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The Development of the Slope Failure Management System

There are many incidents of slope failure across Japan. The measures are required. Recently soft-measures are expected since hard-measures, such as constructing soil fall protections, are difficult to execute because of economical and environmental consideration. As citizens of Yokohama City and advisers of local government, we developed the Slope Failure Management System. We digitized the existing paper data which municipal government owns. ArcGIS is utilized in order to effectively collect, restore, manage and analyze the slope data for the support of the routine work of personnel in municipal government. With this system, we can predict the potential slope failure by using the results of analytical and real-time rainfall data. We think that the predicted result is useful for emergency responses, such as evacuation activity. The targeted area is Yokohama, Japan

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Background

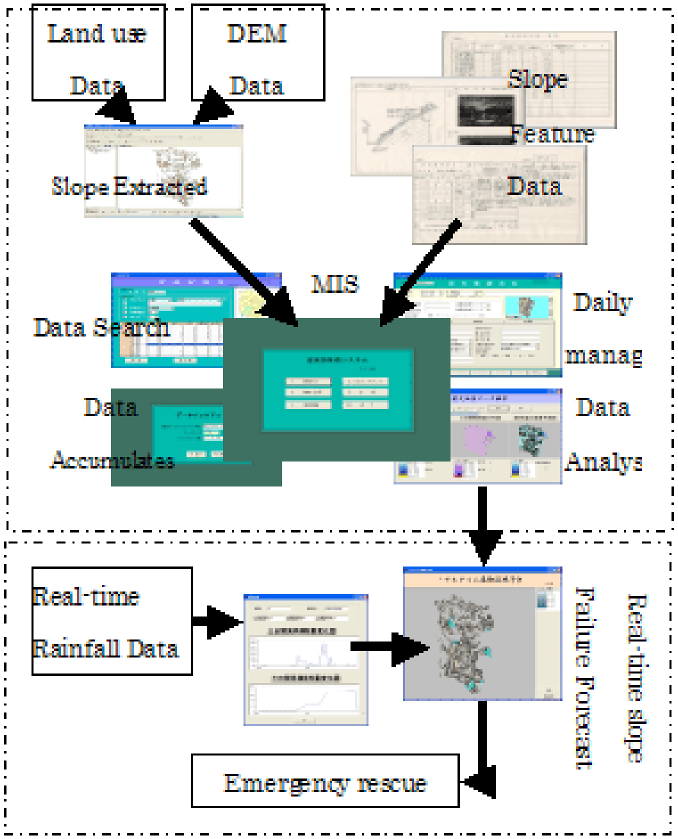
One of the important problems in Yokohama is, there are many steep slopes all around the city. To make matters worse, heavy rains strike Yokohama every year. More than 2000 slope failure disasters happened in past 40 years. Many people, buildings, and city infrastructures are on the hilltop, hillside, and bottom of hills. Recently soft-measures are expected since hard-measures such as constructing soil fall protections are difficult in execution because of economical and environmental consideration.

Fortunately, Municipality of Yokohama has much kind of paper data related to steep slope and dangerous cliff in the city. In order to mitigate the risk of the calamity by slope failure, those paper data was digitized and the slope data warehouse which accumulates the history information on past was built by us. Moreover, the statistics analysis technique was introduced and the slope failure factors were clarified. Finally, the natural slope and the disaster zone were extracted on GIS, and we developing the real-time slope failure forecast system with GIS and slope Data warehouse.

