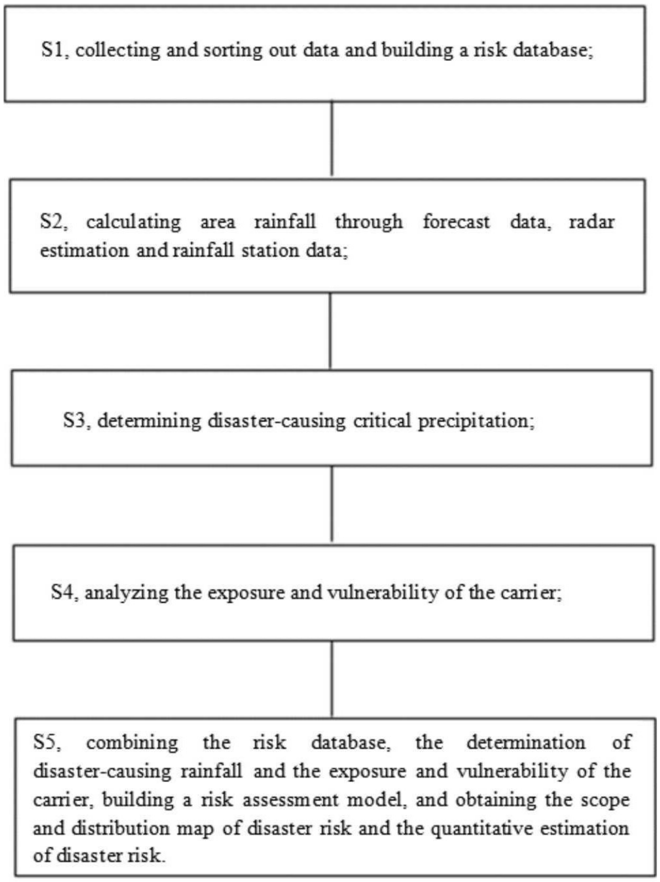

Figure 1

LU500953

DESCRIPTION

Rainstorm disaster risk assessment method and system

TECHNICAL FIELD

The invention belongs to the field of risk assessment, and in particular relates to a method and system for rainstorm disaster risk assessment.

BACKGROUND

In recent years, meteorological disasters have occurred frequently, causing more and more serious social and economic losses. The occurrence of any disaster is the result of the joint action of disaster-causing factors, hazard-formative environments, disaster-bearing body and disaster prevention and mitigation capacity. Among them, disaster-bearing body, as one of the important links of disaster occurrence, has the closest relationship with human system and social and economic system. Therefore, the research on meteorological disaster risk assessment has been widely valued. Rainstorm is one of the most serious and frequent meteorological disasters. It is easy to cause floods, urban waterlogging and other disasters, which in turn leads to casualties and major economic losses. Quantitative estimation of rainwater is one of the hot and difficult topics in weather research at home and abroad, radar prediction can pass rain intensity information with high temporal and high altitude resolution, but its accuracy is limited. Rain gauge measurement is the most widely used simple method to directly measure precipitation, but the station density is limited. In order to improve the accuracy of rainwater estimation, the existing technical means are mainly to assess the risk of heavy rain and disastrous weather through the main forecast data, the actual measurement of automatic stations, and the estimated precipitation by radar. The main deficiencies of this assessment technology are: (1) the accuracy of forecast data is affected by many factors such as model stability and the limitations of analysis factors; (2) the distribution of automatic stations is uneven, and the large area does not reflect the spatial distribution of precipitation well. (3) The coverage area of the precipitation estimated by radar is limited, the quality control is difficult, and it is easily affected by terrain occlusion.

Therefore, it is very important to provide a storm disaster risk assessment method and system for disaster assessment of mountain torrents and small and medium rivers, and it is an urgent problem to realize automatic assessment and efficient assessment of storm disaster risk.

