Development of evacuation support system in the areas affected by multi-hazards

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ABSTRACT :

Our studies are intended to assist the municipality and people in disaster areas affected by multi-hazards. We examined transit plan for evacuate residents to safer areas. We covered confirmation of the safety of people in evacuation center. We will establish a system using the spatial temporal GIS "DiMSIS".
The system consists of three processes; (1) traffic weighting, (2) route search and (3) transportation planning. Process (1) adopts highly versatile processing capable of network identification and two kinds of weighting in distribution region, etc. In process (2), the shortest route is searched using Dijkstra algorithm, taking account of traffic weighting. This process also has neighbor search capability around the destination such as evacuation center, in case of discrepancy between the location of evacuation center and network. Process (3) develops a transportation plan, by combining the optimum solutions at every time points and using greedy algorithm to obtain an approximately optimum solution as a whole.

KEYWORDS: evacuation center, route search, transportation plan, spatial-temporal GIS

1. Introduction

The resident in the stricken area takes evacuation center to the evacuation center for the security of the body for the reasons for uneasiness etc. to coming to difficult use by the dwelling, and the continuing disaster at a lot of natural disasters including the seismic hazard. Generally, facilities that seem to be safe it at the disaster beforehand are scheduled as a evacuation center and it becomes the condition of the evacuation center establishment in the evacuation center there is no fear of a damage of scheduled facilities little and fire in case of ,for instance, the earthquake. The condition investigates the damage situations of various places including the evacuation center by the staff of the municipality and those who support it immediately after the disaster, and is decided in the emergency center based on the information. However, the evacuation center thought to be safe is expected not to be able to be used with the passage of time by the occurrence of the typhoon and the earthquake at a simultaneous period and aftershocks' continuing like the "The Niigataken Chuetsu-oki Earthquake in 2007". The rescue supply supply's when the disaster occurs being done promptly and appropriately leads to the damage reduction as it relates to the stricken area resident's support, and restoration is done smoothly as a result.(Furuto [1]) But the supply of the support goods begins after resident's safety is secured. It is given priority to make the resident take evacuation center to a safer place, and to defend resident's life. than the first
In this text, to support the municipality and the resident of the disaster, it reports on the details for the construction of the resident evacuation support function using Geographical Information System.

2. Resident evacuation support function

The first place to which the resident in the area of distress takes evacuation center first is made a evacuation center, the second places where safety is higher than the first evacuation centers are defined as the evacuation center, and it explains.
The resident evacuation support function achieves the transportation planning process that uses the vehicle that the municipality possesses as one of the support to make the second residents who take evacuation center to the first evacuation center take evacuation center to the evacuation center. To achieve it the function of suiting actually, starting from the collection of evacuation center resident information that is information for processing is necessary, and, therefore, the function.

* Evacuation center on supported side
* Emergency center on supported side

It is necessary to install it in 2 parts. Because correspondence that promptly and is accurate is requested, and the situation changes with the passage of time, numeric information on the number etc. of those who take evacuation center is guessed that the processing result update based on management of the time of the use of Geographical Information System that the sight can be expressed on the map and information and the fact report is necessary. (Yamada [2])

The resident evacuation support function was constructed on the basis of a basic system of spatial-temporal information system "DiMSIS"(Refer to Figure 1). (Hatayama [3]) "DiMSIS" controls the data with spatial-temporal information as a key and has salient usage features such as open data structure and API (Application Programming Interface) as well as technical features such as implicit topology data structure. Such features meet the information infrastructure requirements for the realization of information sharing in local authorities where a variety of systems were introduced.

2.1. Data preparation

Prior related data preparation is necessary to execute appropriate resident support. The geographical features classification data of the digital national land information that numeric map 2500 of Geographical Survey Institute, numeric map 25000, and the Ministry of Land, Infrastructure and Transport are maintaining: as the map data to which it is possible to obtain, to use, and to be maintained the whole country now. It maintains it in the seamless on a nationwide scale as the data of "DiMSIS" (Refer to Figure 2) (Kakumoto [4]). It thinks accuracy to be able to use it enough for a rough situation grasp and the assistance preparation from the detailed data that the municipality manages though it is inferior.

