

EXTRACTION OF LANDSLIDE AREAS USING MSS DATA AND THEMATIC MAP DATABASE SYSTEM

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ABSTRACT :

The objective of this study is to extract areas where landslides may occur in the near future by using MSS data and thematic map data. Occurrences of landslides are considered to be closely related to vegetation, geologic and topographic features.

We used an Image-Map database system based on digitized thematic maps related to landslides and NVI (Normalized Vegetation Index) data which was produced by MSS data. As a result, this analysis system shows that characteristic features in landslide areas can be extracted by using geology, inclination angles and NVI.

KEY WORDS: Thematic map, Landslides, MSS data, NVI

1. INTRODUCTION

Satellite imagery has been used to clarify characteristic property of the ground surface by the advantage of broad area observation and periodicity [1].

Satellite data obtained from space has many advantages. However, if we are going to get more useful results, it is necessary to combine satellite data and ancillary data. In this case, ancillary data implies the condition of ground surface and underground, map information and etc..

In this paper, we will first describe an advanced image analysis system using an image-map database system. This database is constructed by numerous thematic map data. Next, this analysis system will be applied to the Noto area in Japan where landslides generate in all season. And we will discuss the relationship among the angle of inclination, geology and elevation of landslide areas. Then, NVI data corresponding to areas of landslides will be investigated. As a result, it is shown that characteristic features in landslide areas can be extracted by using the Image-map database system.

2. DIGITIZATION OF THEMATIC MAPS AND DATABASE

2.1 Thematic maps

In this study, two types of map information are

used for the landslide areas. One of them is concerned with the landslide, obtained from spot investigation. The other one is Digital National Land Information (DNLI). DNLI consists of some information from the country [2].

Thematic maps prepared for this study are as follows:

- (1) Investigation maps of landslides.
(1:25000-scale map: investigated in 1986)
- (2) Geological map
(ISHIKAWA prefecture:1:100000 scale-map)

Dangerous zone maps on landslides were made mainly by the Ministry of Construction and Forestry Agency. The number of points landslides already occurred in the past were about 700 places (totaling about 290 km^2).

On the other hand, landslides which may occur in the near future are about 200 places (totaling 80 km^2). This data has high level of reliability. The geological map of ISHIKAWA prefecture was divided into 7 blocks. Each segment has 13 to 27 types of geology which was painted with several colors for easy discrimination.

2.2 Methodology of digitization

It is necessary to convert thematic map into digital information because it is analogue data. In digitizing thematic maps, the Standard Local Area Mesh Code (SLAMC) which was used to DNLI, was adopted. The SLAMC consists of three groups of digital code, i.e., First Mesh (4 digit numbers), Second mesh (2 digit numbers)

and Third Mesh code (2 digit numbers). Table 1 shows the size of the local area as referred to by each code of the SLAMC.

Table.1 Size of SLAMC

Mesh code	Size of the local area	
	latitude × longitude	approximate square area
First Mesh	40' × 60'	80km × 80km
Second Mesh	5' × 7' 30"	10km × 10km
Third Mesh	30" × 45"	1km × 1km
Fourth Mesh	3.75" × 5.625"	125m × 125m

Fourth Mesh shown in Table 1 is not available from the DNLI. This code was made by the authors to describe in detail the landslide areas. This procedure let us overlap different scale maps.

3. IMAGE ANALYSIS SYSTEM

3.1 Multi data display

To investigate the basic relations among DNLI, NVI and digitized thematic map data, we constructed an Image-Map database system [4]. Third Mesh in DNLI has approximately 1 square km. Elevation data and inclination angle data are recorded by dividing this mesh into 4 rectangular areas.

Landslide data needs more detailed information. Therefore, we divided the local area specified by the Third Mesh code into 64 rectangular areas to establish the Fourth Mesh code. The size of the Fourth Mesh code is about 125m×125m.

On the other hand, the geological map we used here is 1:100000 scale-map and so it is very difficult to digitize into 125m squares. Therefore, we divided the Third Mesh into 4 rectangular areas. The grid width of the digitized Geological Map becomes about 500m. Figure 1 shows the framework of our image analysis system which involves DNLI and NVI. The sizes of No.1 to No.6 are 10 square km. This size corresponds to the Second Mesh code in DNLI. The minimum mesh size in each window has different sizes as mentioned above.

Each minimum mesh size are

- (1) NVI : 125m
- (2) Elevation : 250m
- (3) Inclination : 250m
- (4) Geology : 500m
- (5) Landslide : 125m
- (6) Overlap : 125m

3.2 Single data display for wide area

Prepared data concerning the Image Analysis system are all Second Mesh size, however, landslides occur in wide areas, therefore we have to investigate as expansively as possible.