SUMMARY

The technical problem to be solved by the invention is to solve the problem of inaccurate determination of rainstorm disaster risk assessment. The application can efficiently assess the disaster risk caused by rainstorm, accurately assess the disasters caused by rainstorm in mountain torrents and small and medium-sized rivers, make disaster prevention preparations in advance, and greatly reduce losses.

To achieve the above objective, the present invention provides a rainstorm disaster risk assessment method, which includes the following steps:

S1, collecting and sorting out data and building a risk database;

S2, calculating area rainfall through forecast data, radar estimation and rainfall station data;

S3, determining disaster-causing critical precipitation;

S4, analyzing the exposure and vulnerability of the carrier;

S5, combining the risk database, the determination of disaster-causing rainfall and the exposure and vulnerability of the carrier, build a risk assessment model, and obtain the scope and distribution map of disaster risk and the quantitative estimation of disaster risk.

Optionally, the data collected and collated in S1 include basic data of meteorological data, hydrology and water conservancy data, urban pipe network data, geographic information data and social statistics data.

Optionally, the steps of calculating the amount of rain in S2 are as follows:

analyze the spatial correlation of forecast data, rainfall station data and radar station data, and select the station data with larger index;

various spatial interpolation methods are used to interpolate discrete station data into fine gridded area data, and according to the spatial distribution characteristics of precipitation, altitude, terrain fluctuation and slope are used as collaborative variables to construct a spatial interpolation model.

Cross-validation method is used to compare the actual effects of different methods and models, and the optimal treatment scheme is selected for area rainfall calculation and gridding calculation.

Optionally, the interpolation method is Kriging method and inverse distance weighting method.

Optionally, the steps of determining the critical precipitation for disaster in S3 are as follows:

make clear the rainstorm intensity and calculate the frequency and recurrence period of rainstorm intensity;

establish the quantitative relationship between surface rainfall and precipitation, hydrological characteristics and underlying surface in the study area;

calculation of rainfall at critical interface of disaster based on hydro-meteorological coupling technology.

Optionally, the steps of exposure and vulnerability analysis of the carrier in S4 are as follows:

through on-the-spot investigation and full cooperation with water conservancy and statistics departments, multi-buffer analysis and spatial superposition spatial analysis technology combined with statistical methods are used to solve the problems of spatial scale disunity and data fusion, and multi-source databases containing different types of carriers are established.

In this paper, the disaster risk caused by severe rainstorm weather is related to the carrier, and the identification result of dynamic rainfall is spatially superimposed with the carrier data under a unified data framework, real-time extraction of the number and spatial distribution of the carriers under different precipitation grades and durations to realize dynamic identification of the exposure of rainstorm carriers;

spatial superposition of simulation results and carrier data is used to extract the exposure of different types of carriers in different grades of precipitation.

Establish the response curve of the damage rate of the bearing body with the change of rainfall, and evaluate the vulnerability of the bearing body.

Optionally, the multi-source database of the carrier includes information data of population, economy, buildings, urban traffic and urban pipe network.

Optionally, the disasters of the output disasters in S5 include waterlogging disasters, and waterlogging simulation adopts a two-dimensional unsteady hydrodynamic model.

A rainstorm disaster risk assessment system includes: a risk database module for collecting and storing meteorological data, hydrological data, urban pipe network data, geographic information data and social statistical data; area rainfall calculation module, which is used to analyze the correlation of site data, construct spatial interpolation model by two methods, and then carry out optimal calculation and gridding calculation of area rainfall by combining with cross-validation method; the disaster-causing critical precipitation determination module is used to determine the rainstorm intensity, calculate the frequency and recurrence period of the rainstorm intensity, and combine the natural geographical conditions and disaster prevention engineering facilities in the study area to obtain the rainfall at the disaster-causing critical interface based on hydro-meteorological coupling technology; the carrier exposure and vulnerability analysis module is used for collecting and establishing a multi-source database containing different types of carriers, realizing the dynamic identification of the exposure of rainstorm carriers and the extraction of the exposure of different types of carriers in various levels of precipitation, and evaluating the vulnerability of carriers; the risk assessment output module is used to analyze the risk database, the disaster-causing rainfall, the exposure and vulnerability of the carrier, and output the disaster risk range and distribution map and the quantitative estimation of disaster risk.

