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LAND SUBSIDENCE IN DELHI, INDIA INVESTIGATED USING SENTINEL-1 INSAR MEASUREMENTS

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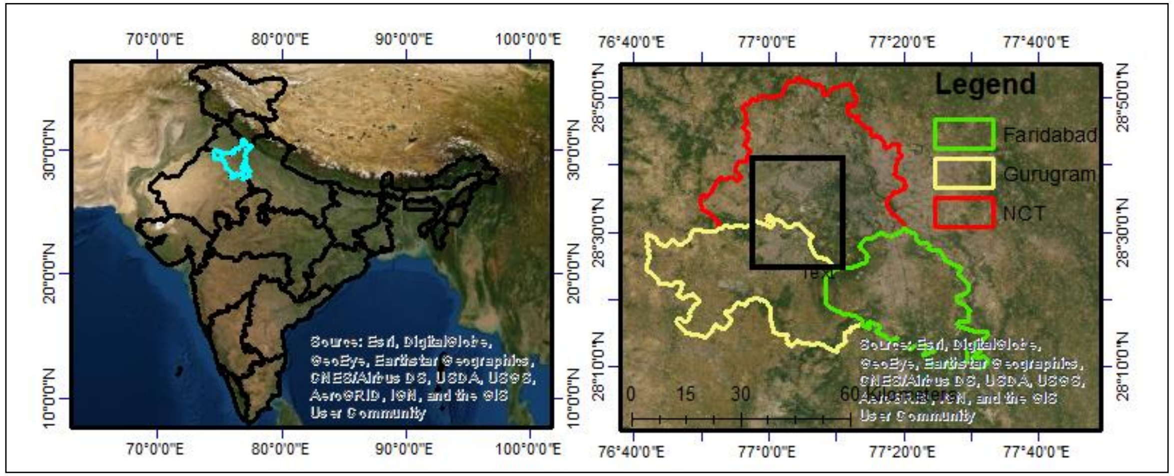
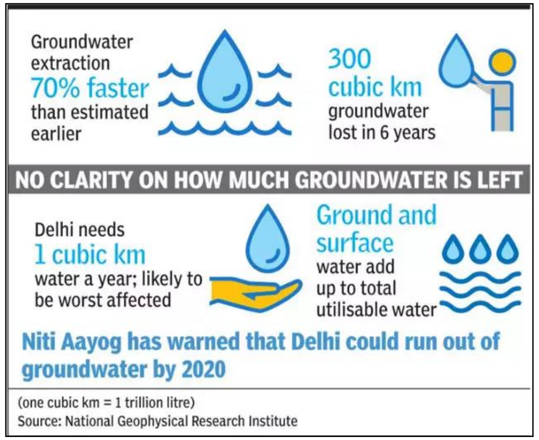
GFZ Helmholtz-Zentrum Potsdam

