MONITORING OF ENVIRONMENTAL CHANGES IN ASIAN MIDDLE LATITUDE ZONE BY ALOS DATA

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Abstract

Because the remarkable environmental change and the frequent abnormal weather pattern are recognized in the middle latitude zone of Asia, it's necessary to investigate the detailed land cover change and disaster situation through the analysis of various kinds of satellite data. This paper describes the analysis results of the environmental fluctuation, environmental change and the flood occurrence through the detection of micro-topographical features and the analysis of land cover change by using the multi-temporal and plural satellite data including ALOS data. Three principal study areas such as the Central Asia, East Asia and Japan were selected in this study. The production of several kinds of multi-satellite datasets covering study areas based on the existing satellite data and other observed sources, the analysis of the fluctuation in closed lakes and change in irrigation land, snow and glacier in the Central Asia, and the relationship between flood phenomena and land cover change situation were carried out as the primary research. Furthermore, the method and algorithm for detection of topographical features by DEM is examined in Japan.

Keywords: PRISM、environmental change、DEM.

1. BACKGROUND AND OBJECTIVES

Due to the rapid environmental change and the frequent abnormal weather pattern have arisen in recent years in the middle latitude zone of Asia, it is necessary to investigate the detailed land cover situation and its change by using various kinds of satellite data, The objectives of this research are to examine the method for monitoring of the wide ranging environmental change phenomena and the frequent disaster situations by using the ALOS with the other satellite data. Especially, the causes of the rapid change and the disaster situation will be investigated by multi-temporal satellite datasets including ALOS data.

2. OBJECT AREAS

The object area covers the middle latitude zone of the Asian continent including the Central Asia, East Asia and Japan. Particularly, three principal study areas such as Tien Shan Mountains and its vicinity, the middle and the lower reaches of Yangtze River in China, and Kanto and Chubu districts in Japan shown as ①, ② and ③ in Figure 1 were selected for the purpose of the investigation of method and application to the detailed analysis of land cover change and disaster situation

Figure 1. Principal study areas such as the Central Asia(①), Yangtze River basin(②) and Chubu and Kanto districts in Japan(③)

3. RESEARCH METHOD

Principal research objects in this study are as followings.

1) Examination of the algorithm for extraction of the topographical information and land cover .
2) Analysis of the changes in land cover and geo-morphological features around closed lakes in the Central Asia.
3) Analysis of the changes in land cover and geo-morphological features in the middle and the lower reaches of Yangtze River .
4) Experimental study for analysis of the relationship between causes of flood and environmental changes.

Multi-temporal and plural satellite data sets from the 1960's to the 2000's are firstly produced in each study area. In the Central Asia, the comparative analysis between long-term and recent environment fluctuation is carried out

based on the results of the detection of geomorphological features distribution around closed lakes and the change analysis of land cover such as the irrigation area and snow/glacier with referring to the meteorological data. The change in the water storage capacity of lakes based on the analyzed change in the land cover situation and the bathymetric topography is also estimated in the middle reaches Yangtze River. Furthermore, the processing of sedimentation at the river mouth of Yangtze River based on the change situation of the coast line and the relation to the land cover change situation in the drainage basin are analyzed. The examination and evaluation for the analysis algorithm and method are enforced in Chubu and Kanto districts of Japan.

4. RESEARCH RESULTS

4.1. Central Asia

In a few closed lakes such as Ebi Nur and Manas Hu of Junggar Basin shown in Figure 2, and Old Juyan Lake of Gobi Desert, the examination of an algorithm of the extraction of micro-topographical features and its relative height along the lake shore line from the satellite stereo pair data, and the actual extraction analysis were firstly carried out. Next, the long term and recent fluctuation in the environment depending on the change in lake water level was estimated.