In the resident support, the road network data for the traffic route calculation in addition to these is necessary. Though the road centerline is made from the city planning chart of the model municipality, and the road network data was generated there in this function construction, the preparation of similar map data nationwide data is needed for the disaster.

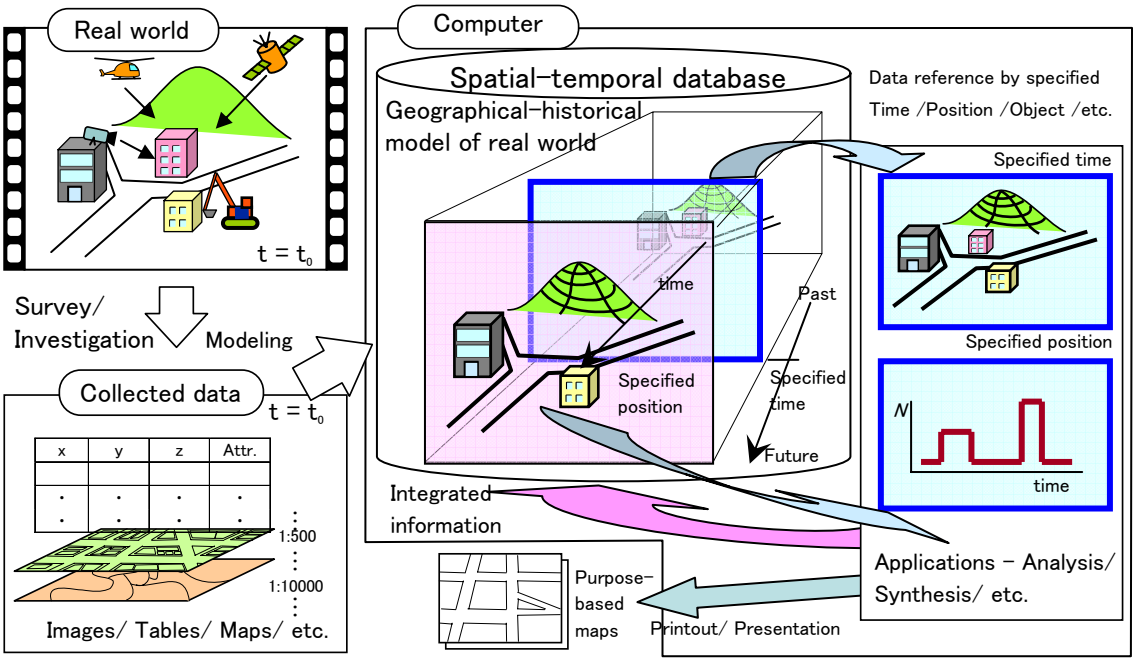

Figure 1 Concept of "DiMSIS"(spatial-temporal information system)

Figure 2 Geography data of Japan

3. Evacuation center function

Acceptance = safety confirmation is usually executed in the evacuation center. Moreover, the confirmation of the physical condition and the injury is executed at the same time.
The situation to date
* Safety confirmation using information processing system(The total is accurate, is easy, and is prompt.)
* Safety confirmation using geographic information processing system
(The dwelling is specified on the map, and it confirms it based on resident information. The confirmation work is easy and is prompt.)
* Safety confirmation using QR code
(The form that encoded the dwelling position beforehand is distributed. The code is confirmed with the QR Code Reader based on reading resident information. The confirmation work is easy and is prompt.) (Sasaki [5])The effectiveness has been confirmed through the experiment by doing and the disaster drill, etc. (Sasaki [5]). These information is resident's information, and it becomes information of the person for support on the resident evacuation center support function.
Moreover, it is thought that many of residents in the stricken area have damage information on the road to take evacuation center to the evacuation center through the struck site. Then, the information of traffic on the road registration function was added to the resident evacuation center support function of the evacuation center side. Because information of traffic on the road is information that relies on the person's memory several hours ago immediately before, vagueness remains, it was possible to pass to the same road, and contradicted information is high and the possibility to be generated is high. It is not possible to have done This problem solving, it is thought that management of the time of information is effective. It is thought that gripping the situation change such as becoming of traffic by the earth and sand disaster's occurring by arranging information at time on the way impossibility becomes possible though it is one method to assume the major opinion to be accurate information.