Study Area : National Capital Region(NCR) Delhi



Significance : Groundwater Depletion


Groundwater extraction 70% faster than estimated earlier

300 cubic km groundwater lost in 6 years

NO CLARITY ON HOW MUCH GROUNDWATER IS LEFT

Delhi needs 1 cubic km water a year; likely to be worst affected

Ground and surface water add up to total utilisable water

Niti Aayog has warned that Delhi could run out of groundwater by 2020

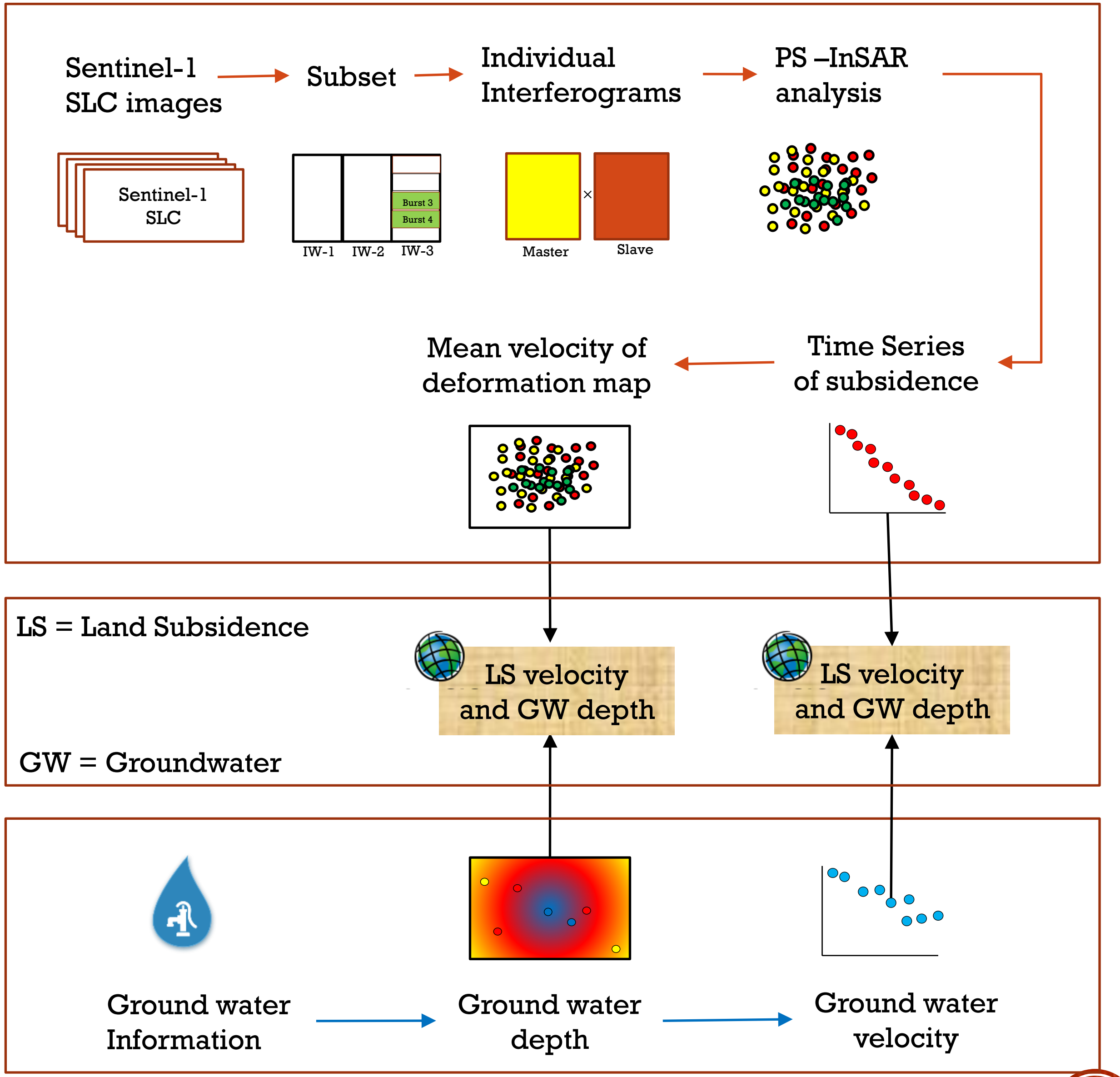
(one cubic km = 1 trillion litre)

Source: National Geophysical Research Institute

Objectives:

(1) Use InSAR to monitor subsidence
(2) Which regions are subsiding and at what rate?
(3) Relation between Groundwater depletion and Land Subsidence.

