Establishment of monitoring and hazard level assessment system for landslide disasters by ALOS, and its application

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Abstract
Landslide disaster is one of major disaster in whole world. In case of Japan, over 1 million sites of landslide are distributing in wide area. Therefore, it is very difficult to monitor all landslides and evaluate its hazard level. To develop the landslide monitoring system that can monitor large area is important because landslide disaster is increasing year by year especially in Asian region.

In the research, we'll develop the prototype of large area landslide monitoring system using ALOS data at a few test sites at Japan. Analytical results of ALOS data will organize by landslide monitoring system that developed by GIS. On the GIS, it is possible to simulate the landslide hazard level by numerical model, and also analyze the movement history of the landslide. Now we are developing this system at one test site of Gifu, Japan. And PALSAR DInSAR analysis is applied to a few test sites in Japan.

In the future, we will propose this system to decision-maker of local and also applies to other sites such as other country.

Keywords: Landslide disaster, ALOS, DInSAR, GIS.

1. INTRODUCTION

A landslide disaster has a big influence to our social activity. In Japan, more than one million landslide places are located. And landslide disaster occurs every year at mountain area and residential region that located on steep terrain. To mitigate the landslide disaster, monitoring the entire landslide hazard site is necessary. But it needs a long time and a huge budget.

Using satellite remote sensing technology is possible to apply as one solution of the large area monitoring. We can get much information from the observation data as deformation, water content, classification, topography, and so on. Integrating these information and existing information, we should be providing the effective information for decision maker.

ALOS carries L-band SAR, PALSAR. L-band SAR had shown high performance to monitor the landslide that located at mountain region in recent research. Result from DInSAR analysis can apply to estimate the factor of landslide. And it can apply to modify the numerical model of simulation.

To establishment the landslide hazard assessment system, using GIS platform is necessary. An author has already established prototype landslide assessment system at Gifu Prefecture, Japan. In this system, entire landslide hazard places of Gifu area are registered. This information helps to estimate the landslide hazard level. In this system, landslide hazard level is estimated by statistical analysis of landslide factor. If we can use the information of behavior of landslide, the system will grows more powerful tool.

In this research, PALSAR DInSAR analysis is applied to monitor landslide behavior. And we will confirm the applicability of DInSAR to monitor landslide at three test sites in Japan. Moreover, we will modify the prototype landslide hazard assessment system using the information of DInSAR and optical sensor image.

2. METHODOLOGY

2.1. Test site

In this research, we selected two areas for analyze and validate the landslide deformation detection by PALSAR DInSAR. And also we selected a test site for establishing prototype landslide monitoring and hazard level assessment system in one prefecture.

The characteristics of test sites are shown in Table.1.

Table 1. Characteristics of the test site

Test site	Takisaka landslide	Zentoku landslide	Gifu Prefecture
District	Fukushima	Tokushima	Gifu
Country	Japan	Japan	Japan
Lat.	37.64805556	33.87682222	
Long.	139.6386111	133.835	
Area	2.1km x 1.3km	0.9km x 2.0km	
Slope angle	Approx. 10 degree	Approx. 30 degree	-
Applied analysis	DInSAR	DInSAR	GIS

To confirm the applicability of DInSAR analysis to monitor the landslide, Takisaka landslide and Zentoku landslide are selected. Takisaka landslide and Zentoku landslide are one of huge landslide in Japan. Area is over 1km x 1km.

To establishing landslide monitoring and hazard level assessment system, Gifu Prefecture, Japan, is selected. For this test site, we have already established the prototype of landslide monitoring and hazard level assessment system using GIS platform without satellite-based data. We adopt the satellite-based data that is amount of deformation, DEM, DSM, and image, and modified and upgrading this system through this research opportunity.

2.2. Method

To evaluate the capability of DInSAR for landslide monitoring, PALSAR data is analyzed as time series data. From analysis, we'll confirm the amount of movement and also understand the factor of landslide by the comparison between DInSAR results and ground-based observation data. In Takisaka landslide there are more than 20 GPS stations and ground-based observation instruments has already installed. And also, there are a lot of ground-based observation instruments are installed in Zentoku landslide.