The rainstorm disaster risk assessment method and system have the advantages that: the application solves the problem that the accuracy of forecast data is influenced and limited by the model, and realizes the uniform distribution of automatic stations, accurate range control and better response to the distribution of precipitation. In this application, the discrete site distribution is used to interpolate the data into a mesh data structure, which realizes the accurate monitoring and evaluation of rainstorm, improves the ability of rainstorm monitoring and forecasting, and uses various interpolation methods to verify, which can accurately obtain the precipitation in the region, laying a foundation for the risk assessment of rainstorm disaster.

BRIEF DESCRIPTION OF THE FIGURES

The drawings, which form a part of this application, are used to provide a further understanding of this application. The illustrative embodiments and descriptions of this application are used to explain this application, and do not constitute undue restrictions on this application. In the drawings:

Fig. 1 is a schematic diagram of the overall scheme of the rainstorm disaster risk assessment method according to the first embodiment of the present invention.

Fig. 2 is a schematic diagram of the overall scheme of the rainstorm disaster risk assessment system according to the second embodiment of the present invention.

DESCRIPTION OF THE INVENTION

It should be noted that the embodiments in this application and the features in the embodiments can be combined with each other without conflict. The application will be described in detail with reference to the drawings and embodiments.

It should be noted that the steps shown in the flowchart of the drawings can be executed in a computer system such as a set of computer-executable instructions, and although the logical sequence is shown in the flowchart, in some cases, the steps shown or described can be executed in a different order than here.

Embodiment 1

As shown in fig. 1, this embodiment provides a rainstorm disaster risk assessment method, which includes:

S1, collecting and sorting out data and building a risk database;

S2, calculating area rainfall through forecast data, radar estimation and rainfall station data;

S3, determining disaster-causing critical precipitation;

S4, analyzing the exposure and vulnerability of the carrier;

S5, combining the risk database, the determination of disaster-causing rainfall and the exposure and vulnerability of the carrier, build a risk assessment model, and obtain the scope and distribution map of disaster risk and the quantitative estimation of disaster risk.

For further optimization, the collected data include: meteorological data, hydrology and water conservancy data, urban pipe network data, geographic information data and social statistics data.

To further optimize the scheme, the steps to calculate the amount of rain surface are as follows:

analyze the spatial correlation of forecast data, rainfall station data and radar station data, and select the station data with larger index; various spatial interpolation methods are used to interpolate discrete station data into fine gridded area data, and according to the spatial distribution characteristics of precipitation, altitude, terrain fluctuation and slope are used as collaborative variables to construct a spatial interpolation model. Cross-validation method is used to compare the actual effects of different methods and models, and the optimal treatment scheme is selected for area rainfall calculation and gridding calculation, in which the interpolation method is Kriging method and inverse distance weight method.

To further optimize the scheme, the steps of determining the critical precipitation for disaster are as follows: make clear the rainstorm intensity and calculate the frequency and recurrence period of the rainstorm intensity; establish the quantitative relationship between surface rainfall and precipitation, hydrological characteristics and underlying surface in the study area; calculate the disaster-causing critical surface rainfall based on the hydro-meteorological coupling technology.

To further optimize the scheme, the steps of exposure and vulnerability analysis of the carrier are as follows:

through on-the-spot investigation and full cooperation with water conservancy and statistics departments, multi-buffer analysis and spatial superposition spatial analysis technology combined with statistical methods are used to solve the problems of spatial scale disunity and data fusion, and multi-source databases containing different types of carriers are established. In this paper, the disaster risk caused by severe rainstorm weather is related to the carrier, and the identification result of dynamic rainfall is spatially superimposed with the carrier data under a unified data framework, real-time extraction of the number and spatial distribution of the carriers under different precipitation grades and durations to realize dynamic identification of the exposure of rainstorm carriers; spatial superposition of simulation results and carrier data is used to extract the exposure of different types of carriers in different grades of precipitation. Establish the response curve of the damage rate of the bearing body with the change of rainfall, and evaluate the vulnerability of the bearing body.