Dataset Used & Methodology



Google Earth Image of the study area | **Vertical subsidence velocity for the study area covering NCR Delhi** | **Subsidence Velocity plots of the three regions.: close up view**

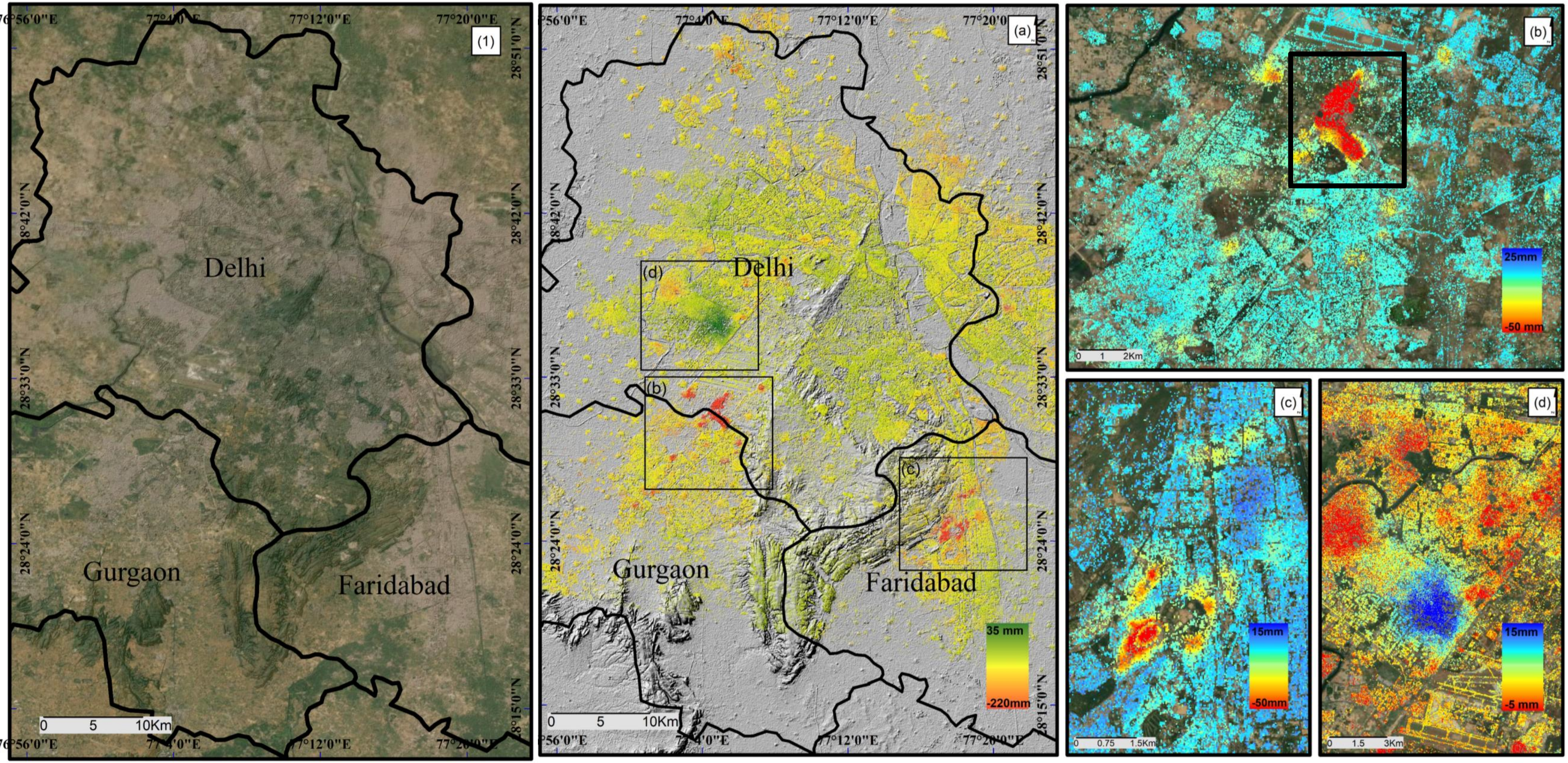


Fig.1. (1) represents the google earth image of the study area . (a) represents vertical subsidence velocity for the Delhi- NCR region. The three areas in (a) are then shown separately in (b),(c),(d) respectively. The wrapped Interferogram of the selected region is shown in Fig.2.

