Monitoring Landscape Change in Nagasaki City Using Remote Sensing

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1. Introduction

Land cover change in Nagasaki City is significant over the past decade, effected by both natural forces and human activities. Japan is located in an area of severe crustal movement, and is situated in one of the world's most seismically active regions. Therefore, it is prone to all types of natural disasters such as earthquake or land sliding etc. According to the available statistics, only 25% of Japans' land area is flat and low lying with plateaus, so the Japanese people have suffered from numerous landslide disasters since ancient time (Fig. 1). The population density of Japan is 340.4 persons/km^2 (based on the 2000 census population of 126.92 million) [1]. However, the population density of low-lying areas and plateaus of Japan is 1,312 persons/km^2 indicating the severity of land use in Japan.

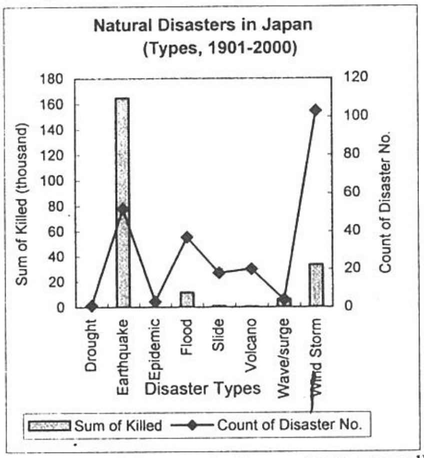


Fig. 1 Natural Disasters in Japan (1901-2000) [1]

Space technologies, like remote sensing, geographic information systems (GIS) etc., play crucial roles in regional sustainable development, disaster management and monitoring. Also these technologies allow us to map the variability of terrain properties, such as vegetation, water and geology, both in spatially and temporally. The aim of this study is to obtain reasonable change by land classification using multi-temporal Landsat/TM data.

2. Study Area and Used Data

Nagasaki City was selected for analyzing land cover variation. The population of Nagasaki City is 426,500 (year 2002) and land area is 241.2km^2 [2]. As other cities, this city includes land cover types of forest, grassland, urban and built-up land, agricultural land, wetland, etc. In the last few decades, due to natural disasters and urbanization, the land cover in this area has changed significantly. For this study, aerial photographs of Nagasaki City and Thematic Mapper (TM) data acquired by Landsat-5 were analyzed by using ERDAS Imagine 8.5 software. The satellite data used are 3 scenes of Landsat/TM, dated 12 May 1986, 12 May 1992 and 2 May 2000.

3. Methodology

Seven banded remotely sensed data were acquired by TM on Landsat 5, having 5,965 lines and 6,920 pixels. For the purpose of temporal land cover change detection, remotely sensed data were obtained in the same month, i.e. May, of 1986, 1992 and 2000. Radiometric and geometric errors are the most common types of errors encountered in remotely sensed imagery. The commercial data provider has removed the radiometric and systematic errors of Landsat/TM data, while the geometric errors were corrected by using ground control points (GCP). While correcting the data geometrically, nearest-neighbor re-sampling method was used. A correlation threshold is used to accept or discard points. The correlation range was within limits i.e. 1 pixel size. The x and y errors were below 0.5 pixel.

Certain classification schemes that can readily incorporate land use and/or land cover data obtained by the interpretation of remotely sensed data have been developed [3] [4]. The US Geological Survey Land Use/Land Cover Classification System (Level I) was chosen and referred to for the classification system of this study. The three remotely sensed images of Nagasaki City were classified with common and popular unsupervised, Iterative Self-Organizing Data Analysis Technique (ISODATA) classification algorithm. The interpreted data were located in the aerial photographs and topographical maps. It confirms the accuracy of evaluation of remotely sensed data. Finally, we converted the pixels into area to detect the change variation.