To further optimize the scheme, establish the response curve of the disaster loss rate of the carrier with the change of rainfall, and evaluate the vulnerability of the carrier.

In a further optimization scheme, the multi-source database of the carrier includes information data of population, economy, buildings, urban traffic and urban pipe network.

For further optimization, the output disasters include waterlogging disasters, and waterlogging simulation adopts two-dimensional unsteady hydrodynamic model.

Embodiment 2

As shown in fig. 2, this embodiment provides a rainstorm disaster risk assessment system, which includes:

the risk database module is used for collecting and storing meteorological data, hydrological and water conservancy data, urban pipe network data, geographic information data and social statistical data;

area rainfall calculation module, which is used to analyze the correlation of site data, construct spatial interpolation model by two methods, and then carry out optimal calculation and gridding calculation of area rainfall by combining with cross-validation method;

the disaster-causing critical precipitation determination module is used to determine the rainstorm intensity, calculate the frequency and recurrence period of the rainstorm intensity, and combine the natural geographical conditions and disaster prevention engineering facilities in the study area to obtain the rainfall at the disaster-causing critical interface based on hydro-meteorological coupling technology;

the carrier exposure and vulnerability analysis module is used for collecting and establishing a multi-source database containing different types of carriers, realizing the dynamic identification of the exposure of rainstorm carriers and the extraction of the exposure of different types of carriers in various levels of precipitation, and evaluating the vulnerability of carriers;

the risk assessment output module is used to analyze the risk database, the disaster-causing rainfall, the exposure and vulnerability of the carrier, and output the disaster risk range and distribution map and the quantitative estimation of disaster risk.

The rainstorm disaster risk assessment method and system have the advantages that: the application solves the problem that the accuracy of forecast data is influenced and limited by the model, and realizes the uniform distribution of automatic stations, accurate range control and better response to the distribution of precipitation. In this application, the discrete site distribution is used to interpolate the data into a mesh data structure, which realizes the accurate monitoring and evaluation of rainstorm, improves the ability of rainstorm monitoring and forecasting, and uses various interpolation methods to verify, which can accurately obtain the precipitation in the region, laying a foundation for the risk assessment of rainstorm disaster.

The above is only the preferred embodiment of this application, but the scope of protection of this application is not limited to this. Any changes or substitutions that can be easily thought of by those skilled in this field within the technical scope disclosed in this application should be covered by this application. Therefore, the scope of protection of this application should be subject to the scope of protection of the claims.

CLAIMS

1. A rainstorm disaster risk assessment method, characterized by comprising the following steps:

S1, collecting and sorting out data and building a risk database;

S2, calculating area rainfall through forecast data, radar estimation and rainfall station data;

S3, determining disaster-causing critical precipitation;

S4, analyzing the exposure and vulnerability of the carrier;

S5, combining the risk database, the determination of disaster-causing rainfall and the exposure and vulnerability of the carrier, building a risk assessment model, and obtaining the scope and distribution map of disaster risk and the quantitative estimation of disaster risk.

2. The rainstorm disaster risk assessment method according to claim 1, characterized in that: the data collected and collated in S1 include basic data of meteorological data, hydrology and water conservancy data, urban pipe network data, geographic information data and social statistics data.

3. The rainstorm disaster risk assessment method according to claim 1, characterized in that:

the steps of calculating the surface rainfall in S2 are as follows:

analyzing the spatial correlation of forecast data, rainfall station data and radar station data, and select the station data with larger index;

various spatial interpolation methods are used to interpolate discrete station data into fine gridded area data, and according to the spatial distribution characteristics of precipitation, altitude, terrain fluctuation and slope are used as collaborative variables to construct a spatial interpolation model;

cross-validation method is used to compare the actual effects of different methods and models, and the optimal treatment scheme is selected for area rainfall calculation and gridding calculation.