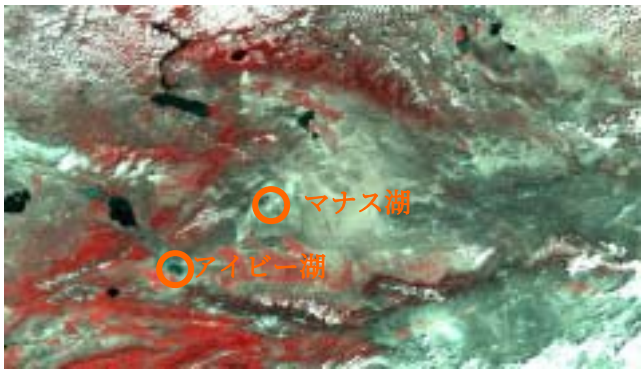

Figure 2. MODIS image showing Ebi Nur and Manas Hu in Junggar Basin

The height of micro-geographical features of the former lake water area was extracted by the DEM derived from Terra/ASTER data and SRTM/DEM because of no observation of the suitable ALOS/PRISM data. Based on the extraction result of the relative height of micro-topographical features, the reconstructed former Ebi lake water areas and their estimated change in the past about 4500 years, and recent one in the past 100 years were shown in Figure 3, 4 and 5, respectively. According to the analyzed results of Ebi Nur, it was grasped that the water area decreasing in the lake and desertification at the vicinity were progressing gradually since the past 4500 years, but the rapid decrease in the water area was suddenly indicated in the mid 1990's as much as no example in the past.

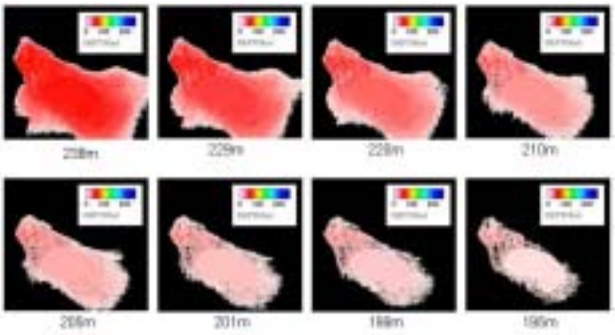

Figure 3. Reconstructed former water areas of Ebi Nur in the past about 4500 years based on DEM

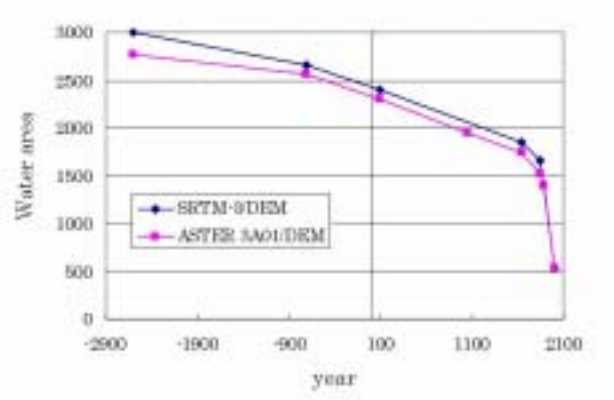

Figure 4. Estimated change in former water areas of Ebi Nur in the past about 4500 years

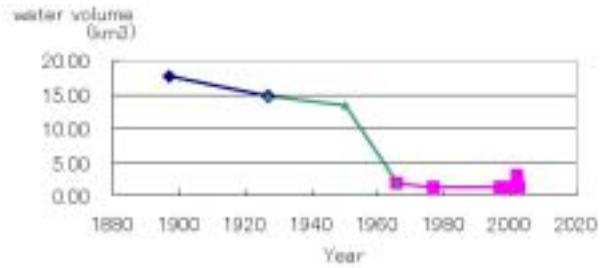

Figure 5. Estimated and detected change in water volumes of Ebi Nur in the past 100 years from DEM

In Manas Hu of Junggar Basin, the relative height of micro-topographical features around the lake was measured by field survey. Therefore, the comparative analysis of measurement results of the relative heights of micro-topographical features at the old lake shore lines due to the change in the past water level fluctuation based on the analysis of the DEM derived from ALOS PRISM with other satellite data such as CORONA, ASTER and SRTM was carried out in the southeastern area in Manas Hu shown as Figure 6. DEM images based on ALOS/PRISM and SRTM, and the distribution of relative heights along cross section of former lake shore lines based on several

satellite data were shown in Figure 7 and 8, respectively. Although DEM from PRISM and DEM by SRTM showed the relative heights close to field measurement data, it were shown that they were a little lower than actual height and their difficulty of the extraction of the steep terrace by these figures.

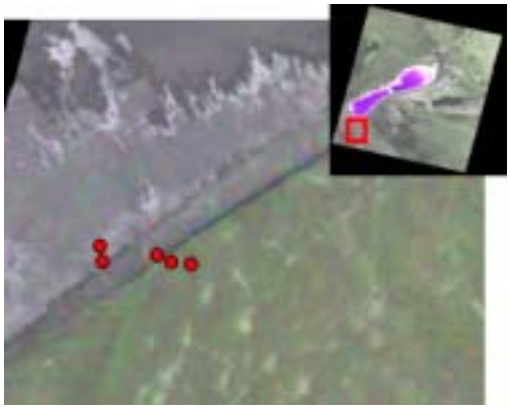

Figure 6. Comparative analysis area of relative heights of micro-topographical features in the southeastern portion of Manas Hu