Figure 2 and 3 shows the whole area and a specified area of NOTO district where landslides often occur in all seasons. Figure 2 shows distribution of elevation data in NOTO district. Figure 3 was magnified. This single data display system can show any optional 9 piece blocking or the whole 54 piece area in the Third Mesh code.

Figure 4 shows NVI data for whole area in the NOTO district by using this system.

4. ANALYSIS OF LANDSLIDE AREAS

4.1 Statistics of Thematic Maps

We investigated the characteristics of thematic maps by using the image analysis system to combine NVI data and map data. Both the distribution and the area of geology in each second mesh were investigated. Figure 5 shows the relationship between the kind of geology and area of WAJIMA district(second mesh). Figure 6 shows the same relationship as figure 5 for all the second mesh of the NOTO peninsula. As a result, we found that andesite lava and sedimental rock are most widely distributed in landslide areas. Sandstone, mudstone and conglomerates were also found in large distribution. It is well known that sedimental rock and mudstone are soft soil, so we can estimate that landslides will generate in these areas. Figure 7 shows the relation between the inclination angle and the ratio of landslide occurrences. The ratio of landslide occurrences is the ratio of landslide area to total area at the one inclination angle. This figure suggested that most landslides in the NOTO district occurred on gentle slopes more than steep slopes.

4.2 Overlapping

The objective of this study is to estimate the area where landslides may occur in the near future. In order to estimate successfully, we have to investigate the characteristics of areas where landslides occurred in the past. Thematic maps (landslide), other maps and DNLI are overlapped. This procedure is conducted by the image analysis system. One example of the WAJIMA region is as following:

Conditions of landslides occurrences in the past in the WAJIMA region are

- (1) the angle of inclination is greater than 12.5 degrees
- (2) the elevation is under 300m
- (3) main geology types are sandstone, mudstone and conglomerates

Landslide area corresponding to these conditions were 72%. This indicated that landslides may occur in regions where these conditions are satisfied.

4.3 NVI data in landslide regions

We are present studying the NVI data calculated from the satellite data to understand the relation to landslides. We are investigating the distribution of frequencies from two groups of NVI data in the NOTO region. The data from one group is data from the areas landslide occurred in the past and pointed dangerous zone. The other is data from non-landslide areas. The average value of each NVI is shown in Table 2.

Table.2 NVI data of each Categories

<i>Items</i>	<i>Total count number</i>	<i>Average values of NVI</i>
Dangerous	5631	80.6
Occurred	14818	79.5
Dangerous+occurred	20449	79.8
Non-landslide	129330	75.1

As seen from Table 2, the value of NVI data in non-landslide areas is relatively small compare to dangerous area and landslides areas. One reason to the NVI values of non-slide area is smaller than those of landslide areas is that the non-landslide areas include urban areas. However, it has been said that the occurrence of landslides is considered to be closely related to the content of underground water [3],[5]. The content of underground water is considered also to be closely related to ground surface vegetation.

Therefore, we need to investigate further to understand the relation between value of NVI data and landslide areas.

5. CONCLUSIONS

An extraction of landslides areas using NVI values which were transformed from MSS data and Thematic maps has been performed. This analysis was mainly made by the Image-Map database system. As a result, it was shown that some characteristic features in landslide areas can be easily extracted by using the Image-Map database system which included satellite data (NVI), landslides area data, geological data, elevation data and inclination angle data. Moreover, it was found that the average value of NVI data in landslide area was larger than non-landslide area.

