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INTERFEROMETRIC SYNTHETIC APERTURE RADAR AS A MONITORING TOOL FOR A FOREST STAND

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Introduction. In this research, the potential of interferometric synthetic aperture radar (InSAR) as a monitoring tool, is discussed. InSAR compares two synthetic aperture radar (SAR) scenes and measures changes in topography that occurred between the two acquisition dates. Generally, damage from any kind of soil erosion on a slope with forest stands is not as huge as earthquakes, hurricanes, floods and other catastrophes of this scale.

Presentation of the material. At the present moment, common practices of the landslide monitoring are based on ground point observations, including absolute deformation measurements constructed on Global Positioning Systems (GPS), electronic total stations, levels and etc. Relative deformation measurements approach consists on displacement meters, crack meters or fibre sensors and quantitative analysis relies on light detection and ranging (LIDAR) technology [1]. These methods have the advantage of high precision but the number of monitoring points is limited by the large amounts of fieldwork and economic costs involved and as in the result, these methods cannot identify the distribution and dynamics of landslides [2, 3].

In the last years, InSAR has shown excellent application prospects for monitoring landslide displacement and achievement of good results. In order to improve the spatial resolution and success rate of large-scale landslide hazard detection, an adaptive distributed scatterer InSAR (ADS-InSAR) method is proposed. This method automatically adjusts the distributed scatterer (DS) target detection threshold according to the spatiotemporal coherence of different distributed targets, thus improving the spatial distribution density and reliability of DS detection in landslide areas.

Encouraging points for successful application are possible by largely collected and available SAR data libraries by Radar Earth Observation Missions. In particular, free-available SAR data collected by Sentinel-1A and Sentinel-1B satellites, which represent a unique opportunity for applying mentioned methods on a global scale [2-4]. Use of additional data, such as GPS, will be helpful for better constraining the solution of the multi-track combination methods.

SAR satellites collect swaths of side-looking echoes of forest plots at a typical resolution of 20 m and along-track sampling rate in order to produce high resolution imagery, based on pulse length and the incidence angle, fig. 1. In synthetic aperture method, the image can be focused on a point reflector on the ground by coherently summing plurals of consecutive echoes creating a synthetic aperture. Thus, obtained image contains both amplitude and phase information for each pixel.

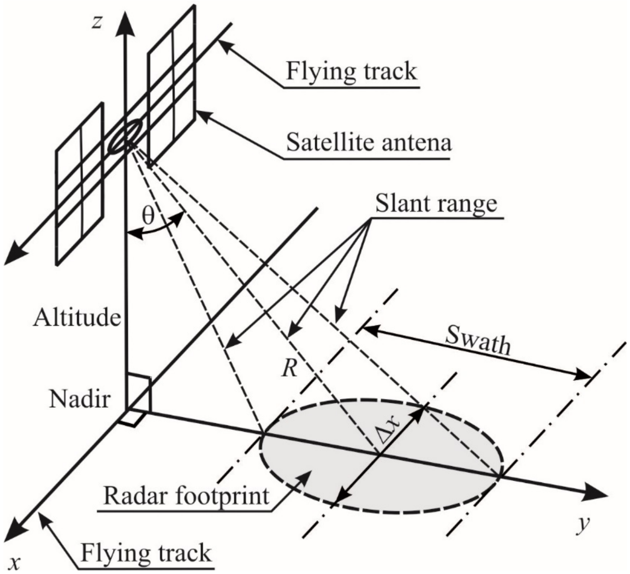
InSAR is created by multiplying the reference image by the complex conjugate of the repeat image. When the reference and repeat images are exactly coincident, the phase difference between the two images will not reflect differences, but must be accounted the existence of an offset between the trajectories of the reference and repeat orbits.

The SNAP software can provide reliable output for interferometry, due to available precise orbital information (Sentinel-1, Sentinel-2, ERS-1, ERS-2 etc.) [1, 2].

In the past, studies about deformation of the forest landscape mainly relied on fieldwork, but due to natural complicated conditions this approach lead to huge difficulties during performance. The development of InSAR methods, provides technical support for research about forest landscape and forest roads.

Certain requirements must be met during detection and analysis of forest landscape and road transportation networks. Firstly, areas of the forest landscape and transportation networks requiring large-scale synchronous measurements along with the reference data. Secondly, the forest ecosystems demanding for continuing and near-real-time monitoring, followed by low time-consumption and expenses.

InSAR is a unique tool for the quantitative measurement of the soil surface deformations influenced by a variety of natural and anthropogenic causes, as soil deterioration, ground-water extraction, and construction of roads. In this framework, the use of InSAR technology can achieve monitoring of surface deformations and the analysis of relevant geodynamic phenomena of the ecosystem on large areas during long period of time.



Surface deformation monitoring forest landscape is one of the most sophisticated applications of InSAR technology. Specifically, the time series analysis methods based on InSAR data. Also, the mentioned method can provide effective assessment of landslide insights and occurrence for the identification and evaluation in complex mountainous areas.

Figure 1 – Satellite radar data acquisition visualization

Conclusions. Currently, although there are many reliable methods for landslide monitoring in forest stands, but due to the special and complex conditions in mountainous areas, the majority are technically difficult to perform and cannot achieve high-density and large-scale continuous change monitoring forest landscape.

Developed combination methodologies of InSAR principles can allow to identify the 3D components of deformation processes and to follow their temporal evolution. The increasing availability of SAR data collected by complementary illumination angles and from different radar tools, makes the use of multi-satellite InSAR techniques very promising for the formation of models deformation and assessment of risks landslides of the forest landscape.

In the future, a few case studies will be held, with a particular focus on the proposed multi-track InSAR method known as a combination approach.

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