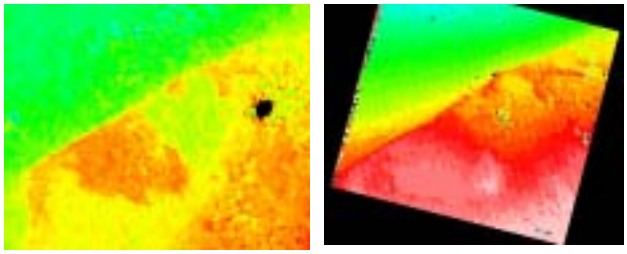

Figure 7. DEM color coded images based on SRTM (right) and ALOS/PRISM (left) and in the southeastern portion of Manas Hu

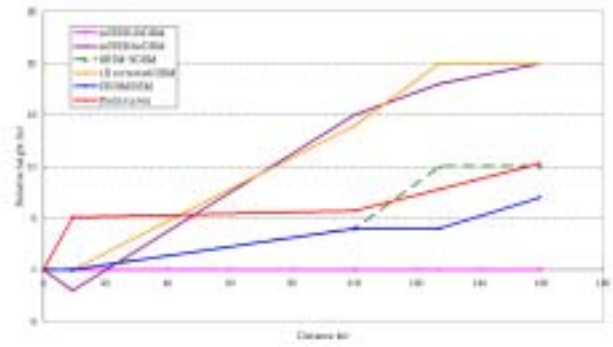

Figure 7. Distribution of relative heights along cross section of former lake shore lines based on several satellite data

For the purpose of the comparative analysis of the change tendency with Junggar basin, the reconstruction of the former water area in Old Juyan Lake where was located in Gobi Desert for several thousand years was experimentally carried out by using SRTM/DEM because there were no ALOS/PRISM observation data. An example of the perspective view image which reconstructed former water area of A.D.225 in Old Juyan Lake is shown in the Figure 9.

It was considered that the detailed analysis of the fluctuation in the environment and the extraction of the micro-topographical features based on the improved DEM based on the future observation ALOS data could be enforced in the Central Asia.

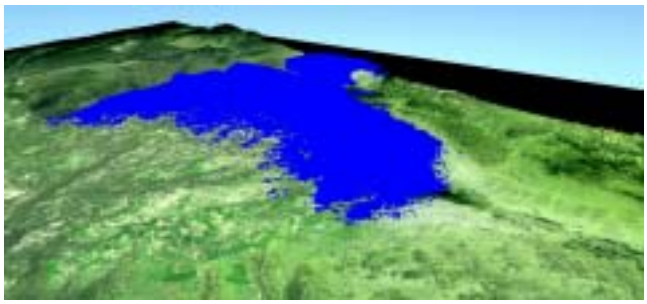

Figure 9. A Perspective view image showing reconstructed former water area of A.D.225 in Old Juyan Lake

4.2. Yangtze River drainage basin

In the middle reaches of Yangtze River (Chang Jiang) from Three Gorges Dam to Nanjing, frequent large floods occurred because the river meanders in the very gentle slope. There are a few large lakes such as Dongting Lake and Poyang Lake which have a function as natural retarding basin. According to the detailed analysis results of water area, bathymetric features and land cover change in the catchments basin, the relationship between the change in the lake or the land cover and the flood occurrence was analyzed with referring to the various statistics data and the meteorological data. Time-series satellite data sets consisting of CORONA data in the 1960's, LANDSAT/MSS・TM・ETM data from the 1970's to the 2000's and Terra/ASTER data were applied to the analysis of the change in land cover and the DEM generation, because of no observation of the suitable ALOS/PRISM data in this areas.

A color coded image showing the water area change and the estimated water level of Dongting Lake are shown in Figure 10 and Figure 11, respectively. The water area reduction of about 790km^2 from 1964 to 1987 and the decrease in the water storage capacity of about 24×10^8 m^3 in Dongting Lake were recognized by analyzing satellite data sets. Therefore, it was presumed that the decrease in water storage volume due to the reduction of the lake water area of Dongting Lake was one of the factors of the flood occurrence. However, the necessity of analysis by ALOS data was indicated because DEM derived from the existing data such as ASTER and SRTM wasn't suitable to detect the topographical features in the lake bottom and around lake with regard to the spatial resolution.