4. Emergency center function

The resident's transportation planning process is achieved in the emergency center. The transportation route is calculated from the road network data, and the transportation programming is planned based on resident's evacuation center information and transportation vehicle information (Refer to Figure 3).

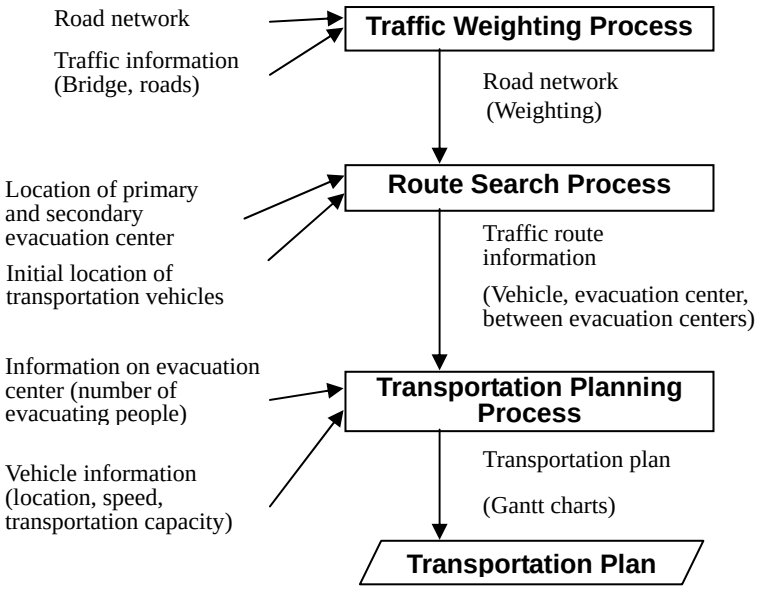

Figure 3 Outline of transportation planning process

4.1. Traffic weighting process

It has weight putting information in addition to distance information in the road network data. Weight putting information is used as a coefficient against the distance in this function by the one to express easiness like the road. That is, it is assumed to be a road to pass usually by the coefficient large as one difficult. Moreover, it is expressed not to be able to set 99999 to the road to which cannot traffic in the road collapse etc, and to pass as a special code.

Road network and information on the road collapse, the bridge damage, and the earth and sand disaster, etc. is added to this weight putting information at the disaster in normal circumstances. The damage presumption result is applied for the part where the damage investigation is not done.

The result of the research endeavor in which authors participated is used, and in this function construction, when the earthquake occurs, various damage of the bridge damage presumption etc. is presumed based on information from the urgent earthquake news flash offered by the Meteorological Agency and the seismograph, and weight putting information is set as an initial condition. The weight putting is updated to this based on information that the staff etc. of the municipality collect on the struck site immediately after traffic information and the disaster the collections in the evacuation center. As a result, the road network data establishes it. It is guessed that previous information need not be memorized because situation = weight putting information changes as passing on the road that cannot pass by the road repair construction etc. becomes possible, and it leads to efficient processing though the weight putting storage area is felt to be installed as a coefficient because distance = putting weight on the character of data like inefficiency use for the memory and the file (Refer to Figure 4).