4. The rainstorm disaster risk assessment method according to claim 3, characterized in that the interpolation method is Kriging method and inverse distance weight method.

5. The rainstorm disaster risk assessment method according to claim 1, characterized in that the steps of determining the critical precipitation for disaster in S3 are as follows:

make clear the rainstorm intensity and calculate the frequency and recurrence period of rainstorm intensity;

establishing the quantitative relationship between surface rainfall and precipitation, hydrological characteristics and underlying surface in the study area;

calculate the disaster-causing critical surface rainfall based on the hydro-meteorological coupling technology.

6. The rainstorm disaster risk assessment method according to claim 1, characterized in that the steps of the carrier exposure and vulnerability analysis in S4 are as follows:

through on-the-spot investigation and full cooperation with water conservancy and statistics departments, multi-buffer analysis and spatial superposition spatial analysis technology combined with statistical methods are used to solve the problems of spatial scale disunity and data fusion, and multi-source databases containing different types of carriers are established;

the disaster risk caused by rainstorm weather is related to the carrier; under the unified data framework, the identification result of dynamic rainfall is spatially superimposed with the carrier data; real-time extraction of the number and spatial distribution of the carriers under different precipitation grades and durations to realize dynamic identification of the exposure of rainstorm carriers;

spatial superposition of simulation results and carrier data is used to extract the exposure of different types of carriers in different grades of precipitation;

establishing the response curve of the damage rate of the bearing body with the change of rainfall, and evaluating the vulnerability of the bearing body.

7. The rainstorm disaster risk assessment method according to claim 6, characterized in that: the multi-source database of the carrier includes information data of population, economy, buildings, urban traffic and urban pipe network.

8. The rainstorm disaster risk assessment method according to claim 1, characterized in that: the disasters of the output disasters in S5 include waterlogging disasters, and waterlogging simulation adopts a two-dimensional unsteady hydrodynamic model.

9. A rainstorm disaster risk assessment system is characterized by comprising:

the risk database module is used for collecting and storing meteorological data, hydrological and water conservancy data, urban pipe network data, geographic information data and social statistical data;

area rainfall calculation module, which is used to analyze the correlation of site data, construct spatial interpolation model by two methods, and then carry out optimal calculation and gridding calculation of area rainfall by combining with cross-validation method;

the disaster-causing critical precipitation determination module is used to determine the rainstorm intensity, calculate the frequency and recurrence period of the rainstorm intensity, and combine the natural geographical conditions and disaster prevention engineering facilities in the study area to obtain the rainfall at the disaster-causing critical interface based on hydro-meteorological coupling technology;

the carrier exposure and vulnerability analysis module is used for collecting and establishing a multi-source database containing different types of carriers, realizing the dynamic identification of the exposure of rainstorm carriers and the extraction of the exposure of different types of carriers in various levels of precipitation, and evaluating the vulnerability of carriers;

the risk assessment output module is used to analyze the risk database, the disaster-causing rainfall, the exposure and vulnerability of the carrier, and output the disaster risk range and distribution map and the quantitative estimation of disaster risk.

PATENTANSPRÜCHE

1. Verfahren zur Bewertung des Risikos von Unwetter, dadurch gekennzeichnet, dass es die folgenden Schritte umfasst:

S1, Sammeln und Sortieren von Daten und Aufbau einer Risikodatenbank;

S2, Berechnung der Niederschlagsmenge in Einheitfläche anhand von Vorhersagendaten, Radarschätzungen und Daten von Regenmesser;

S3, Bestimmung des Katastrophe verursachenden kritischen Niederschlags;

S4, Analyse der Exposition und Schwachstelle des Trägers;

S5, Kombination der Risikodatenbank, der Bestimmung des Katastrophe verursachenden Niederschlags und der Exposition und Schwachstelle des Trägers, Erstellung eines Risikobewertungsmodells, und die Erstellung einer Karte des Umfangs und der Verteilung des Risikos sowie die quantitative Einschätzung des Risikos.