System development

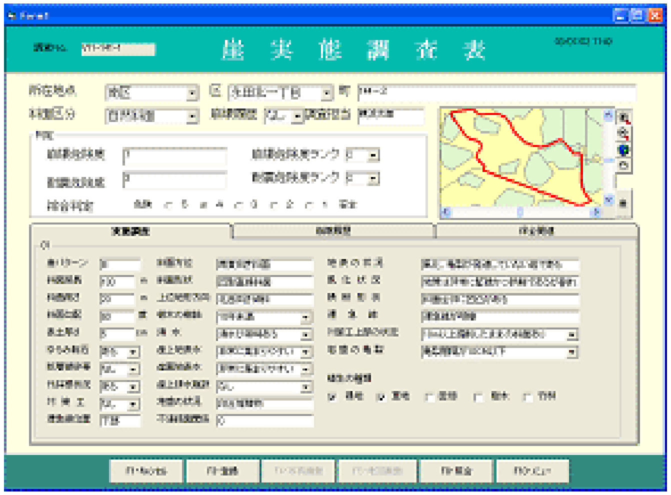
The utilization of mass data in municipal governments, as property, is very important on the field of urban planning and urban disaster prevention field. As new data management technology, the Data warehouse is utilized to do it. The decision support function of Data warehouse, and use of a statistics function, an analysis function, etc. is utilized in the real-time slope failure forecast system.

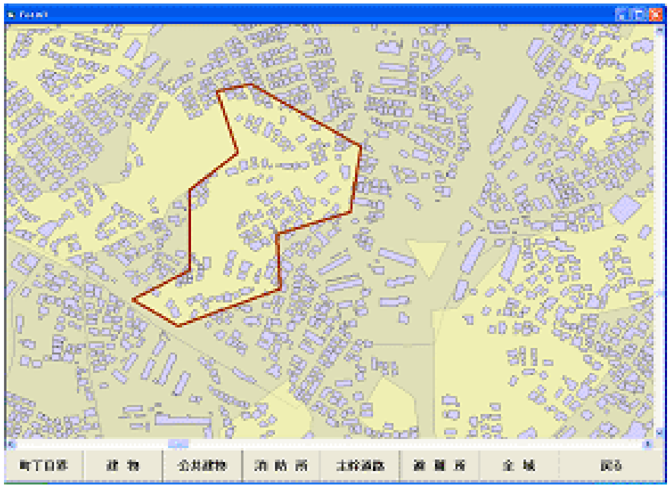
System flow chart


Land use Data
DEM Data
Slope Extracted
Slope Feature Data
MIS
Data Search
Daily manag
Data Accumulates
Data Analys
Real-time Rainfall Data
Emergency rescue
Failure Forecast
Real-time slope

Management

The existing paper data is digitized and manages in Geo database. Accumulated slope feature data can be displayed on form directly and with map for location. Used the daily management form, you can edit those slope feature data, such as add a new feature data or update feature data, and edit the map. Only by having a look on maps, you can understand the slope position data and spatial relationship, and various map data can be piled up. It is useful for speedup decision at the time of Emergency rescue. In addition, it is also possible to draw a disaster danger spot centering on a specific slope, to clarify the danger area of each slope for the land use plan around the slope.





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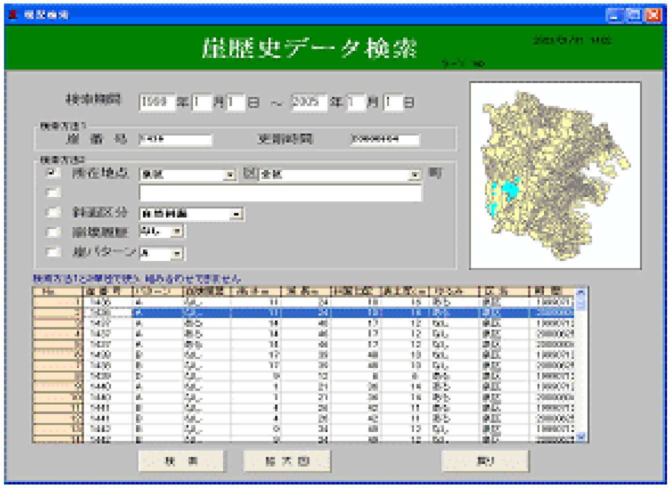
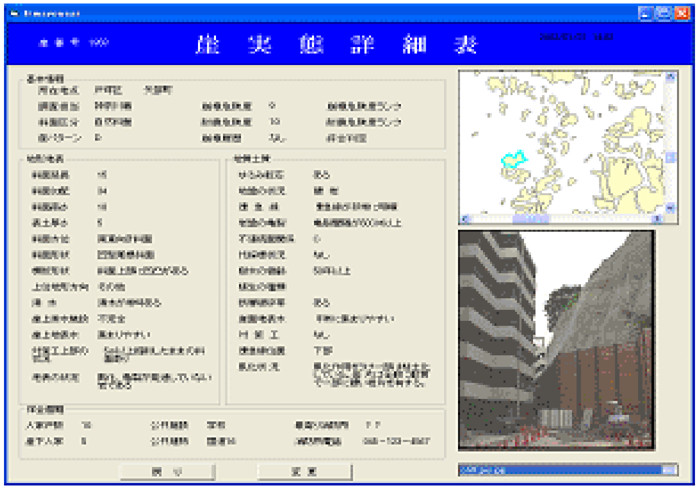
In order to manage the various data about slopes those was increased on every day, it is important to find state on time and situation on spatial location quickly.

