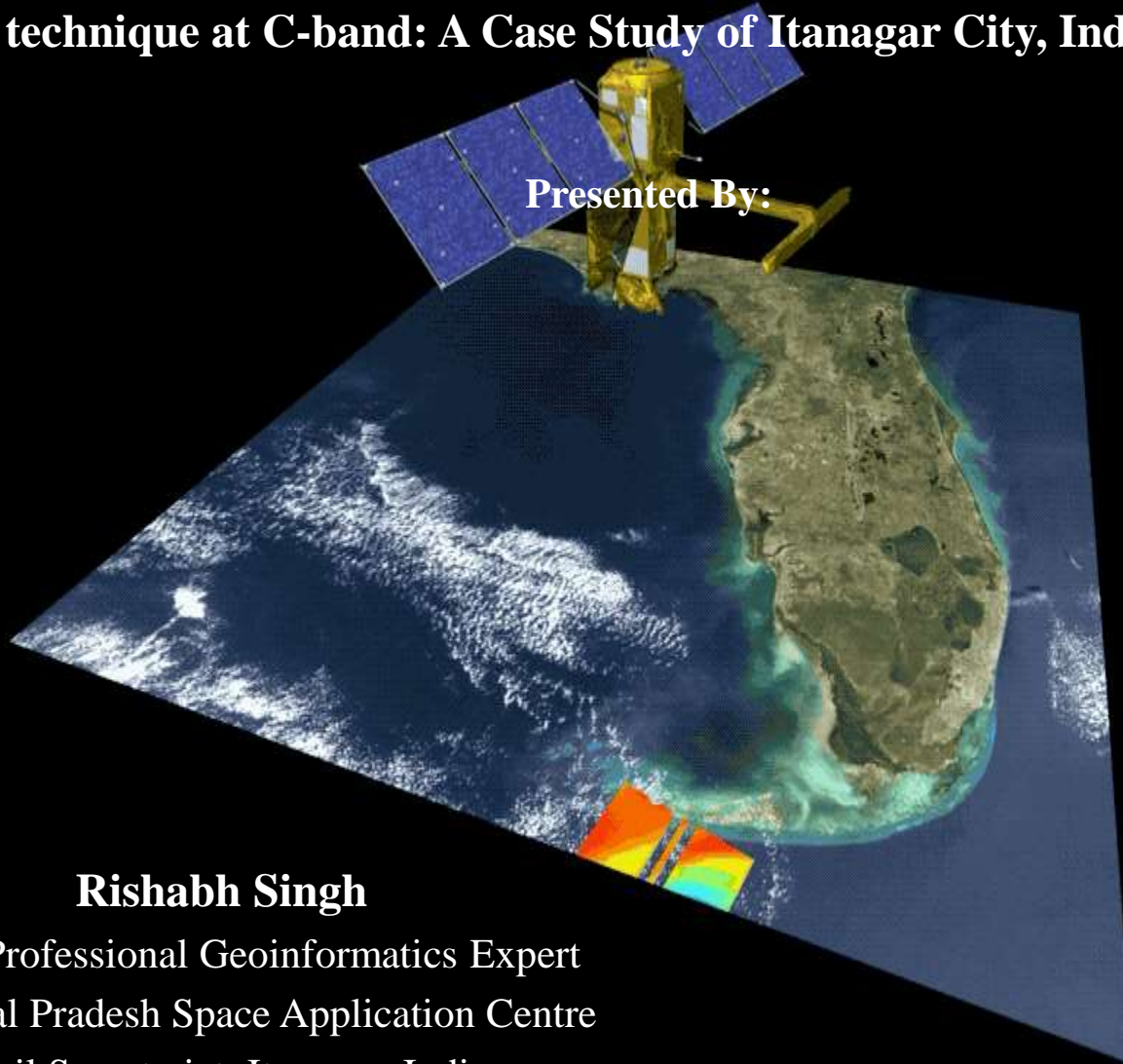




Spatio-Temporal analysis of Land subsidence using Differential InSAR technique at C-band: A Case Study of Itanagar City, India

Presented By:



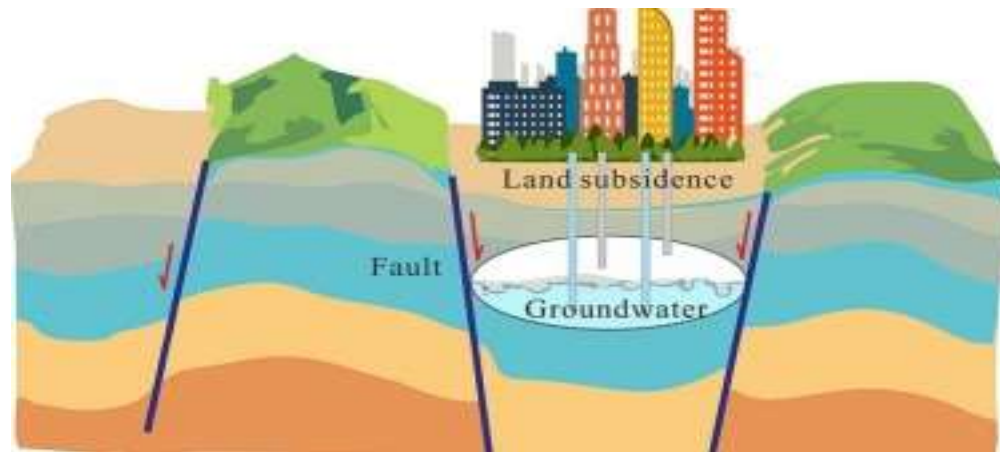
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Introduction

What is Land subsidence?

- **Land subsidence** is the gradual lowering or sinking of the Earth's surface.
- **Causes:** Natural factors and human activities, such as over-extraction of groundwater and oil/gas, mining, and natural sediment compaction from urbanization.
- **Impacts:** Damage to buildings, roads, and infrastructure.



Fig(1)

How to Monitor Subsidence Using SAR Satellites

- Satellite radar monitoring of land subsidence uses a technique called **InSAR**(Interferometric Synthetic Aperture Radar), which compares the phase difference of radar signals from two images taken at different times to detect ground deformation with millimeter to centimeter accuracy.

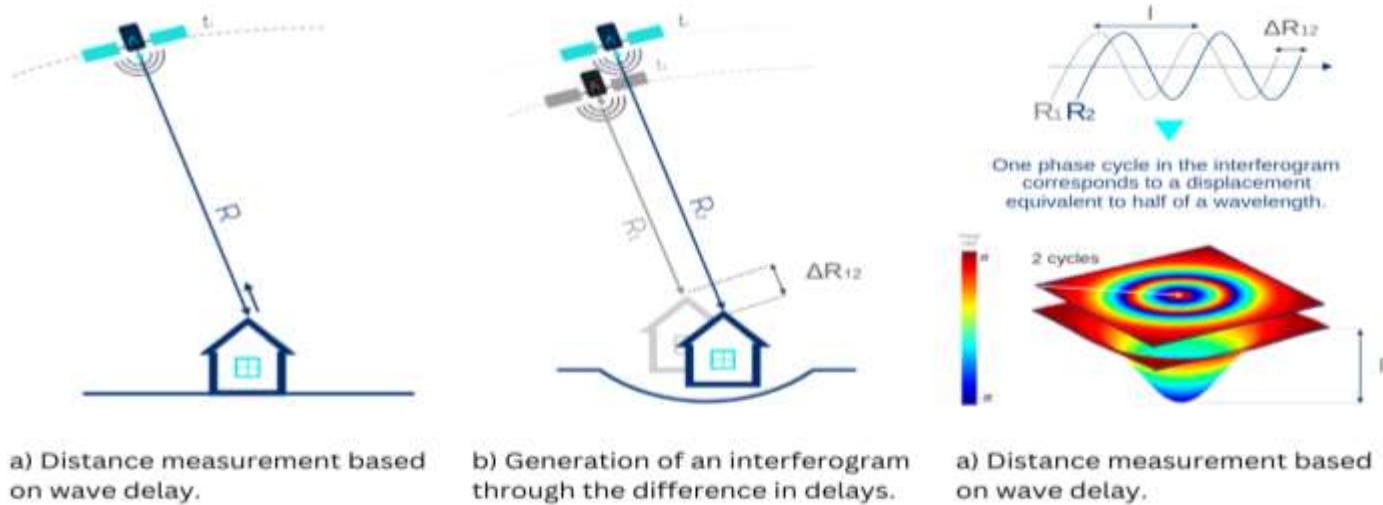


Fig.(2)



Objectives

- To detect, measure, and map ground deformation across Itanagar using multi-temporal DInSAR techniques.
- To determine the rate and extent of subsidence at a city-wide scale.