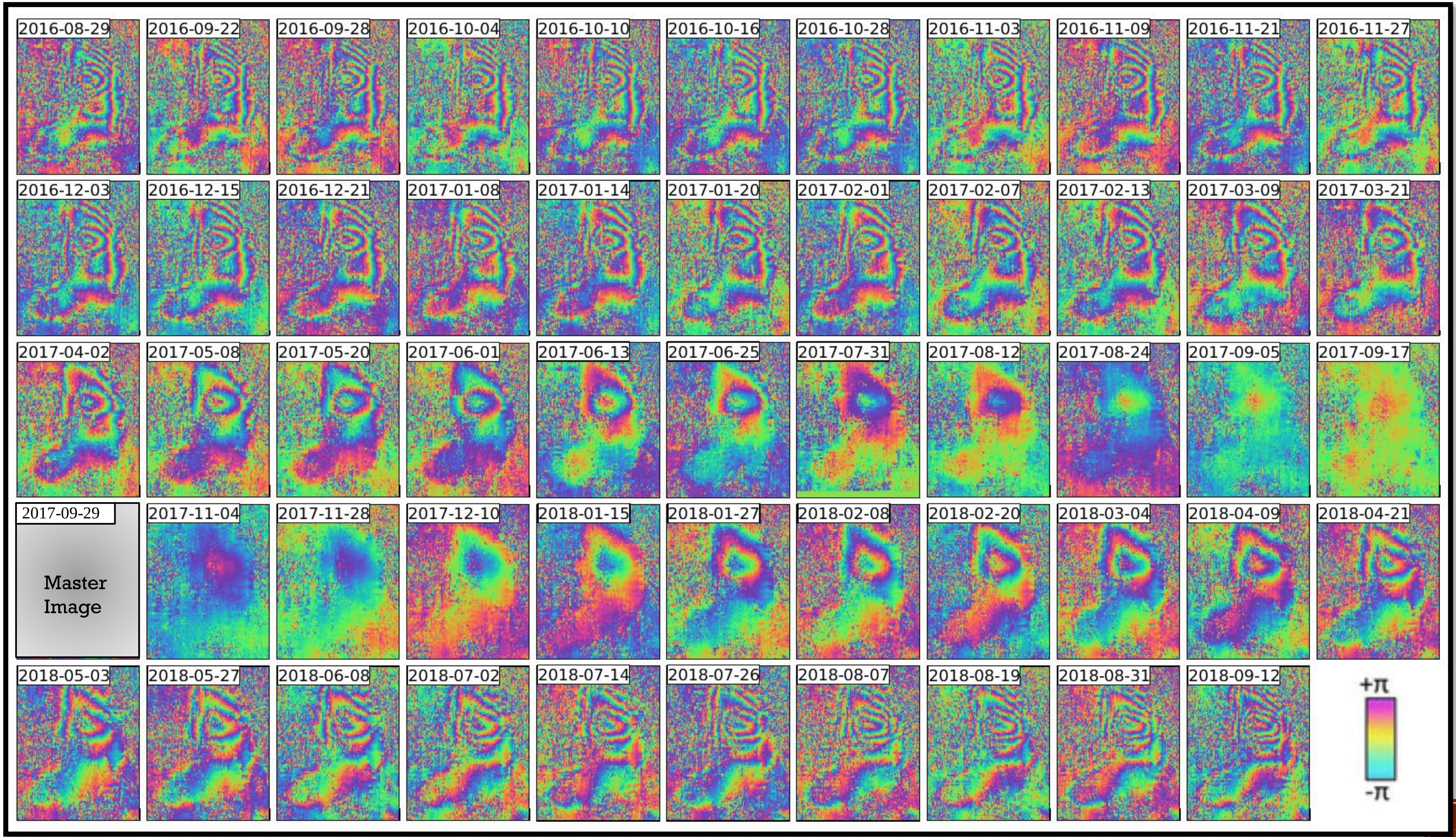


Fig.2. Wrapped Interferogram of the area highlighted in Fig.1b. The Fringes are obtained using Sentinel-1 SLC images acquired in descending direction. SRTM DEM 90m was used to remove the Topography.