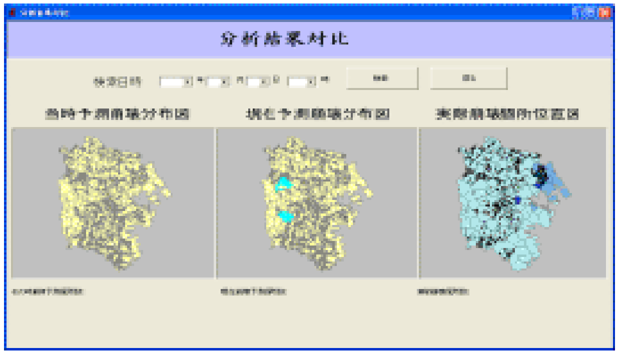
The slope Geo database was built and the time-axis and space axis was taken in. By choosing arbitrary items from the list, the classification-by-color display on a map screen can be performed. The table of the basic attribute of a related slope is displayed Furthermore, it can express as a detailed screen also about the detailed information on a selected slope.

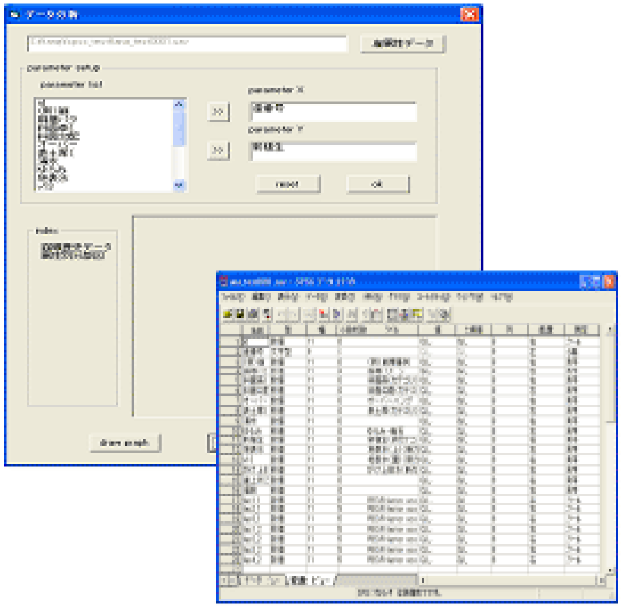




Slope failure history analysis & Slope failure attribution analysis

For grasp slope failure reason, analyze a related factor according to an attribute to a slope attribute history or a failure history to "analysis" functional slope failure. By used the statistics analysis technique into slope Data warehouse, and analysis the related factor from different viewpoints (space, time, attribute, etc.) We get the prediction method from many-sided analysis on slope failure factors.