STUDY AREA

- The study area Itanagar capital region town of Papum Pare District, Arunachal Pradesh, India (Fig.3) is situated in the northeastern region of Arunachal Pradesh, India, with a town center at $27^{\circ}05' 54''$ N and $93^{\circ}37' 19''$ E, Both cities have a humid subtropical climate with abundant natural resources and favorable environmental circumstances.

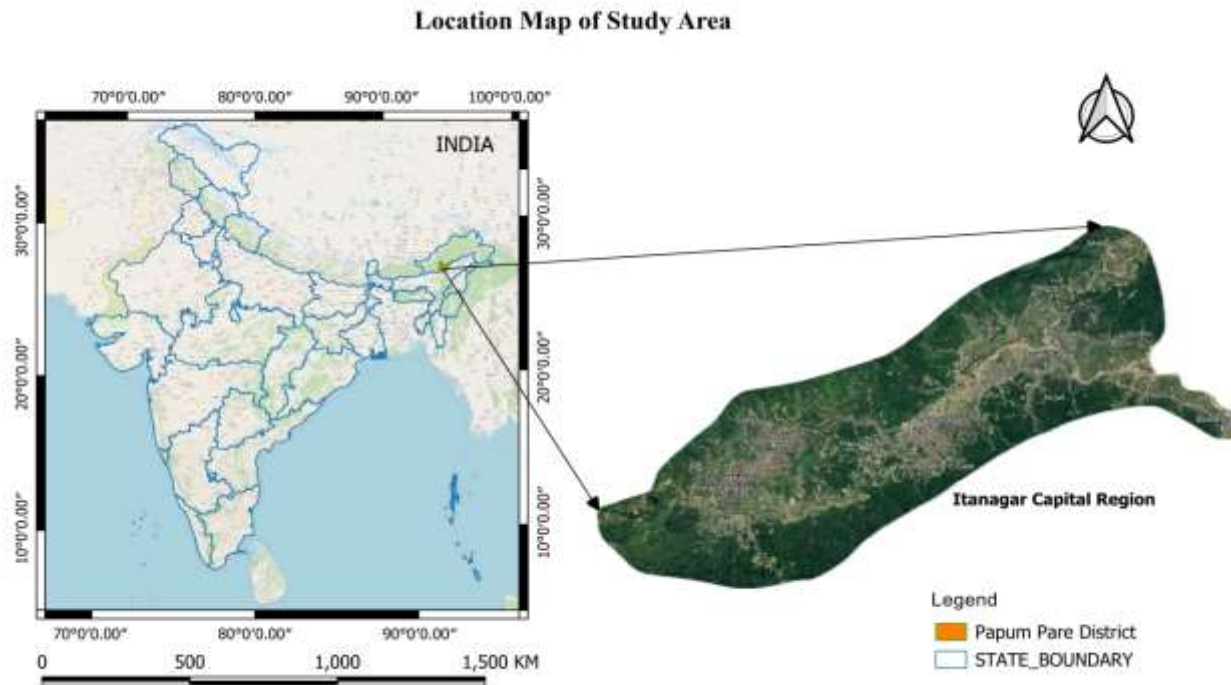


Fig.(3)



Materials and Methods:

Materials Used:

- **Open Source Toolboxes-** ESA SNAP software

Satellite data collection:

- **Satellite-** Sentinel-1A IW (Single Look Complex)SLC.
- **Mode-** Interferometric wide (IW)
- **Swath-** 250 km swath and a 5 m × 20 m resolution
- **Frequency-**5.405GHz at C-band.
- **Revisit time-** 12 days.