Relation between Land subsidence and Groundwater

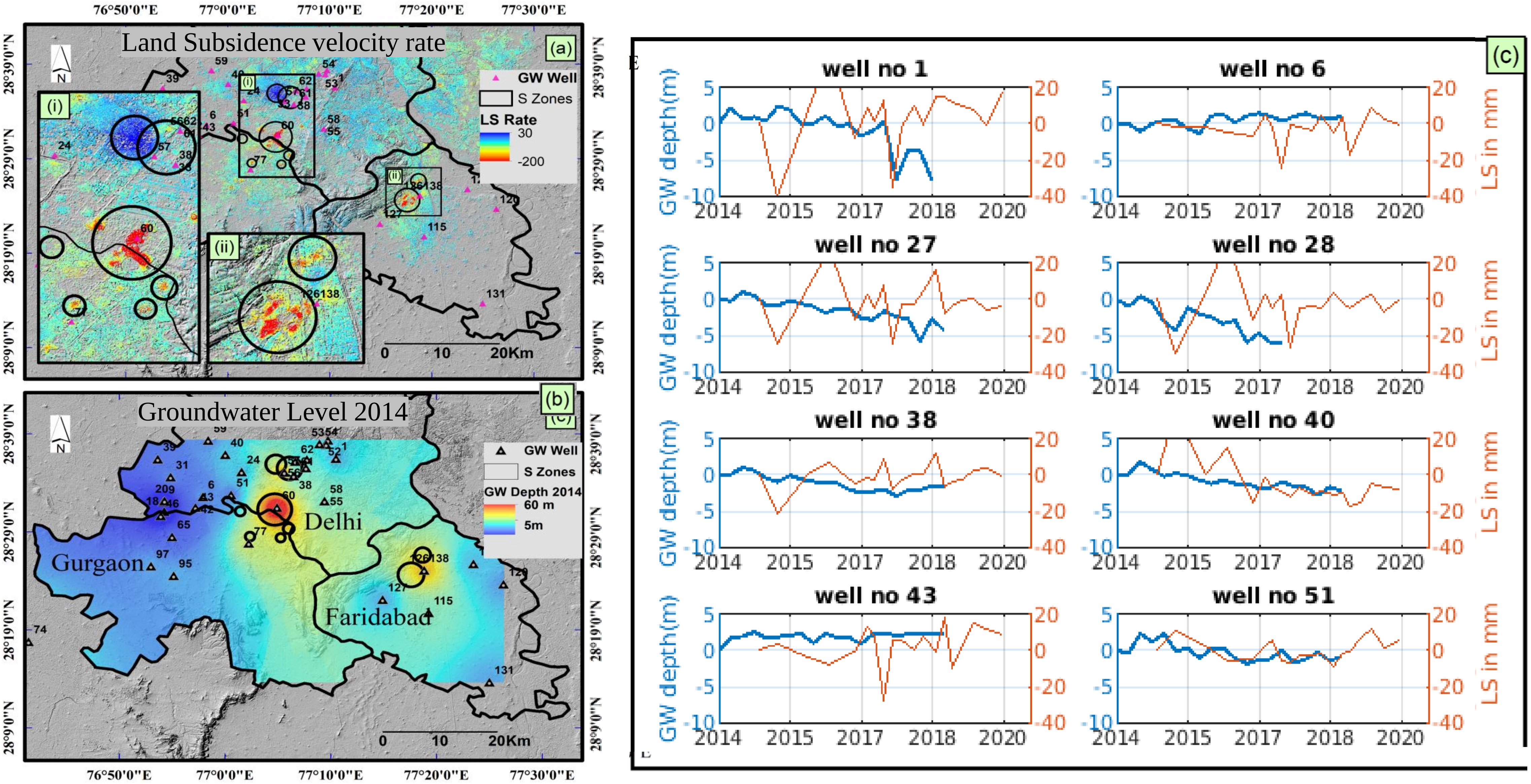
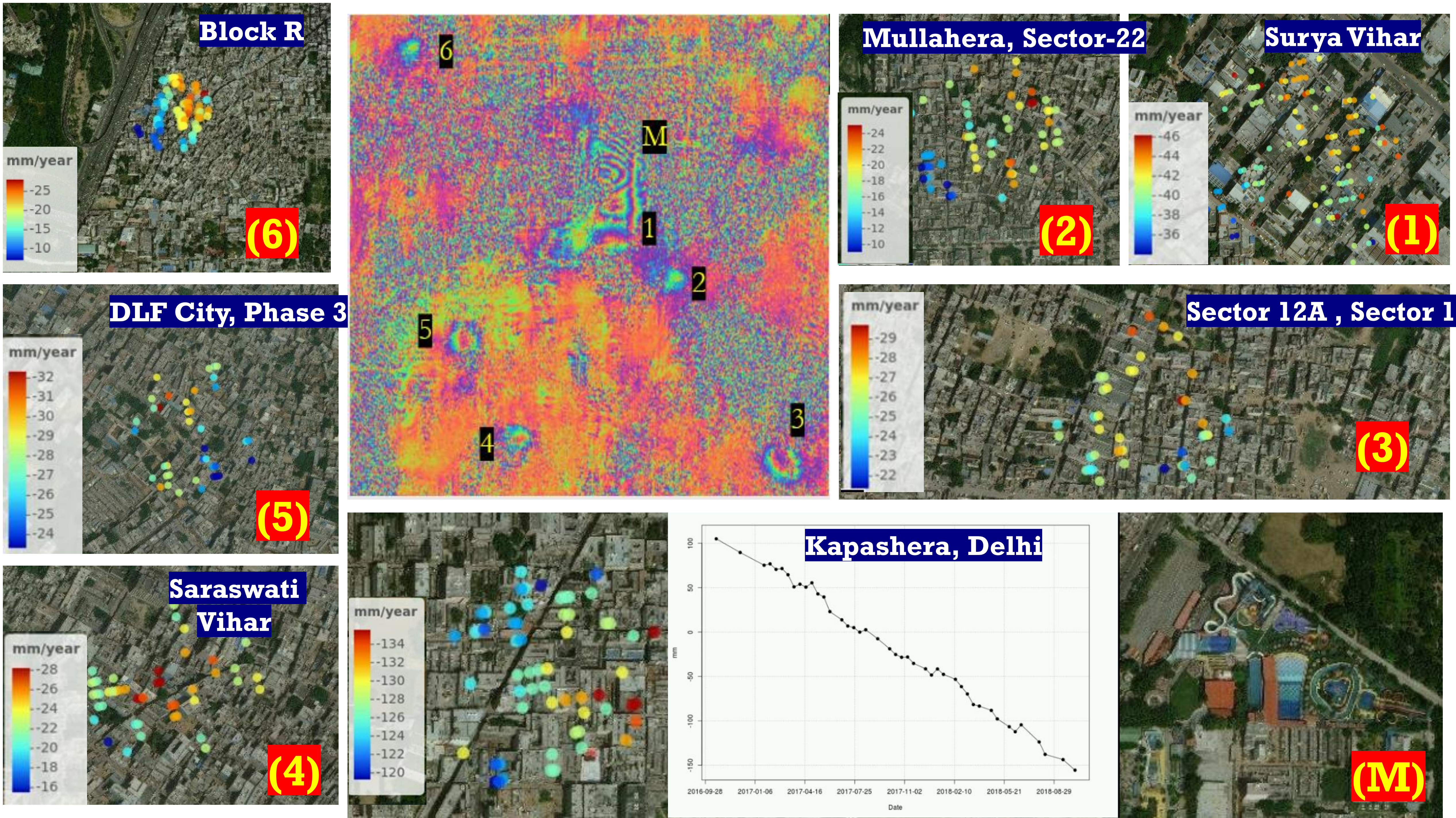