2. Verfahren zur Bewertung des Risikos von Unwetter nach Anspruch 1, dadurch gekennzeichnet, dass die in S1 gesammelten und zusammengestellten Daten meteorologische Daten, hydrologische Daten, Daten des städtischen Leitungsnetzes, geographische Daten und sozialstatistische Daten umfassen.

3. Verfahren zur Bewertung des Risikos von Unwetter nach Anspruch 1, dadurch gekennzeichnet, dass:

die Schritte zur Berechnung des Niederschlagsmenge in Einheitfläche in S2 wie folgt sind:

Analyse der räumlichen Korrelation von Vorhersagedaten, Regenmesserdaten und Radarstationsdaten und Auswahl der Stationsdaten mit größerem Index;

verschiedene räumliche Interpolationsmethoden werden verwendet, um diskrete Stationsdaten in fein gerasterte Daten in Einheitflächezu interpolieren, und um entsprechend den räumlichen Verteilungsmerkmalen von Niederschlag mit der Höhe, der Landform und der Neigung als kooperative Variablen ein räumliches Interpolationsmodell zu erstellen;

die Kreuzvalidierungsmethode wird verwendet, um die tatsächlichen Auswirkungen verschiedener Methoden und Modelle zu vergleichen, dann das optimale Schema wird für Berechnung der Niederschlagsmenge in Einheitfläche und die Rasterberechnung ausgewählt.

4. Verfahren zur Bewertung des Risikos von Unwetter nach Anspruch 3, dadurch gekennzeichnet, dass Interpolationsverfahren das Kriging-Verfahren und das inverse Abstandsgewichtung-Verfahren sind.

5. Verfahren zur Bewertung des Risikos von Unwetter nach Anspruch 1, dadurch gekennzeichnet, dass die Schritte zur Bestimmung des kritischen Niederschlags für eine Katastrophe in S3 wie folgt umfassen:

das Ausmaß von Regen bestimmen und die Häufigkeit und Wiederholungsperiode der Regenintensität berechnen;

Ermittlung der quantitativen Beziehung zwischen Niederschlagsmenge in Einheitfläche und Niederschlag, den hydrologischen Eigenschaften und dem Untergrund im Untersuchungsgebiet;

Berechnung der Katastrophe Verursachenden kritischen Niederschlagsmenge in Einheitfläche auf der Grundlage der hydro-meteorologischen Kopplungstechnologie.

6. Verfahren zur Bewertung des Risikos von Unwetter nach Anspruch 1, dadurch gekennzeichnet, dass die Schritte zur Analyse der Exposition und Schwachstelle des Trägers in S4 wie folgt ablaufen:

durch Untersuchungen an Ort und Stelle und eine umfassende Zusammenarbeit mit den Abteilungen für Wasserwirtschaft und Statistik werden Multi-Puffer-Analysen und die Overlay-Raumanalyse-Technologie in Kombination mit statistischen Methoden verwendet, um die Uneinheitlichkeit der räumlichen Skala und die Datenfusion zu lösen, und um Multi-Quellen-Datenbanken mit verschiedenen Arten von Trägern zu erstellen;

das Katastrophenrisiko, das durch Regenwetter verursacht wird, ist mit dem Träger verbunden; im Rahmen des einheitlichen Datenrahmens wird das Ergebnis der Identifizierung von dynamischen Regenfällen räumlich mit den Trägerdaten überlagert; in Echtzeit wird die Anzahl und räumlichen Verteilung der Träger unter verschiedenen Niederschlagsgraden und –dauern extrahiert, um eine dynamische Identifizierung der Exposition von Regenträgern zu ermöglichen;

die räumliche Überlagerung von Simulationsergebnissen und Trägerdaten wird verwendet, um die Exposition verschiedener Trägerarten in verschiedenen Niederschlagsgraden zu ermitteln;

Erstellung der Reaktionskurve der Schadensrate des Trägers mit der Veränderung des Niederschlags und Bewertung der Schwachstelle des Trägers.

