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Flood inundation prediction model on spatial characteristics with utilization of OLAP-based multidimensional cube information

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Abstract. Serious vulnerabilities regarding the preparation of flood and inundation with respect to natural disasters are present due to the destructions of the ecosystem and climate changes caused by global warming as new towns are created with concentrations of smart buildings with rapid developments of IT technologies and architecture systems, and therefore, nations' assets are suffering damage and accidents involving human injuries are taking place worldwide. To solve such problems, this thesis suggest a water level prediction modeling on geographical changes caused by flood by regional groups by constructing a multidimensional cube and forming the OLAP-based fact tables with the utilization of historical precipitation data by regional groups.

Keywords: Climate change, multidimensional cube, pattern algorithm

1 Introduction

High-tech systems are making advances with the increase of discoveries made on accumulated technologies and scientific technologies, and despite new urbanization have rapidly increased with the emergence of smart buildings with U-CITYs as foundation, the destruction of the ecosystem caused by climate changes and topographic changes by its detrimental effects are coming to the fore in particular. For such reasons, vulnerabilities are present regarding the flood preparation with respect to natural disasters, and property losses and human damages are being caused. This thesis constructs a data warehouse, and models the normalization of OLAP-based flood prediction data tables with the utilization of historical precipitation data. Fact tables are created on the basis of data tables designed, and predictions are made on the possibilities of inundation at the area of flooding by the construction of multidimensional cubes. Flood patterns are calculated via multidimensional cubes by region, and an inundation level prediction model on past and current changes of geographic environment was suggested.

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2 Related Work

The OLAP(On-line analytical processing) engine by and large shows the structure that suggest the logical scale of the multidimensional data in the form of cubes, and the cubes can be defined into two parts, dimension tables and fact tables, in which the data are modeled into one or more dimensions [1][2]. The OLAP cube may have varied forms structured from accumulated data values at the data warehouse and can provide accurate numerical values in terms of decision making of the data [3]. In spite of the fact various software capable of conducting simulations on flood inundation levels such as LEC-RAS, FLUMEN, MIKE FLOOD(MIKE 11 + MIKE 21) have been released in studies in the field of environmental engineering and safety today, it has been indicated their prediction accuracies are still at inaccurate levels, for simulators used in these software utilize the data suggested on the foundation of the present and precipitation data of the past had been processed and thus fact data have not been laid on their foundation [4].

3 Proposed Method

This thesis has processed the quantitative data made use of statistics in consideration of the characteristic that risk level of annual inundation can be influenced by topographical changes and geographical conditions of concentration areas due to formations of new towns, albeit regular precipitation was recorded in the same region when source data were successively classified with patterns shown in the past one year as standard. However, for anomalous patterns and construct of natural drainage system or river system of flood preparation facilities built by the formation of new towns which induces the flow of water through dispersion, data were calculated with the quantitative approach.

3.1 Process of multidimensional table prediction model

This thesis was designed in the following processes.

STEP 1 Sorting of the identical regions and assortment by calculation of the past meteorological information.
STEP 2 For meteorological information, time, date and region were classified by using the clustering method and dimension tables and fact tables are calculated.
STEP 3 Normalization of object entities and creation of multidimensional cubes.
STEP 4 Calculation of prediction value of precipitation scale via analyses of pattern data utilized multidimensional cubes

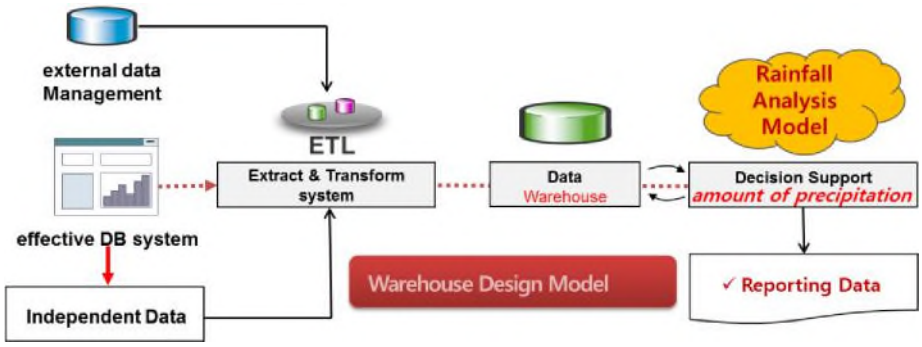

Fig.1. Model of structuralization process of data warehouse

The operating procedure model of the data warehouse has the structuralization capable of predicting precipitation data via the analyses of external data. Storage space for saving information regarding geographical changes corresponding to the data of the existing region is required to be maintained to be able to utilize the historical data on precipitation, and to this end, a scale for the process of quantitative data regarding inundation level to geographical conditions of the past and the present is required. In this thesis, MIKE FLOOD has been used for the data design on quantitative spatial geography model of the past and the present.