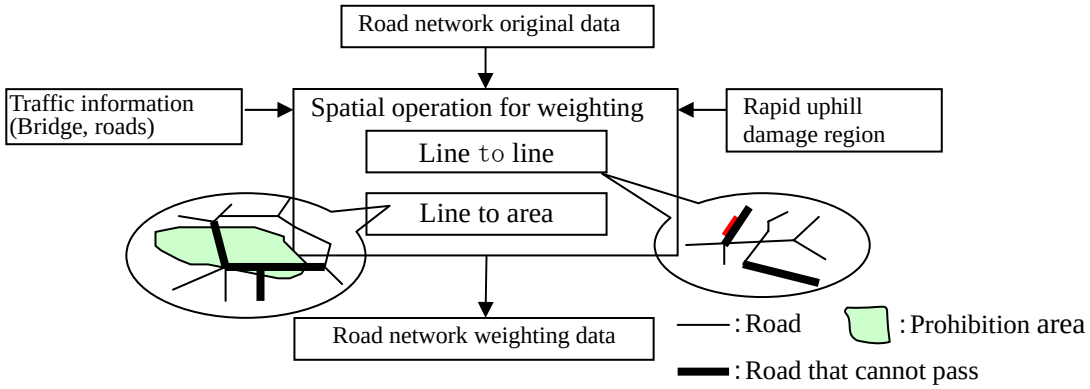

Figure 4 Outline of weighting process

4.2. Transportation route search process

The basis of the transportation route calculation processing is to find the shortest route because it is important that the transportation for resident evacuation center is prompt. Because the basic technique of the best route retrieval etc. had been established, a typical Dijkstra algorithm was used in this function construction. To use it to plan the transportation programming as shown in the above-mentioned, the constructed processing calculates the route between evacuation centers from route between the 1st and 2nd evacuation centers, vehicle initial position, and the 1st road network data on which weight is put.

Moreover, to secure traffic corresponding to the state of emergency to start evacuation center and the rescue when a large-scale earthquake occurs, and to execute wide emergency measures activity like the restoration of a supply of goods and various facilities etc. in the large area, an important route is decided as the urgent transportation road. It thinks these routes to need the device to which processing (special weight putting) as the priority road can be done might restrict general traffic for the emergency measures activity in the emergency.

4.3. Transportation planning process

This processing requests the transportation programming from calculated transportation routing information, evacuation center information, and vehicle information.

Because a great amount of processing time is expected to be required to have to obtain the solution of all the combinations when the transportation programming is strictly requested, it is thought non-reality processing. The situation is expected for the processing speed to be valued because it changes hourly, and to change the processing condition and to be executed many times when thinking about use in the emergency center. Then, processing to which the processing speed was made to give priority was achieved by using a greedy algorithm that was the technique for requesting the best as a whole one by repeating that the best one was selected at the time of each in this processing. The transportation programming result did the file output by the form that was able to be used in a lot of spreadsheets used in the world (Refer to Figure 5).

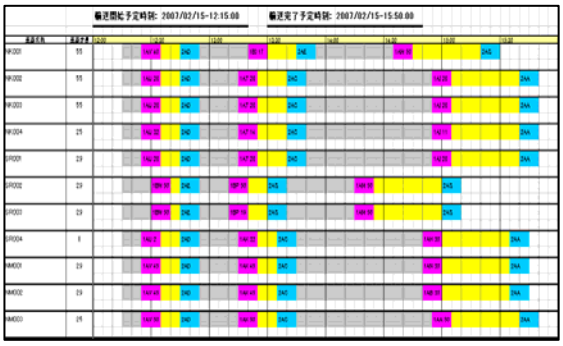

Figure 5 Example of output file(Gantt Chart)

5. Conclusion

To support the resident of the disaster, the resident evacuation center support function using Geographical Information System was constructed. It was able to be confirmed that being able to update the road situation appropriately by the space operation by using Geographical Information System, and managing those who took evacuation center and road information at time led to the function achievement actually suited.
I want to aim at enhancing to the processing that can be put to practical use as processing according to obtaining information is enabled by analyzing and classifying consideration of the transportation after the neighborhood retrieval processing is used, the evacuation center resident walks, and it moves, indispensable information, and addition information in the future. Moreover, I want to examine the application to the rescue supply generated immediately after evacuation center of the resident.

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