The factor of landslide is very important information for the decision maker. And understanding the behavior of landslide is also important to estimate the hazard level. If we consolidate the information of landslide in one system, it may help landslide hazard level assessment. To consolidation of information, proposed prototype landslide monitoring and hazard level assessment system is used. At first, we develop the processor to analyze the standard product. Second, AVNIR-2 image is added to the layer of the background of the digital map. Third, we develop the processor to extract the DSM from the PRISM data.

3. Initial results of the research

3.1 Confirmation of applicability of landslide monitoring by DInSAR

In this research, DInSAR analysis is applied to Takisaka landslide at first. An author was analyzed the DInSAR of JERS-1 in Takisaka landslide, and he confirmed that the possibility of DInSAR analysis to landslide monitoring. In Japan, most landslides are covered by high vegetation. Also, Takisaka landslide is covered by high vegetation. However, we can detect landslide movement by JERS-1 DInSAR. It means that the L-band SAR shows high performance to penetrate vegetation in mountain area. From this knowledge, PALSAR DInSAR is applied to Takisaka landslide.

Figure. 1 is a result of InSAR that processed by the ©Gamma software. Analytical data was acquired on 8 Aug., 2006 and 23 Sep., 2006. Observation mode is Fine Beam Single (FBS) observation mode on the ascending flight direction. From baseline analysis, perpendicular baseline was calculated as approximately 580m. This analytical pair shows high coherency on entire image. Point viewing of Takisaka landslide, it can estimate that landslide is stable in this term because we can't find the abnormal fringes.

3.2 Establishment of landslide hazard level assessment system using ALOS data

AVNIR-2 data added to the layer of prototype landslide hazard level assessment system. Utilized AVNIR-2 data was processed by developed processor. It can process the data from L1B1 to UTM product. And at least, we are developing the processor for extract DSM from the PRISM data.

Figure 2 shows the captured image of AVNIR-2 image that adapted to prototype landslide hazard level assessment system. We can find the trace of small slope collapsed area from AVNIR-2 image. And also we can understand the location of landslide from image with the map in convenient.

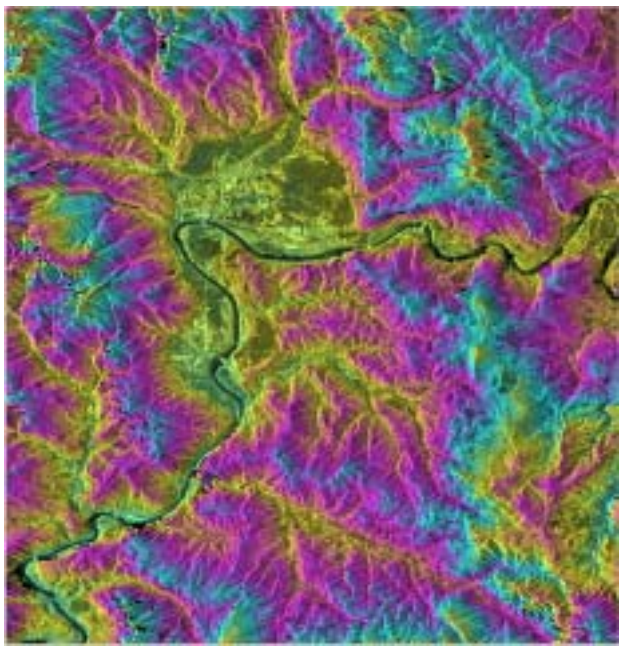

Figure 1. Extracted topography around the Takisaka landslide

4. Summary and future plan

PALSAR shows good coherence in the analytical pair of this analysis. And from comparison of InSAR and GSI's DEM, we estimated that the Takisaka landslide is stable. In the next step, we analyze the differential interferogram and starting evaluation and validation of the DInSAR for monitor the behavior of this landslide. Moreover, we apply this technique to Zentoku landslide in the future.

Figure 2. Image of landslide hazard monitoring and assessment system.

Landslide monitoring and hazard level assessment system have started to modification using ALOS data. Using AVNIR-2 data on the prototype landslide monitoring and hazard level assessment system, we can understand the location of landslide from image with the map in convenient. We'll start the operation of this system from early 2008.

Development of DSM processor for maintains the base-map of GIS will be done in near future.

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