

EGU2020-12625

<https://doi.org/10.5194/egusphere-egu2020-12625>

EGU General Assembly 2020

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Activities of Musan Mine observed by Sentinel-1 Coherence Imagery

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Musan mine in North Korea is the largest open-pit iron mine in Asia with the proved reserves of about 2.06 billion tons and more than 9 square kilometers. Open-pit mining is one of the surface mining technique extracting minerals from the surface. Vegetation is rarely distributed at the mining site because the topsoil is removed and the ore is mined directly from the surface. Therefore, it is effective to observe surface displacement at the mining site using Interferometric Synthetic Aperture Radar (InSAR) technology. InSAR coherence detects random surface change that measures the activity or stability of the interferometric phase of InSAR data. High coherence will be maintained on the surface where there is no movement and only surface scattering. On the other hand, the surface where there is a lot of movement and volumetric scattering has low coherence value. Therefore, using 12-days InSAR coherence images from Sentinel-1 satellites, for example, it is possible to analyze how active the open-pit mine is during the 12 days. Sentinel-1A satellite images were acquired from June 11, 2015 to May 24, 2016, followed by Sentinel-1B satellite images from September 27, 2016 to April 21, 2019. A total of 102 SAR images were downloaded from European Space Agency (ESA) portal. There is a gap between May 24 and September 27, 2016 due to the transition of the data acquisition plan. Over 100 12-days coherence data were obtained by applying InSAR. Stable spots and target spots were selected through average and standard deviation of the entire coherence time series data. Coherence values include not only the mining activity but also the effects of perpendicular baseline, temporal baseline, and weather. Therefore, NDAI (Normalized Difference Activity Index) was newly defined to remove the noise and only the coherence value due to the influence of the mining activity was extracted. The degree of activities can be observed by the time series coherence and NDAI images. This study needs other references related to mining activities in order to analyze the mining activities in more detail. This method can be applied to other open-pit mine.