THE EXTRACTING AREAS OF HAZARDOUS-SLOPE UNIFIED VARIOUS FACTORS BY GIS

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ABSTRACT It is difficult to find out the extracting area of hazardous-slope. The difficulty would be caused by the various factors is acted spacially and complicatedly. In this research, various factor of slope failure were considered and used at the same time. The specific extracting area can be found by integrating these datasets in ArcGIS spatially and visually.

INTRODUCTION: Landslides occurring around overhead transmission lines (OHTL) are one of the most difficult problems in the field. The difficulty would be caused by the various factors is acted spatially and complicatedly. Satellite data is widely used to identify hazardous slopes as well as statistical method for various factors [Obayashi et. al. 1990]. And numerous studies have been performed using different methods (Quantification methods, Neural networks) up to the present [Takasao 1982] [Obayashi et. al. 1996]. However, these techniques and studies are individually used in general. The authors analyzed the areas in danger of the slope failure using ArcGIS. In this research, not only watersheds, valley-density induced by digital elevation data, safety factor of slope stability induced by the angle of slope and geological characteristics, but also normalized vegetation index (NVI) induced by satellite data were used at the same time. It can be found out the specific extracting area by integrating geological and special analysis datasets in ArcGIS.

PROCEDURES, RESTULTS AND DISCUSSION: The analytical method in this research can be classified into two parts. One is the geographical analysis and the rainfall analysis is another one. The analysis was executed not only slope failure analysis but also verified the analytical result with the slope failures occurred at the past. The analytical area is about 7.5km×5km as shown in Fig. 1. Fig. 2 shows the analytical process.