Methods:

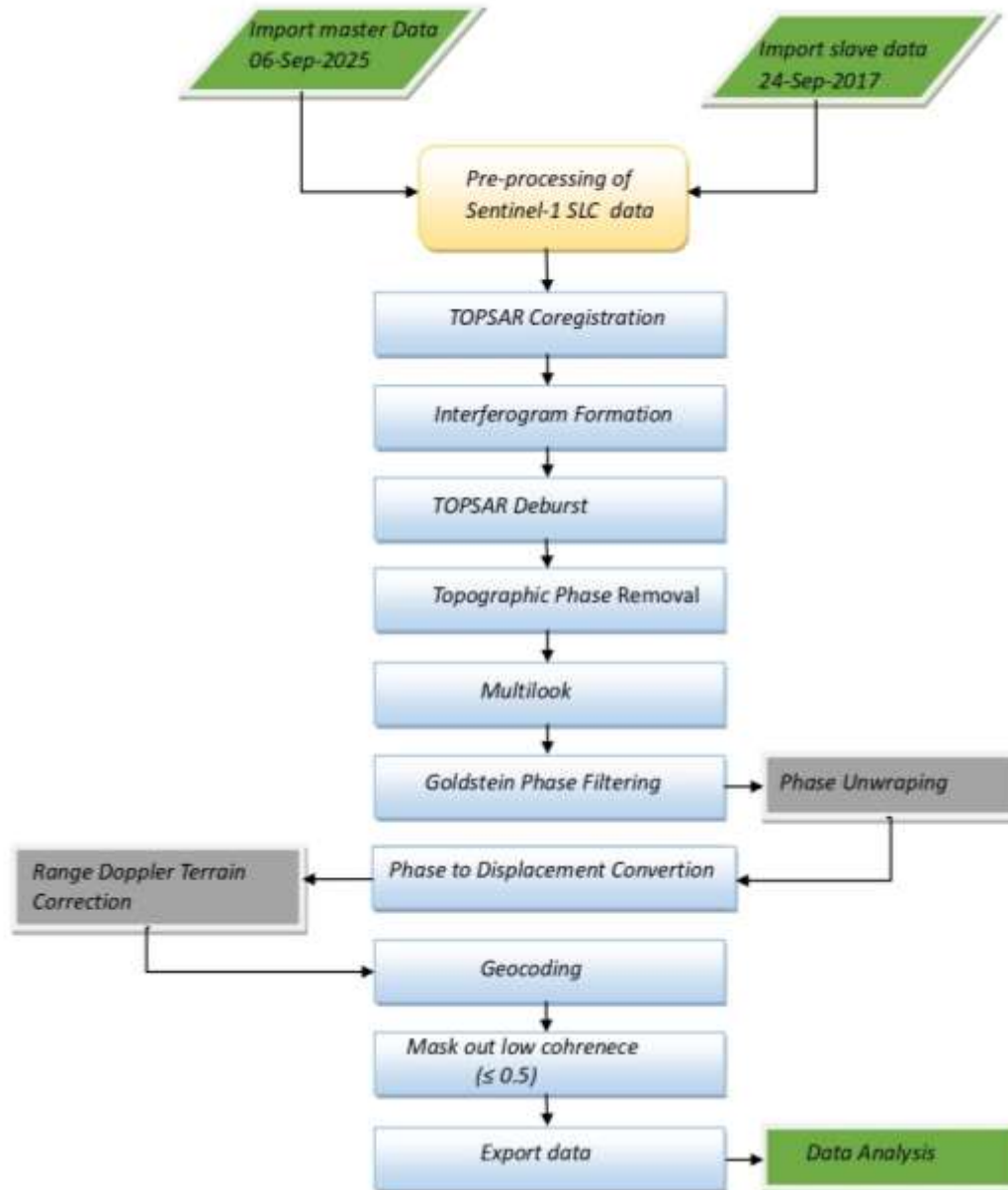


Fig.(4)



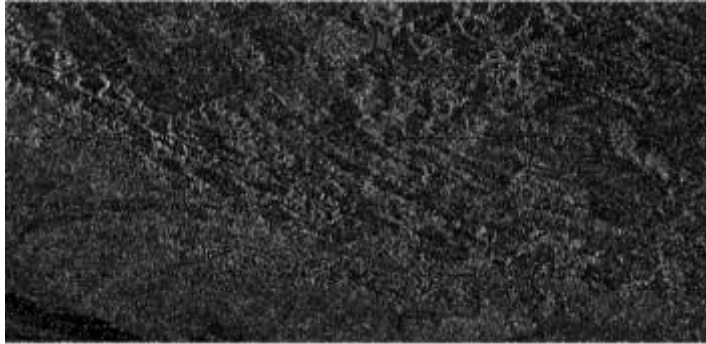
- The methodology of this study focused on creating a DInSAR(Differential Interferometric Synthetic Aperture Radar) in SNAP using the Two Pass Interferometry method based on two radar images.