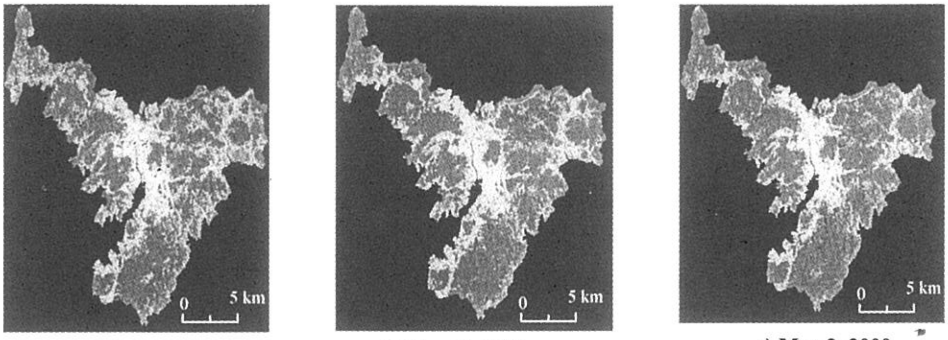
The ISODATA method uses minimum spectral distance to assign a cluster for each candidate pixel. To perform ISODATA clustering, following parameters were specified:

- N – the maximum number of cluster to be considered. Since each cluster is the basis for a class, this number becomes the maximum number of classes to be formed (10 in this study).
- T – a convergence threshold, which is the maximum percentage of pixels whose class values are allowed to be unchanged between iterations (95% in this study).
- M – the maximum number of iterations to be performed (24 in this study).

4. Results and Discussion

The results of ISODATA classification of Nagasaki City are presented in Figure 2 a) ~ c). The calculated areas of each land cover are shown in Table 1 and Figure 3. From the over all result of the area, it is visible that vegetated area is decreasing and urban land is increasing. Urban land is constantly showing its tendency towards increasing from 1986 till 2000; on the other hand, agricultural and barren land decreased from 1986 till 1992 and then started increasing from 1992 till 2000.

Referring to the City Statistics, managed agricultural land has decreased for more than 15 years. Therefore, the agricultural area of 1986, seen in Table 1, seems to be too large. On the other hand, the forest seems to be small. We interpret that part of the forestland is classified into the agricultural land in 1986.



a) May 12, 1986   b) May 12, 1992   c) May 2, 2000

Fig. 2 Result of Land Classification of Nagasaki City

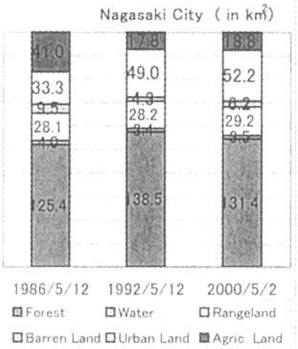


Fig. 3 Graphically Representation of Land Cover Change in Nagasaki City

Table 1 Statistical result of Land Cover Change in Nagasaki City

(Area in km²)

	1986/5/12	1992/5/12	2000/5/2
Water	4.0	3.4	3.5
Forest	125.4	138.5	131.4
Rangeland	28.1	28.2	29.2
Urban Land	33.3	49.0	52.2
Agricultural Land	41.0	17.8	18.8
Barren Land	9.5	4.3	6.2

Color	Class Names
	Water
	Forest
	Rangeland
	Urban & Built-up Land
	Agricultural Land
	Barren Land

(Legend for Fig. 2)

5.Conclusion

Land cover changes can impact ecosystems, environment and regional sustainable development directly and/or indirectly by affecting a wide range of processes, such as the movement of nutrients through plants, soils, water and the atmosphere. After summing up forestland and agricultural land, the result comes in a drastic and continuous decrease from 166.4km^2 in 1986 to 156.3km^2 in 1992 and further 150.2km^2 in 2000. The dynamic changes of forestland and agricultural land can affect environmentally and economically. With economic growth, industrialization and urbanization, the decrease in forestland and agricultural land is a serious problem. It is thus very important for governmental decision making at local, national and regional scales to obtain real time information on land cover and also to take some measures, based on more detailed investigations, to protect forests and agricultural land. If not, then it may directly impact on the activities of human beings and the survival of other living organisms in this area.

References

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