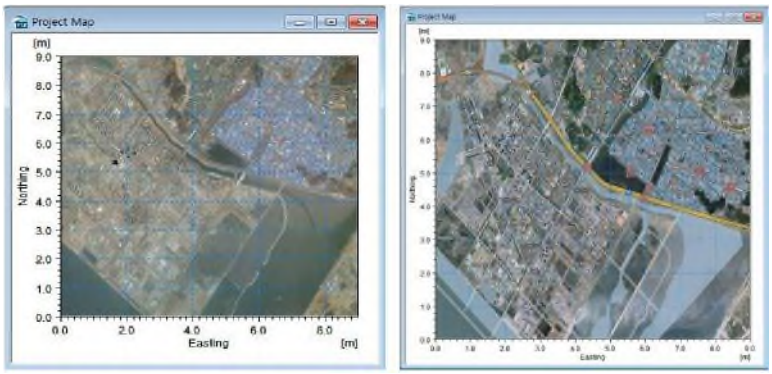

Fig. 2. As is and to-be models on geographical changes

3.2 Design of multidimensional prediction model

The structuralization of the data warehouse was constructed with star schema, one of the methods of relational modeling. For each category, dimension tables of position data, dimension tables of weather data, dimension tables of precipitation data and dimension tables of time were used for the modeling of fact tables of the multidimensional space.

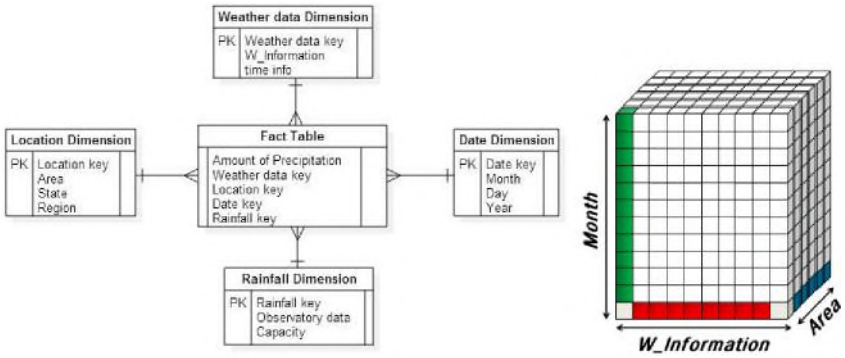

Fig. 3. Definition of the multidimensional cube model on the precipitation forecast

4 Performance Evaluation

In this thesis, an international new town corresponding to Region I distance S in South Korea was selected, and prediction test of the precipitation data was carried out based on a region of an area of 93 ㎡.

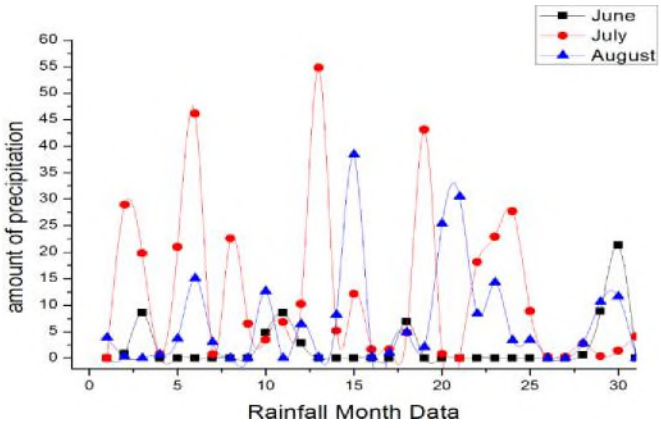

Fig. 4. Precipitation forecast information of Region I during the rainy season

The testing has calculated the prediction information of precipitation to the cube modeling of the summer season which tends to show higher precipitation levels due to meteorological nature of South Korea by extracting date information, weather information and regional information on the basis of partial data of the past three years applicable to the cube data. The graph being suggested in [Fig. 4] is the

information on the partial prediction of precipitation calculated from the cube model. The X value represents the date information and the Y value represents the prediction data of precipitation on the season. With regard to the forecast information of precipitation, forecast information can be assigned by applying an arithmetic operation to the accumulated flood inundation data of the past with OLAP multidimensional data models.

5 Conclusion

This thesis has designed a prediction model of precipitation inundation levels via multidimensional array modeling by extracting the information of space changed topographically and precipitation data accumulated through observation records of the past. The study further plans to conduct researches on the development of spatial data based integrated systems of precipitation forecast can be applied by increasing the accuracy of the schema changes and geographical information for the enhancement of accuracy of normalization and data expansion via extensions of fact tables.

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