Images	Role	Perpendicular Baseline(m)
06 sep 2025 24 Sep 2017	Master Slave	-24

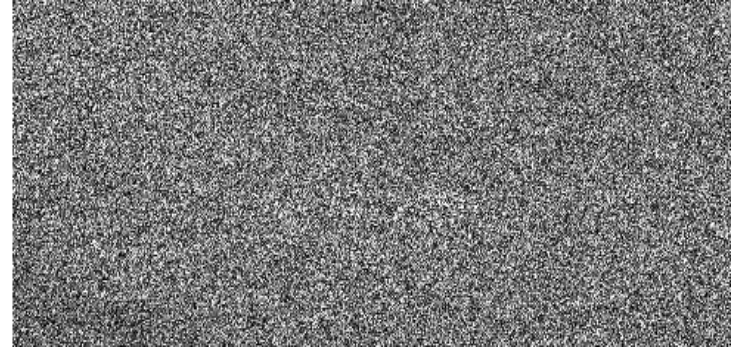
Table.1

- We chose three IW1 bursts to monitor the study area.
- An interferogram was created by pairing both of these images to create a deformation map with uplift or subsidence values.

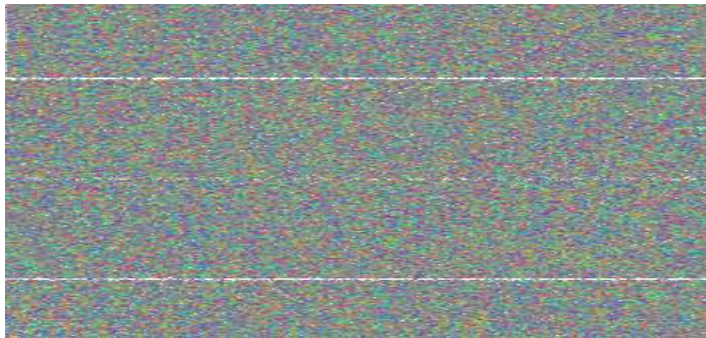
Glimpse of processed SAR data



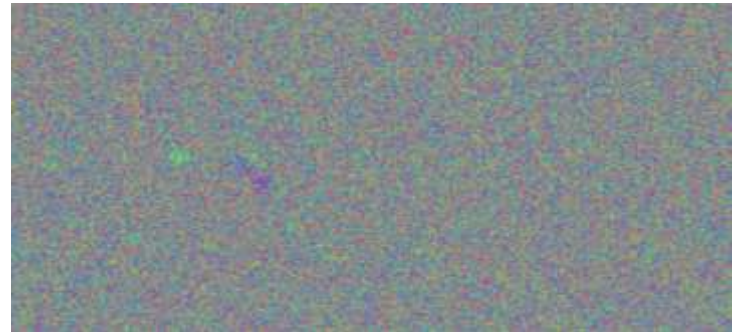
SAR SLC Image



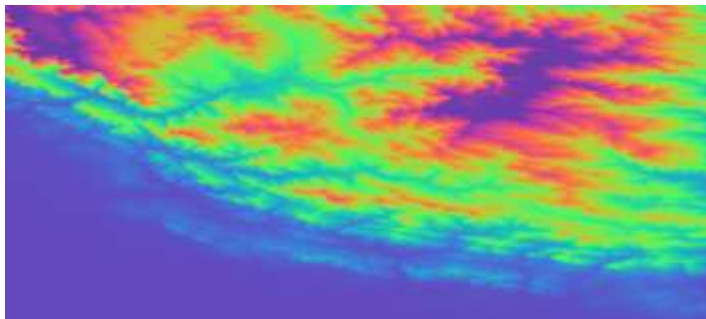
Coherence Image



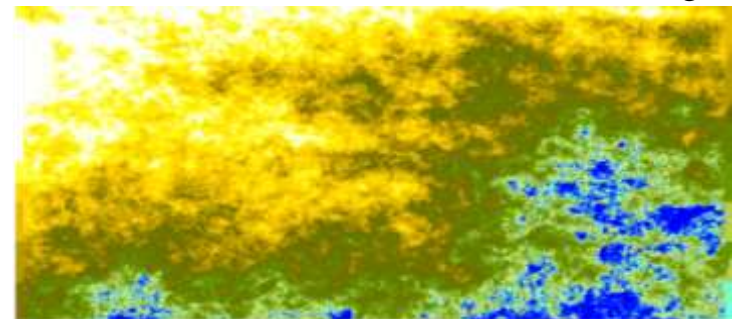
Interferogram Image



Interferogram Image with Debrust, Topographic Phase Removal and Goldstein Phase Filtering



Topo-phase image



Phase to displacement Image



Results and Discussion

- Prominently, Land displacement is categorized as vertical displacement and horizontal displacement.
- Since in this study has taken two datasets over the period of 8 years first image is 06 sep 2025 considered as a master image and second one is 24 Sep 2017 considered as a slave image..