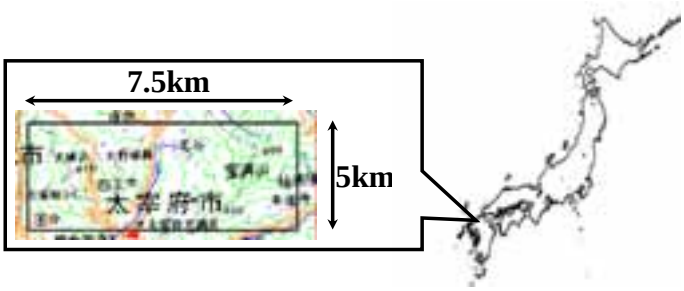


Fig.1 Analytical Area

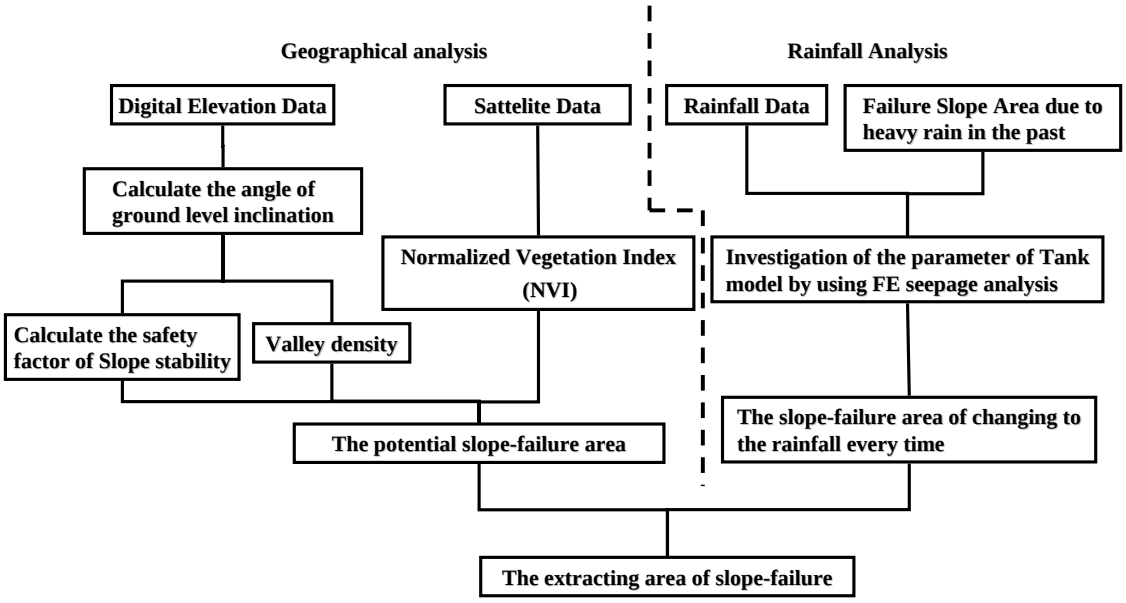


Fig.2 The Procces of this research

In analytical area, the geological feature is the weathered granites. Therefore, the safety factor of slope stability is calculated by following formula [Enoki 1999]. And the analytical result is shown in Fig. 3. In this formula, the values of c_{drain} and ϕ_{drain} used 0[kPa], 30[degree] respectively [Yagi et. al. 1990].

$$Z = \left(1 - \frac{\gamma_{water} H_{water}}{\gamma_{soil} H_{surface\_layer}}\right) \cdot \frac{\tan\phi_{drain}}{\tan\alpha} + \frac{c_{drain}}{\gamma_{soil} H_{surface\_layer}} \cdot \frac{1}{\sin\alpha \cdot \cos\alpha} - 1 \qquad (1)$$

Where, Z: The evaluation value (z>0; stable slope, z<0; unstable slope),

$\gamma_{soil}, \gamma_{water}$: Unit weight per volume for soil and water respectively,

c_{drain}, ϕ_{drain} : Cohesion and frictional angle of soil at drained condition respectively,

$H_{water}, H_{surface\_layer}$: Height of ground-water level and surface layer respectively,

α : Slope angle of ground surface

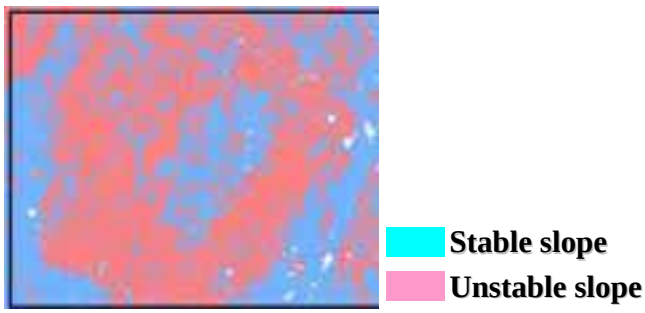
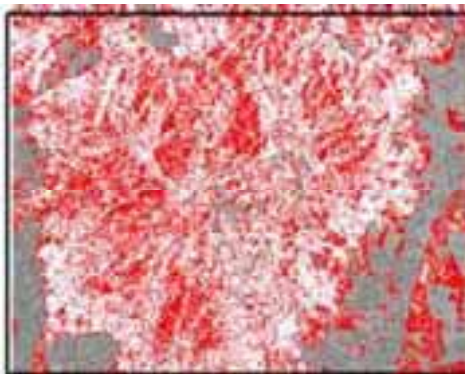


Fig.3 The analytical result of surface failure.

Size of valley density

Fig. 4 The analytical result
(Valley-density)

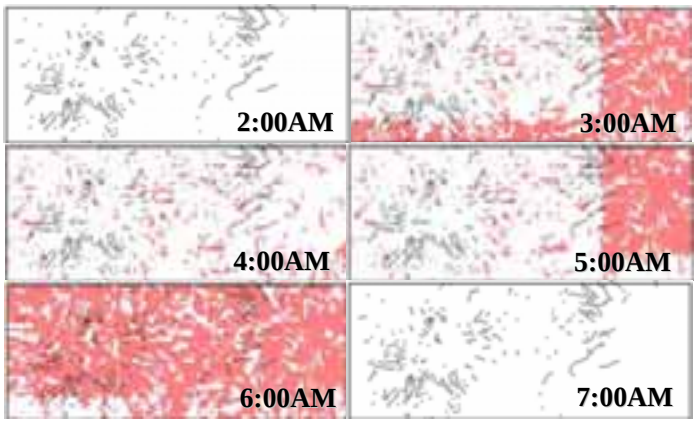


Low plant revitalization

Fig. 5 The analytical result
(NDI)

And the analytical result of induced by digital elevation data and normalized vegetation index (NVI) induced by satellite data were also shown in Fig. 4 and Fig. 5.