References

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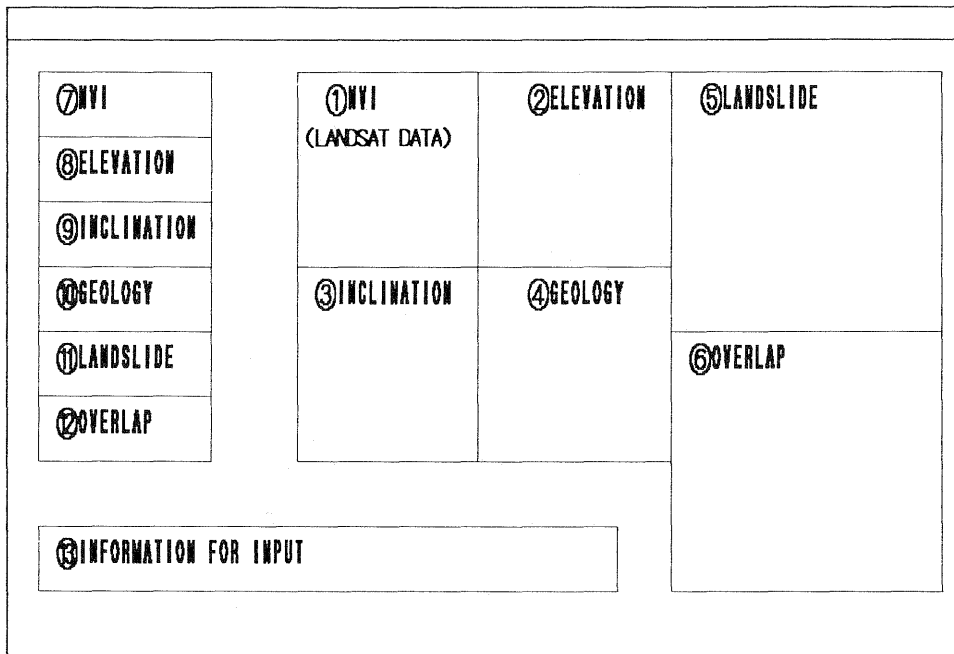


Fig. 1 Framework in image analysis system

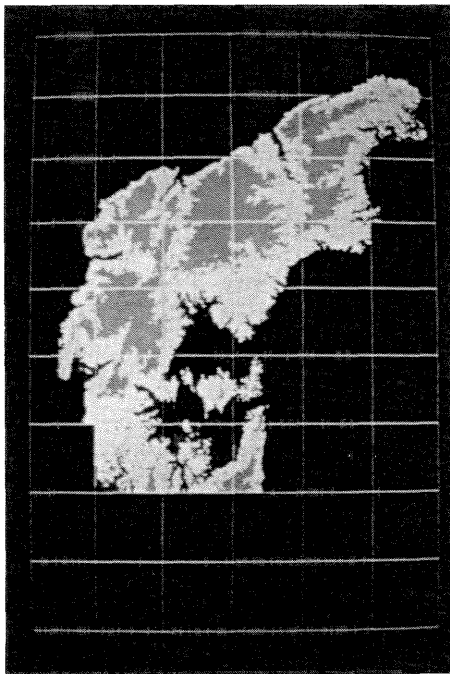


Fig. 2 Single data display for wide area
(distribution of elevation : whole area)

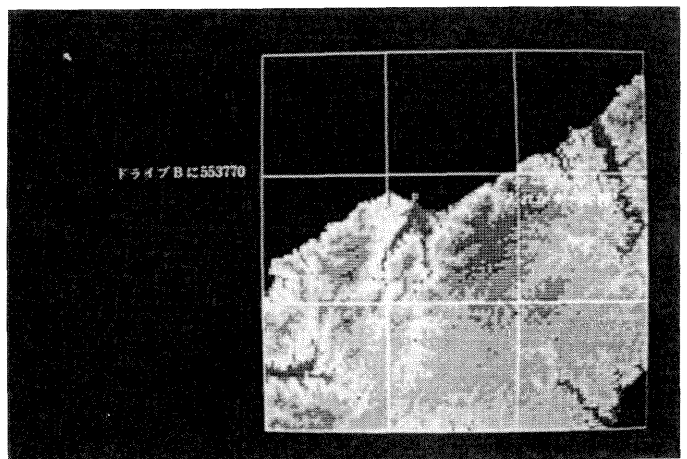


Fig. 3 Single data display for wide area
(distribution of elevation : optional 9 pieces)