- After processing on SNAP software we have export the data on Google Earth Engine and found the result, we have analyze the result and found only displacement happen in the study area(Fig.5) there is no any upliftment occurred in any areas in Itanagar Capital region.

Displacement Map



Fig.(5)

- The minimum subsidence rate is 3.3cm is marked as a blue box(Fig.6) is located at Doimukh, Nirjuli Village and Tarajuli areas of eastern part of the city.
- The high rate of subsidence is 15.1cm is mark as red box(Fig.7) at specific surrounding part of the the Poma village areas of western part of the city.
- Here we can see and marked as green box(Fig.8) shown the majorly covered area in the overall land displacement area in this study at the average scale of 9.2cm.
- In fig(9), here we can see clearly, marked as a yellow circle the Dikrong River Railway Bridge is severely effected from displacement.
- The high and low rate of subsidence estimated was localized in specific locations including buildings ,road network and Bridges.

Specific Areas of Land subsidence



Fig.(6)

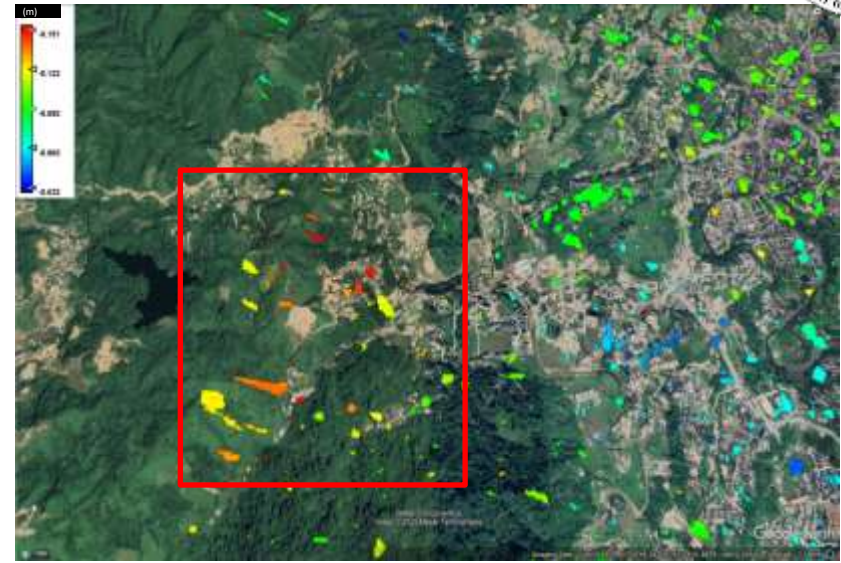


Fig.(7)

