

LAND SUBSIDENCE MONITORING USING PS-InSAR TECHNIQUE FOR L-BAND SAR DATA

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ABSTRACT:

Differential SAR-Interferometry (D-InSAR) is one of the potential source to measure land surface motion induced due to underground coal mining. However, this technique has many limitation such as atmospheric in homogeneities, spatial de-correlation, and temporal decorrelation. Persistent Scatterer Interferometry synthetic aperture radar (PS-InSAR) belongs to a family of time series InSAR technique, which utilizes the properties of some of the stable natural and anthropogenic targets which remain coherent over long time period. In this study PS-InSAR technique has been used to monitor land subsidence over selected location of Jharia Coal field which has been correlated with the ground levelling measurement. This time series deformation observed using PS InSAR helped us to understand the nature of the ground surface deformation due to underground mining activity

1. INTRODUCTION

In India, Jharia Coal field covers the area of about 456 sq.km, situated 260 km northwest of Calcutta in the heart of Damodar valley. Jharia has witness intensive effort of exploitation since 1894 till nationalization of coal in 1972 due to unscientific techniques of mining. As a result, land subsidence phenomena has been seen in many places. Different types of subsidence phenomena can take place over the coal mining area:

- 1) Continuous Subsidence-Involves formation of gentle depression over broad area. This type of subsidence is associated with thin, horizontal or lateral dipping ore bodies is overlaid by weak and non-brittle strata, mostly seen in the case of long wall mining.
- 2) Discontinuous Subsidence- It is characterized by large surface displacement over limited surface area. Such as
 - a). Sink hole -This type of subsidence is very abrupt seen mostly in case of Room and Pillar mining,
 - b). Pillar Collapse-Seen in case of abandoned mining.

All the above mentioned subsidence phenomena in coal mining results in to severe damage of buildings, infrastructure, economy loss.

Ground based techniques like GPS and Levelling can measure lands subsidence phenomena up to cm to mm level precision. GPS can give all the three component of land subsidence with highest temporal resolution for a point locations. However, Point wise measurement of GPS reading does not provide required spatial density to identify the occurrence and magnitude of local- small scale land subsidence phenomena (Sharav, 2003). The Ground based conventional techniques are costly, time consuming, requires man power. InSAR has unique advantage as it can measure land subsidence in the absence of man power over large contiguous area with centimetric accuracy.

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However, In most of all interferogram there exist some area which experience decorrelation due to change in scattering properties of surface scatterer with time, change in sensor geometry and due to variation in intervening atmospheric properties.

PS-InSAR is one of the multi time Interferometric technique which addresses both temporal and spatial decorrelation and atmospheric in homogeneities (Hernandez et al., 2014). In the present study PS-InSAR analysis has been performed over ALOS -1 data for Jharia Coal field. A specific focus is set on Jharia area, where subsidence has been identified using PS-InSAR technique for a small test site, for validation levelling and conventional InSAR measurement has been used.

2. RESEARCH AREA AND ACQUIRED DATASET

2.1 Research Area

The research area is situated in Jharia Coal field, Jharkhand, Dhanbad, India. This is the only storehouse of prime coking coal in the country, which has a history of mining since 1894 also population wise it is one of the densely populated coal field in the world.

It is one of the oldest and chief coal field in India. Jharia and it's near around area are considered to have undulating and rolling topography, having slope towards east -south -east. The elevation of this area ranges from 240 m in the west to 140m in the south east (Kumar. et al., 2012). During nationalization period all 398 mines (184 non- coking and 214 coking) were distributed under the management of Bharat Coking Coal Limited (BCL), out of which six mine were authorized under the management of Tata Iron and Steel Company (TISCO) and two under Indian Iron and Steel Company (IISCO)(Singh. et al., 2010). In this area coal mining is the major occupation and it gives employment to 100,000 people which is the 10% of the total population of the area. Out of the total reserves of coal only 25 % of coal have been extracted or consumed by coal fire

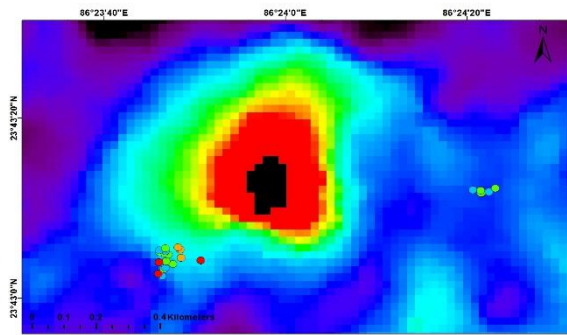


Figure 3. The fringe obtained from D-InSAR overlaid by PS-InSAR result

4.2 PS InSAR integration with D-InSAR Result

Also, we have tried to compare the results of D-InSAR with PS-InSAR result. It has been observed that for the same test site the subsidence rate obtained from D-InSAR processing is coming very close to the PS-InSAR displacement rate. The value obtained for Jamadoba Test site using D-InSAR is coming value of 39.04 cm/yr (R. S. Chatterjee et al., 2015).

5. CONCLUSION

PS-InSAR is an advanced Interferometric tool, which gives surface deformation history, but the only limiting factor is availability of data. This is very good technique to understand and delineate surface deformation dynamics using large data set. It has been seen from this study that ten scenes of ALOS PALSAR also gives good agreement with the ground based and D-InSAR result. Increasing the number of Data pair will give more close and appropriate results for the surface deformation studies.

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6. REFERENCES

- Hernandez, N. D., Madrigal, D., Exposito, J. L., Antonio, X., 2014. Multi-Temporal Analysis of Land Subsidence in Toluca Valley (Mexico) through a combination of Persistent Scatterer Interferometry (PSI) and Historical Piezo metric Data, *Advances in Remote Sensing*, 3, 49-60.
- Kumar, P., Kumar, D., Mandal, V. V., Pandey, P. C., Rani, M., Tomar, Vandana, 2012. Settlement Risk Zone Recognition Using High Resolution Satellite Data in Jharia Coal Field, Dhanbad, India, *Life Science Journal* ; 9(1S), ISSN :1097-8135).

Chatterjee, R. S., Thapa, Shailaja., Singh, K. B., Varunkumar, G., Raju, E.V. R., 2015. Detecting, mapping and monitoring of Land Subsidence in Jharia Coalfield, Jharkhand, India by spaceborne differential interferometric SAR , GPS and precision levelling techniques. *Journal of Earth system science* 124, No 6, pp. 1359-376

Sharav, A., 2003. Differential SAR Interferometry for Crustal Deformation Study, M.Sc., International Institute for Geo-Information and Earth Observation, the Netherlands.

Singh, G., Jain, M.K.,S Paul, B., Gupta, R.D., Raju, E.V.R., 2010. Clusterization of mines for Obtaining Comprehensive Environmental Clearance: A Case Study of BCCL Lease Hold Areas, *Journal of Indian School of Mines, Special Volume* 2010, pp. 13-20.