Deduction of Important Causal Factors of Deep-seated Landslide and of Conditions for Its Occurrence or Non-occurrence through Rough Set

Soichi KAIHARA[1], Yasutaka TANAKA[2], Atsuhiko KINOSHITA[3], Hiroaki SUGAWARA[2], Gengo YOSHIMURA[2], Wataru SAKURAI[3] and Noriko TADAKUMA[1]

[1] Eight-Japan Engineering Consultants Inc., Japan
[2] Large-Scale Sediment Disaster Control Technology Center, Kinki Regional Development Bureau, MLIT, Japan
[3] National Institute for Land and Infrastructure Management, MLIT, Japan
*Corresponding author. E-mail: kaihara-so@ej-hds.co.jp

INTRODUCTION

In September, 2011, Typhoon Talas caused a number of deep-seated landslides in southern Nara Prefecture as well as Wakayama Prefecture due to total rainfall exceeding 1,000 mm. Apart from the formation of natural dams, huge amounts of collapsed sediment inflicted severe damage in the affected areas, including direct human damage. As understanding of the risk of occurrence of deep-seated landslides is essential for risk management to prevent disasters, it is important to understand the primary and contributory factors, such as the geographical and geological factors, as well as the rainfall indices, all of which are highly relevant to the occurrence of deep-seated landslides.

Even though there are positive research outcomes by Suzuki et al.[1)] regarding such conditions for the occurrence of deep-seated landslides in a wide area as geographical factors, there has been no precedence of a study simultaneously dealing with both the geographical conditions and rainfall conditions. In view of this, the present study objectively clarifies the conditions for occurrence or non-occurrence in relation to primary and contributory factors in an integral manner in addition to the deduction of important causal factors relating to the geography, geology and rainfall.

OUTLINE OF ROUGH SET

Rough set was first proposed by Zdzislaw Pawlak[2)], a Polish mathematician and computer scientist, in 1982. Its basic concept is similar to classification and focuses on how to simplify a database without damaging its separateness. The concept of rough set is presented in **Fig. 1**. Coherent rate is the rate of the coherent data number on the total data number, if Coherent rate value is large; it is possible to distinguish between occurrence and non-occurrence. The main functions of rough set are reduction of a database and deduction of rules. For example, suppose that the exclusion of geography condition 2 in **Tab. 1** does not affect the occurrence or non-occurrence of a disaster, the rough set theory suggests that geography condition 2 can be omitted from the database. In other words, geography condition 2 doesn't contribute coherent rate increasing in this database. The remaining geography conditions 1 and 3 are, therefore, considered to be important factors affecting the occurrence or non-occurrence of a disaster.

METHOD

For analysis using rough set in this study, a database was developed consisting of data on geographical and geological items with a potentially close link to deep-seated landslides for each sub-drainage basin of some 1 km^2 which is used as the unit area for evaluation. The potentially

highly relevant geographical and geological items identified are slope direction, gradient, elevation difference (summit level-bottom), valley density, geological category and distance from a fault, while those related to rainfall are 36 hour rainfall, 48 hour rainfall, total rainfall and probability of excess of total rainfall. The actual database consists of data for five categories (eight categories for direction) for each item. Meanwhile, those sub-drainage basins where a collapse with a plane area of 10,000 m^2 per site or more took place due to Typhoon Talas in 2011 are defined as occurrence sub-drainage basins. Those where no collapse took place are defined as non-occurrence sub-drainage basins.

Using this database, important items thought to be closely related to the occurrence or non-occurrence of sediment disasters were deducted using rough set.

CONCLUSIONS

The important factors to be considered in relation to the occurrence or non-occurrence of deep-seated landslides are, in order of the degree of influence, slope direction, number of micro-topography, probability of excess of total rainfall, elevation difference (top-bottom), elevation difference (summit level-bottom) and distance from a fault. Highly ranked conditions consist of both geographical/geological and rainfall conditions.

REFERENCES

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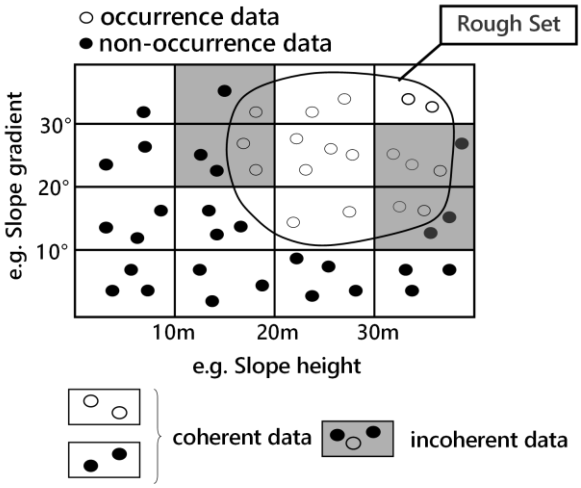

Fig.1 The concept of rough set

Table 1 Image of the reduction of the database using rough set

drainage basin ID	geography condition 1	geography condition 2	geography condition 3	disasters results
A	2	1	1	occurrence
B	1	2	2	non-occurrence
C	1	1	2	non-occurrence
D	2	3	1	occurrence
E	1	1	2	non-occurrence

eliminate geography condition 2

drainage basin ID	geography condition 1	geography condition 3	disasters results
A	2	1	occurrence
B	1	2	non-occurrence
C	1	2	non-occurrence
D	2	1	occurrence
E	1	2	non-occurrence

Keywords: deep-seated landslide, geographical factors, geographical conditions, rainfall conditions, rough set