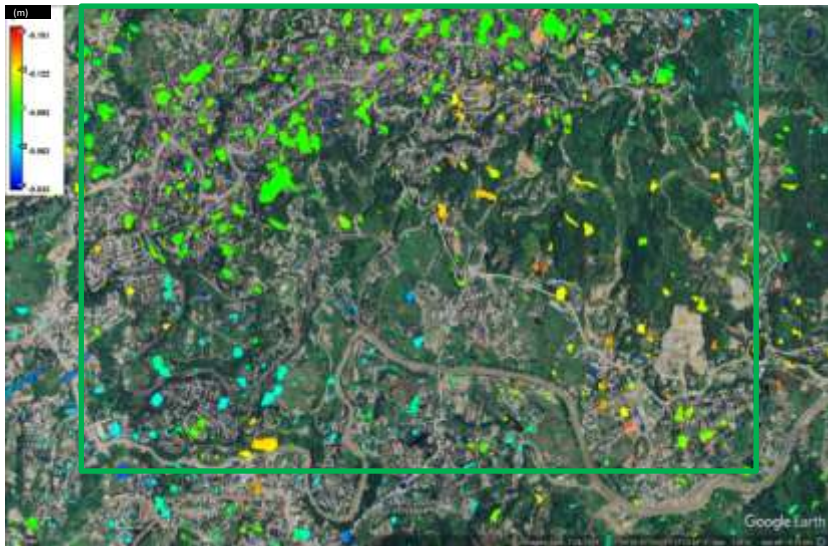


Fig.(8)

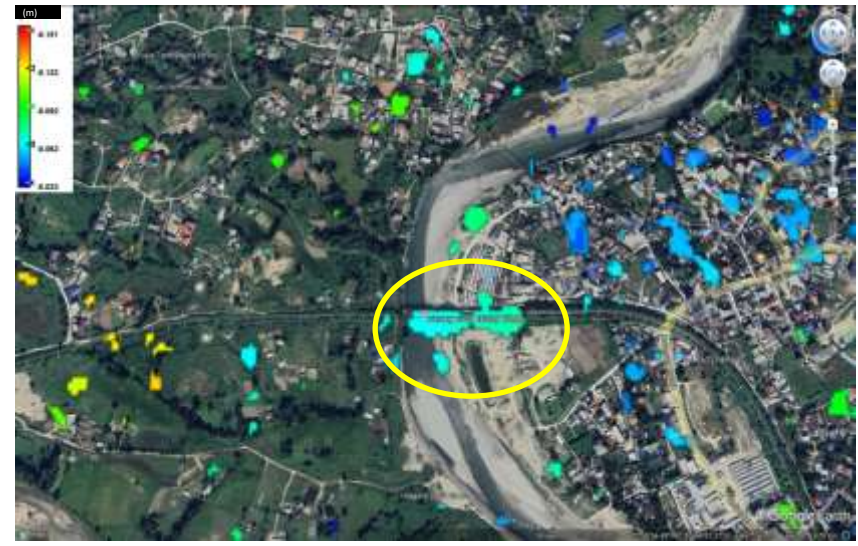


Fig.(9)



Conclusions

- In this study we have utilized the capabilities of the Interferometric Synthetic Aperture Radar (InSAR) technique for the land subsidence observation. We use the Differential Interferometric Synthetic Aperture Radar (DInSAR) method to calculate the deformation of subsiding land using temporal data for urban deformation of Itanagar City and surrounding areas for the first time using Sentinel-1A data with the descending orbits. Finally, a dedicated analysis was performed highlighting the subsidence rate of land displacement along urban infrastructures, including road networks, buildings, and bridges. This study has observed the maximum and minimum subsidence of 15.1 cm and 3.3 cm respectively for a period of 8 years.



Future scope of the study

- We can perform studies which are based on various SAR band (C, L, and P band) will be compared for improving the accuracy of the results.
- A correlation study also can be conduct between subsidence causes factor and GPS point of subside area, which can help to understand the factor which are majorly responsible for subsidence and making plan for prevent any disaster related subsidence.



References:

- Fig(1)Source:<https://www.sciencedirect.com/science/article/abs/pii/S0048969724002687>.
- Fig(2)Source:<https://dares.tech/how-to-read-insar-data-for-monitoring-ground-displacement>
- SNAP Software Download: <https://step.esa.int/main/download/snap-download/>
- Sentinel data download: <https://dataspace.copernicus.eu/data-collections/sentinel-data/sentinel-1>



THANK YOU!