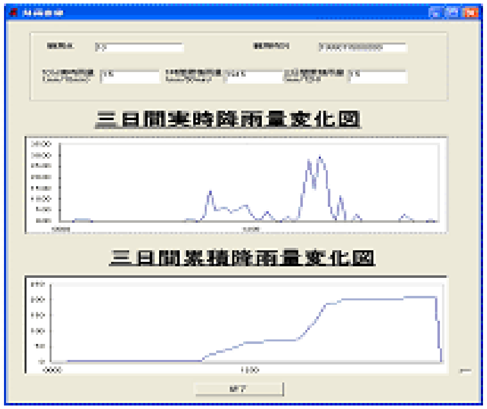

分析結果対比
当時予測崩壊分布図
現在予測崩壊分布図
実際崩壊箇所位置図

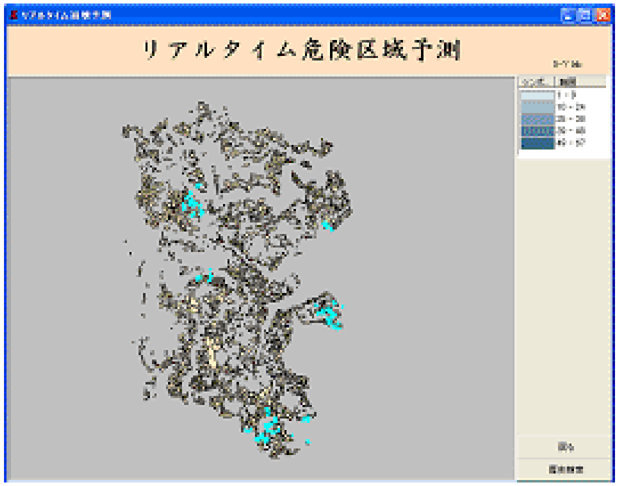

parameter setup
parameter list
parameter X
parameter Y
reset
ok
draw graph

Real-time rainfall curvilinear & Real-time prediction

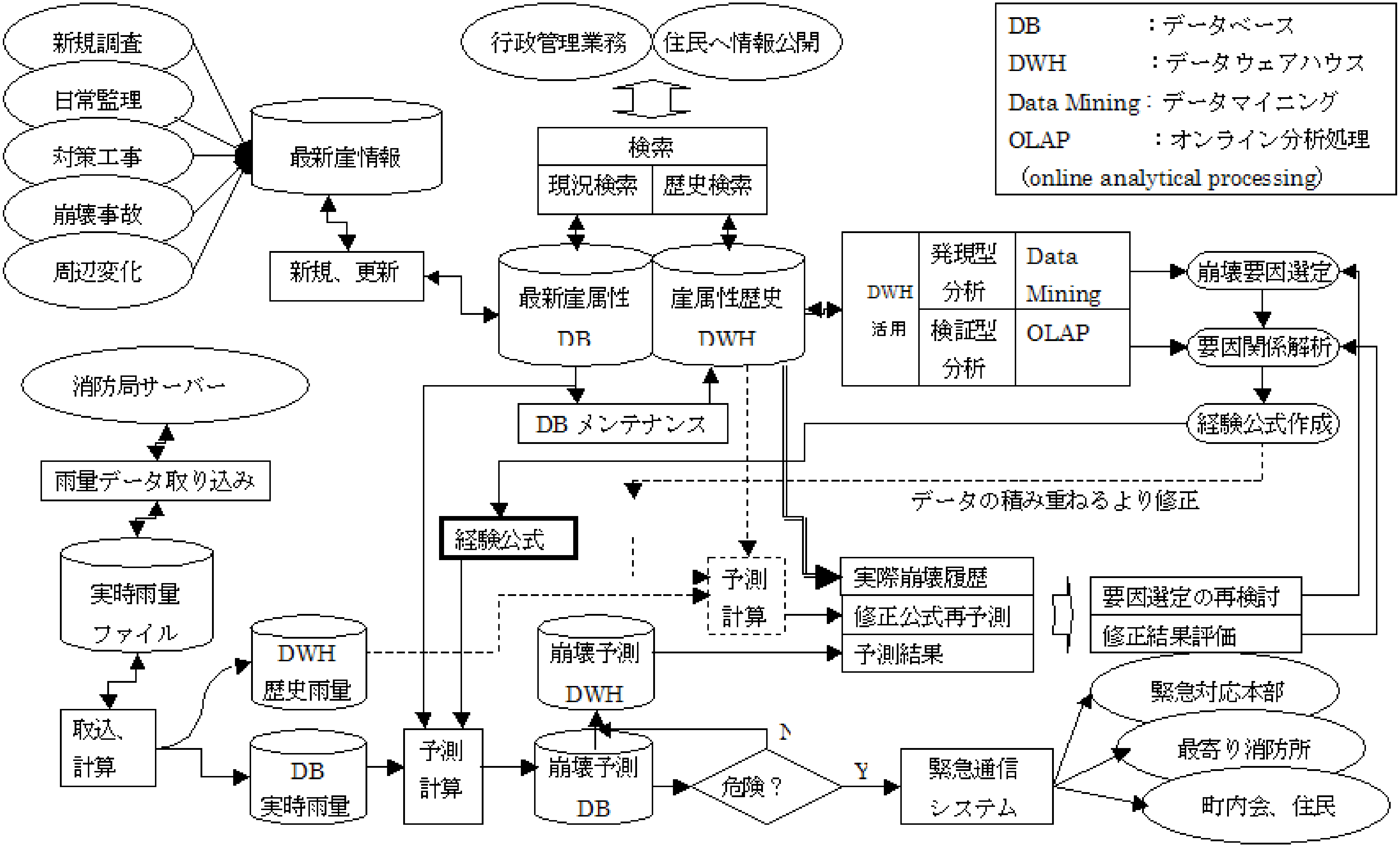
System will be collected have rainfall data by 97 rain gauge around city. Rainfall data is observed every quarter hour. And system will put 1-hour rainfall and 3 days rainfall into ArcGIS spatial analyst with the approximate expression for slope failure from analysis results, then ArcGIS calculate the dangerous area for slope failure at the time.

The result of Real-time prediction that carried out will be expressed by classification by color on a map. Then we have to prepare for emergency response against the collapse. Promoting evacuation to local residents and so on.


三日間実時降雨量変化図
三日間累積降雨量変化図


リアルタイム危険区域予測

Data Flow Chart


DB ：データベース
