MULTI-SENSOR ANALYSIS OF COAL FIRE INDUCED LAND SUBSIDENCE IN JHARIA COALFIELDS, INDIA

A DISSERTATION

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By

VAMSHI KRISHNA RAO K

(18520013)

Under the Guidance of

Prof. Dr Kamal Jain,
Indian Institute of Technology Roorkee, India

Prof. Dr. Mahdi Motagh,
Leibniz University Hannover, Germany

GEOMATICS ENGINEERING GROUP
DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE, INDIA, 247667
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ABSTRACT

Jharia Coalfields, the largest and one of the oldest coalfields in India, are critically affected by coal fires due to the poor management of coal mines in the past. Apart from causing loss of the non-renewable and precious coking coal, coal fires also contaminate the environment, thus substantially contributing to global warming. The subsidence induced by surface and subsurface fires in Jharia coalfields is a prominent concern that requires immediate attention. Coal fires burn the underground coal leading to land subsidence, which in turn aggravates the coal fires by creating cracks and fissures that serve as inlets for oxygen. Also, gases formed due to subsurface coal fires create pressure resulting in surface uplift. This phenomenon leads to the creation of sinkholes in the area resulting in severe loss of lives and infrastructure. The current study aims at analyzing the effect of coal fires on land subsidence in the Jharia Coalfields, India.

For the study, satellite imagery from thermal, and microwave regions of the electromagnetic spectrum are used to deduce the effect of coal fires on mining-induced subsidence. The study is divided into two phases to monitor the change in the land subsidence phenomenon induced by coal fires. Phase I includes Nov 2017- Apr 2018, and phase II is from Nov 2018- Apr 2019. The spatial relation between subsidence and coal fires has been analyzed. 60 Sentinel-1, C-band images captured in ascending and descending direction are used for the PSInSAR analysis. The thermal Infrared data acquired from the Landsat-8 thermal band (band 10) are used to derive the Land Surface Temperature of the study area. The Sentinel-1 data are pre-processed using SNAP. The PSI analysis is carried out using the Stanford Method for Persistent Scatterers (StaMPS) method. GACOS model is applied using the TRAIN toolbox for minimizing the atmospheric errors. The results are decomposed into vertical and east-west displacement, substantially to quantify the subsidence caused by the subsurface coal fires. The coal fields are divided into 8 zones based on the subsidence patterns and analyzed separately. A risk map is generated using the deformation data, coal fires data, and Land Use Land Cover map for the study area.

The results show a maximum subsidence rate of approximately 20 cm/yr in the Jharia coalfields. An uplift of up to 7 cm/year is observed in the study area. Just a few meters away from the settlements, the largest deformation zone covering approximately 2 sq. km is identified in the Kusunda underground mine. The mine is affected by both subsidence and uplift. With the help of thermal imagery, surface and subsurface coal fires are detected and compared to the land subsidence information. The findings exhibit a positive correlation between the subsidence velocity and land surface temperature in the study area. It is noted that the collieries with subsidence show a high spatial correlation with the coal fires in the area. The study also establishes the relationship between the change in the coal fire regions and the deformation areas. The study demonstrates the potential of the combination of SAR data and thermal imagery for effective monitoring of coal fire-induced land subsidence.