On the other hand, the detection of the change in the coastline along the river mouth of Yangtze River and the investigation of factors for the change is being carried out by using time series satellite data sets including ALOS/AVNIR2 data with existing satellite data such as CORONA, LANDDSAT/MSS,TM,ETM and MOS-1/MESSR since the 1960's

According to the analysis result, it was shown that the speed of the expansion of the artificial coast line was rising after 1990 and it was especially remarkable at 2000 and 2002. The possibility to take the influence of the change in the economic activities was shown by the reference of the social statistics.

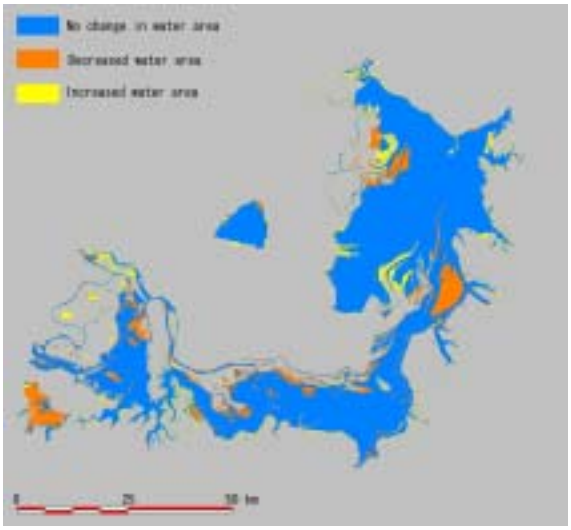

Figure 10. Change in the water area of Dongting Lake by time-series satellite data

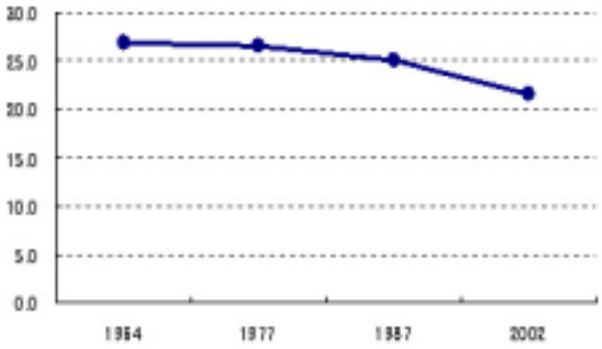

Figure 11. Change in the water level(m) of Dongting Lake by time-series satellite data

4.2. Japan

The study aims to develop and evaluate an algorithm for generation of DEM from PRISM stereo pair data, and examine the possibility to apply ALOS data to the disaster monitoring in Kanto plain, Mt Fuji and Izu Oshima. The development and verification of an algorithm of the DEM generation were carried out by using the ASTER data covering Izu Ooshima, because the ALOS data which were suitable for the analysis weren't observed by 2007. Thus, An expectation for the DEM generation by the triplet observation data of ALOS/PRISM was shown.

5. SUMMARY

The result of this paper is summarized as follows;

1. Concerning micro-topographical features extraction by the stereo pair data, the improvement of the accuracy was expected by the high spatial resolution and the triplet observation of ALOS/PRISM data.
2. More improvement of the detection accuracy of micro-topographical features was expected by the improved algorithm.
3. The advanced analysis for land cover and its change was expected by using the time series satellite data sets including ALOS data.
4. The advanced accuracy of long time and recent environment change analysis in arid and semi-arid regions, and the analysis of factors of the disaster occurrence and their influence were expected by applying ALOS/PRISM and AVNIR2 data

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References

[1] Y.Nakayama, T.Yanagi, S.Yamaguchi, J. Nishimura, G.Mu, “Monitoring of Environ-mental Change in Dzungar Basin by the Analysis of Multi Temporal Satellite Data Sets”, Advances in Space Research, Vol. 39, pp.52-59、2007

[2] Yoshiaki Furuno, Yasunori .Nakayama, Kunihiko Endo and Guijin Mu, “Analysis of change in lake water area in the catchment basin of Hei He by time series remote sensing data”, Proceedings of The 2007 Meeting The Japanese Association for Arid Land Studies, pp.15-16、2007 (in Japanese)

[3] Yoshiaki Furuno, Yasunori .Nakayama, Shino Yamaguchi and Toshiro Sugimura, “Generation of the DEM for the detection of microtopography in arid area by using ALOS/PRISM and Terra/ASTER data”, Proceedings of The 42nd Autumn Conference of The Remote Sensing Society of Japan, pp.197-198、2007 (in Japanese)

[4] Norihiro Murayama and Yasunori Nakayama, “Investigation of change in lakes and its effect for flood of the middle reaches of Yangtze River by the analysis of satellite data”, Proceedings of The Institute of Natural Sciences, Nihon University, No.40, pp.131-139、2005 (in Japanese)