7. Verfahren zur Bewertung des Risikos von Unwetter nach Anspruch 6, dadurch gekennzeichnet, dass die Multi-Source-Datenbank des Trägers Informationsdaten über Bevölkerung, Wirtschaft, Gebäude, städtischen Verkehr und städtisches Leitungsnetz enthält.

8. Verfahren zur Bewertung des Risikos von Unwetter nach Anspruch 1, dadurch gekennzeichnet, dass die in S5 ausgegebenen Katastrophen Vernässung umfassen und die Simulation von Vernässung ein zweidimensionales instationäres hydrodynamisches Modell verwendet.

9. Ein System zur Bewertung des Risikos von Unwetter ist dadurch gekennzeichnet, dass es Folgendes umfasst:

das Risikodatenbankmodul dient der Erfassung und Speicherung von meteorologischen Daten, hydrologischen Daten, Daten des städtischen Leitungsnetzes, geografischen Informationsdaten und sozialstatistischen Daten;

Modul zur Berechnung der Niederschlagsmenge in Einheitfläche, mit dem die Korrelation der Standortdaten analysiert wird; ein räumliches Interpolationsmodell wird mit zwei Methoden erstellt und dann eine optimale Berechnung und Rasterberechnung der Niederschlagsmenge in Einheitfläche wird durch räumliches Interpolationsmodell und Kreuzvalidierungsmethode durchgeführt;

das Modul zur Bestimmung des Katastrophe Verursachenden kritischen Niederschlags wird verwendet, die Regenintensität zu bestimmen, die Häufigkeit und die Wiederholungsperiode der Regenintensität zu berechnen, und mithilfe der natürlichen geografischen Bedingungen und der technischen Einrichtungen des Katastrophenschutzes im Untersuchungsgebiet die Katastrophe verursachende kritischen Niederschlagsmenge in Einheitfläche auf der Grundlage der hydro-meteorologischen Kopplungstechnologie zu ermitteln;

das Modul zur Analyse der Exposition und Schwachstelle von Trägern dient der Sammlung und Erstellung einer Datenbank mit mehreren Quellen, die verschiedene Arten von Trägern enthält, der dynamischen Identifizierung der Exposition von Trägern und der Extraktion der Exposition verschiedener Arten von Trägern bei verschiedenen Niederschlagsmengen sowie der Bewertung der Schwachstelle von Trägern;

das Modul für Ausgabe der Risikobewertung dient der Analyse der Risikodatenbank, der Katastrophe verursachenden Niederschläge, der Exposition und der Schwachstelle des Trägers und der Ausgabe der Karte des Umfangs und der Verteilung des Risikos sowie der quantitativen Schätzung des Katastrophenrisikos.