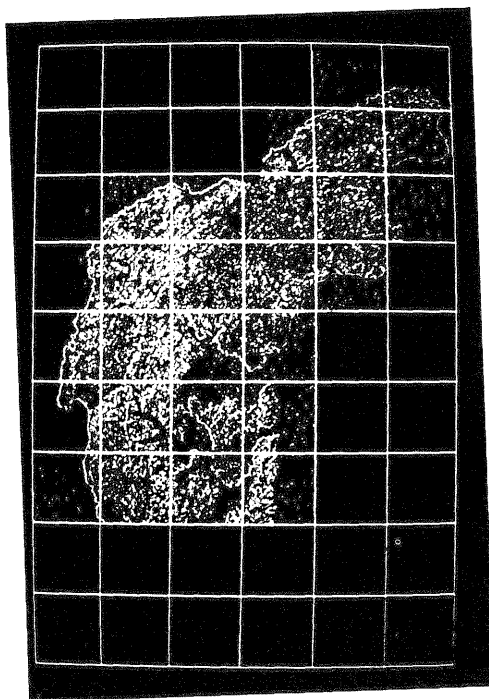


Fig. 4 NVI data for whole area in the NOTO district

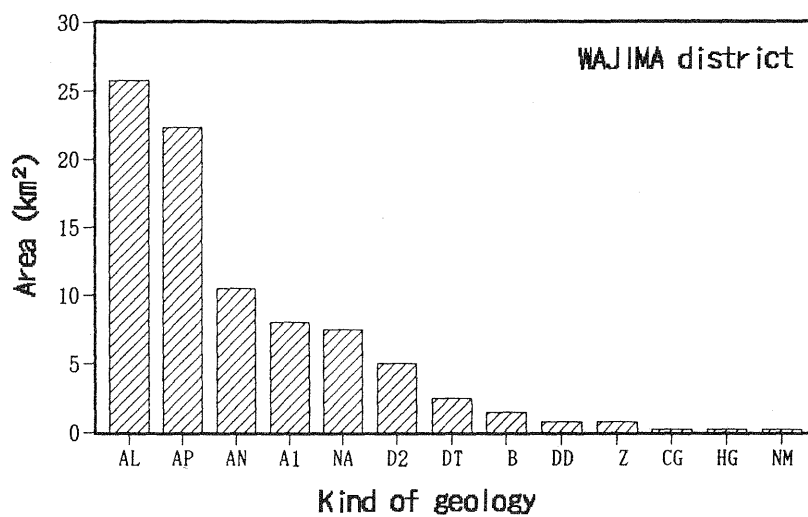


Fig. 5 Relationship between the kind of geology and area of WAJIMA

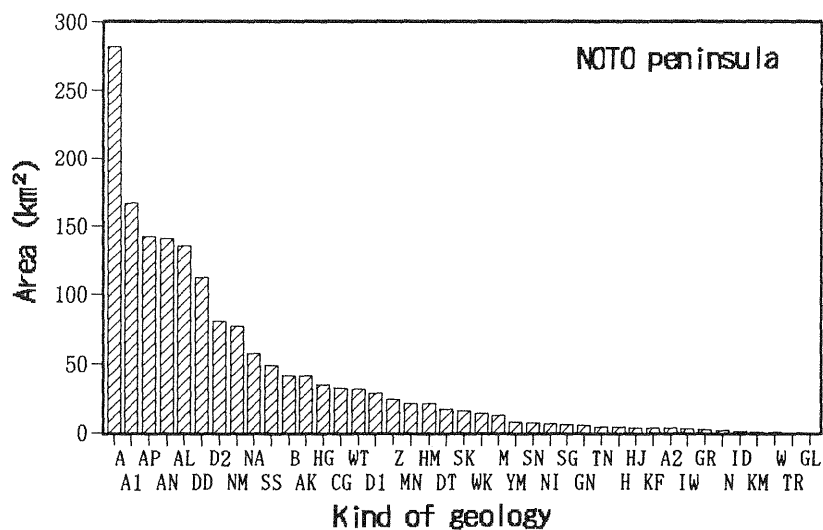


Fig. 6 Relationship between the kind of geology and area for all the second mesh of the NOTO peninsula

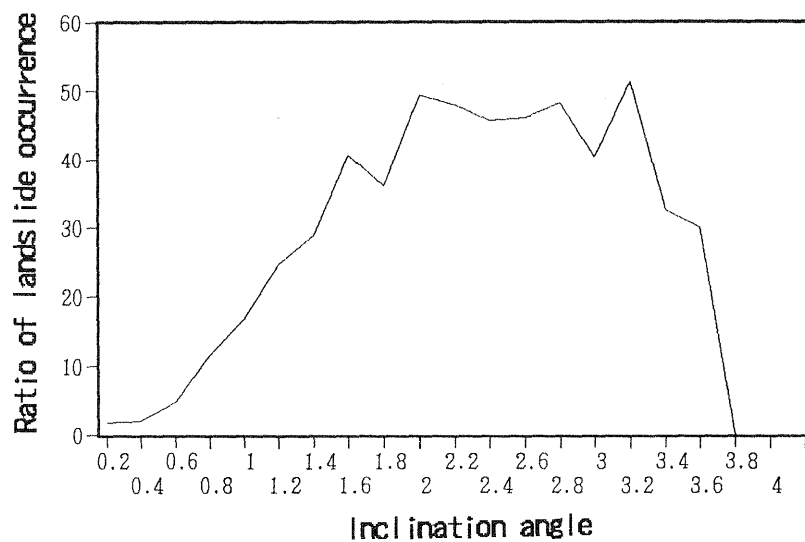


Fig. 7 Relationship between inclination angle and ratio of landslide occurrences