DWH ：データウェアハウス
Data Mining：データマイニング
OLAP ：オンライン分析処理
（online analytical processing）
新規調査
日常監理
対策工事
崩壊事故
周辺変化
最新崖情報
新規、更新
行政管理業務
住民へ情報公開
検索
現況検索
歴史検索
最新崖属性 DB
崖属性歴史 DWH
DWH 活用
発現型分析
検証型分析
Data Mining
OLAP
崩壊要因選定
要因関係解析
経験公式作成
DB メンテナンス
消防局サーバー
雨量データ取り込み
実時雨量ファイル
データの積み重ねるより修正
経験公式
予測計算
実際崩壊履歴
修正公式再予測
予測結果
要因選定の再検討
修正結果評価
DWH 歴史雨量
崩壊予測 DWH
取込、計算
DB 実時雨量
予測計算
崩壊予測 DB
危険？
N
Y
緊急通信システム
緊急対応本部
最寄り消防所
町内会、住民

CONCLUSION (PRIMARY HEADING)

A GIS-based application has been developed for Slope Failure Management. In order to support the disaster prevention activities and urgent correspondence we developed this slope failure prediction system. It is a cooperative analyze system with GIS and DWH synthetically.

REFERENCES OR ACKNOWLEDGMENTS

Akiyuki KAWASAKI,The Utilization of GIS for the Measure against Slope Failure Disaster in Urban Area": Joint Workshop on US-Japan Cooperative

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