The rainfall analysis used the tank model proposed by Sugawara [Sugawara 1972]. The parameters of the tank model were decided by 2D-Finite Element (FE) seepage analysis [Kobatake 1983] [Michiue 1990]. The value of inclination and amount of rainfall is changed by FE analysis models and the numbers of analysis were 66 cases. In seepage analysis, rain which the amount of the rainfall was changed fell on the slope where the inclination was changed, and slope head pressure was calculated and extracted. The flow velocity of the head pressure which the maximum value was indicated was extracted, and the result applied to the parameter of the tank model. The parameter of the tank model was reflected the result of seepage analysis. And the relationship between the horizontal outflow of a center tank and previous slope failures was examined.



Slope-failure at 6AM, July 23, 2003

Predicted Slope-failure by the rainfall analysis

Fig. 6 The result of rainfall analysis at elapsed time

As compared with the product of the horizontal outflow and the length of streamline, the product of amount of rainfall every time and drainage area changes by 35-500 times at 6:00 on July 19, 2003 when large slope failure occurred. As a result, the relationship value is calculated every time, and the input values of meshes is used the ratio changed by 35-500 times. The analytical result at elapsed time is shown in Fig. 6. The extracted meshes and "Potential slope failure part" were overlapped, and the extracting areas of hazardous-slope (EAHS) were analyzed. EAHS was made by using against the background of geographical analytical result and piling up rainfall analytical result.

The analytical result of EAHS is shown in Fig. 7 and the result of comparing numbers of slope-failure between investigated result and predicted one are listed in Table 1. This analytical result agrees comparatively well with the investigated results. The digital elevation data based on 50m is used in this analysis. However, it seems that the ratio agrees by using digital elevation data precisely grows.

Table 1

The number of Slope-failure (6AM, July 23, 2003)		Agreeing ratio
Investigated	Predicted	
206	115	56%

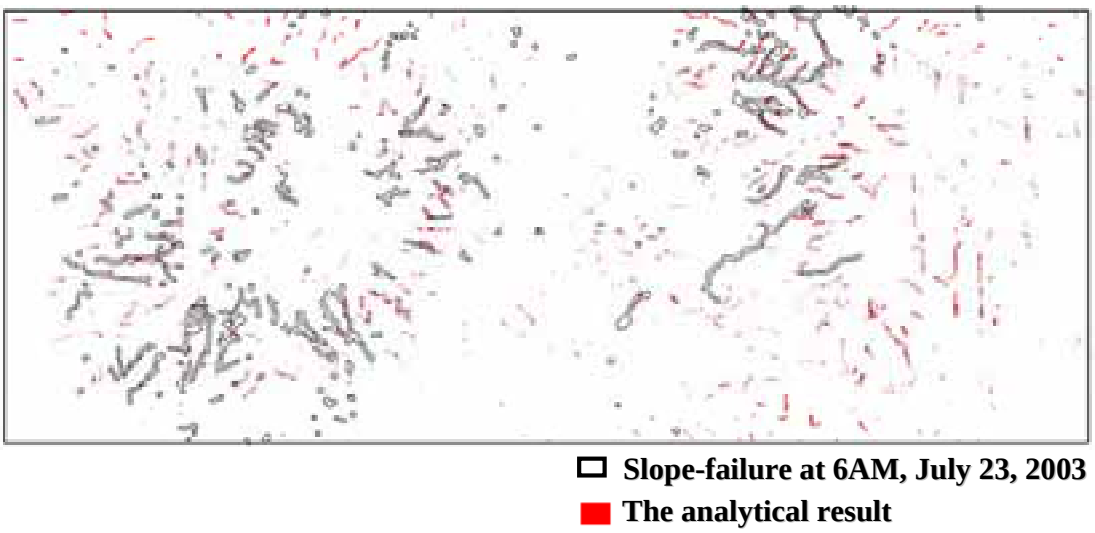


Fig. 7 The integrated analytical result
at 6AM, July 23, 2003

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