FIGRUES

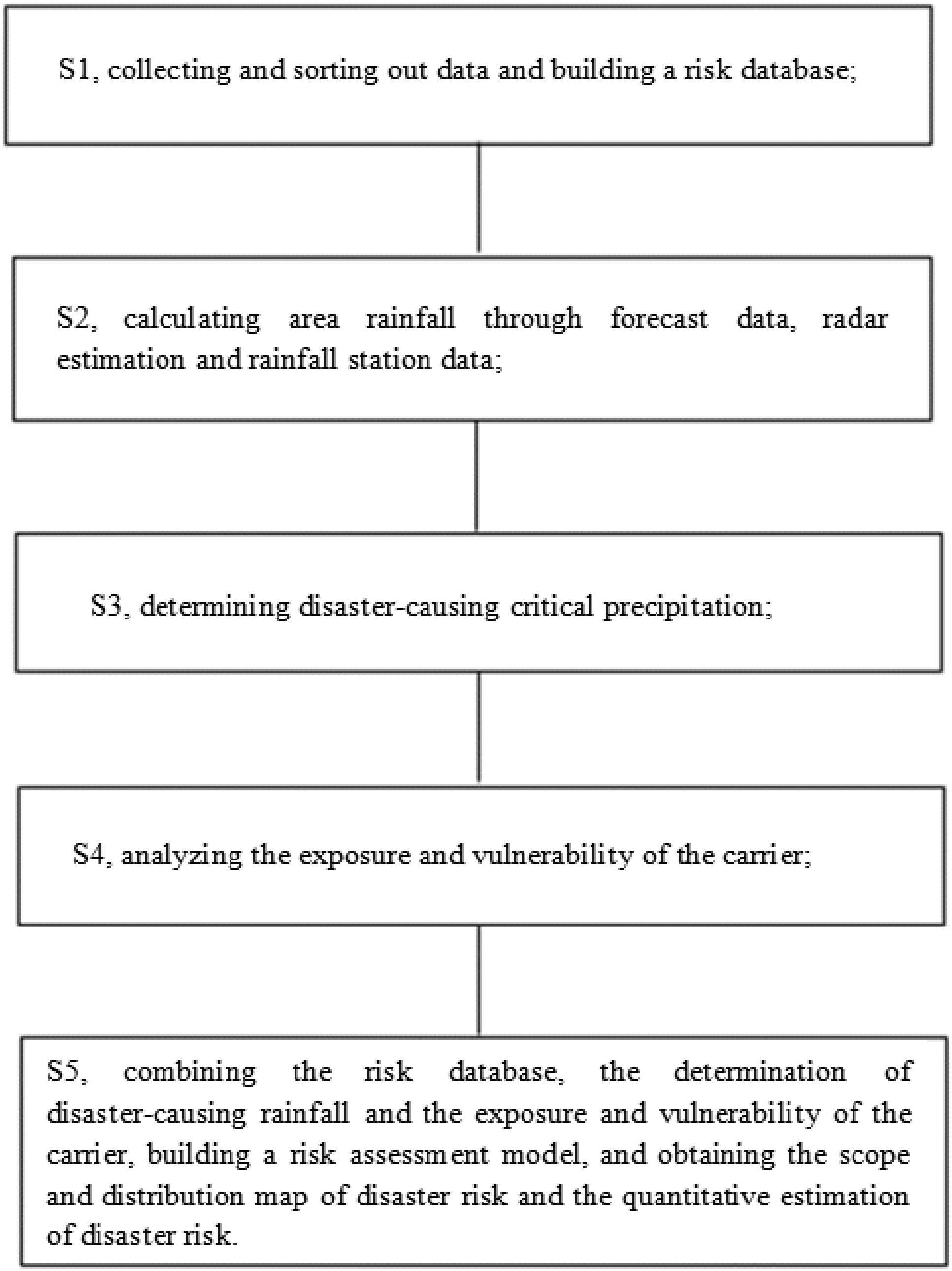

Figure 1

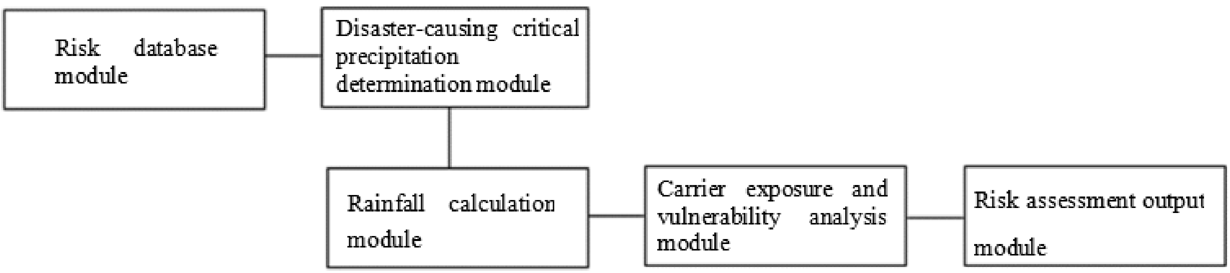

Figure 2