Fig. 4. Land Subsidence velocity calculated using PS-InSAR technique is shown in Fig(a). The regions of high deformation/uplift are demarcated using black circles and are named as **S-Zones** (Shagun's research Zone ☺.Fig (a)- (i, ii) represents zoomed view of many such S-Zones. These S-Zones are then overlaid on groundwater depth of 2014 Fig(c) .Interestingly the S-zones exactly overlaps the region of high depth to groundwater levels. Fig.(c) compares the time series of groundwater with land subsidence and shows similar trend.



Block R
mm/year
-25
-20
-15
-10
(6)
6
M
1
2
5
4
3
Mullahera, Sector-22
mm/year
-24
-22
-20
-18
-16
-14
-12
-10
(2)
Surya Vihar
mm/year
-46
-44
-42
-40
-38
-36
(1)
DLF City, Phase 3
mm/year
-32
-31
-30
-29
-28
-27
-26
-25
-24
(5)
Sector 12A , Sector 1
mm/year
-29
-28
-27
-26
-25
-24
-23
-22
(3)
Saraswati Vihar
mm/year
-28
-26
-24
-22
-20
-18
-16
(4)
mm/year
-134
-132
-130
-128
-126
-124
-122
-120
Kapashera, Delhi
100
50
0
-50
-100
-150
mm
2016-09-28
2017-01-06
2017-04-16
2017-07-25
2017-11-02
2018-02-10
2018-05-21
2018-08-29
Date
(M)

RESULTS

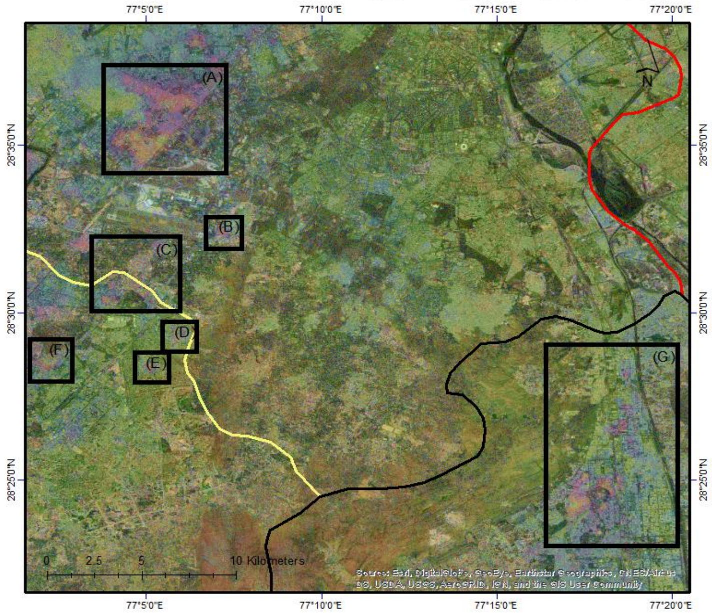


Table.1. Rate of subsidence in the regions highlighted above . (+ shows uplift)

Region	Region Name	Subsidence Investigated in LOS (cm/year)
(A)	Dwarka	+3.1
(B)	Mahipalpur Village	- 5
(C)	Kapashera	-15
(D)	Sector 24, Gurugram	-5
(E)	Saraswati Vihar	-4.8
(F)	Sector 13, Gurugram	-4.5
(G)	Sector 48, Faridabad	-6

CONCLUSION

1. Using PS-InSAR technique, we investigated maximum vertical deformation of **20 cm/year** in parts of Delhi –NCR.
2. The region showing maximum deformation is a slum area having population more than 1,00,000. Urgent action needs to be taken to monitor the infrastructure and to prevent any disaster.
3. Land Subsidence rate is high in places of high depth to groundwater.
4. Delhi –NCR is one of the most over exploited states in India and declared as a groundwater critical zone by government of India. The supporting hydrogeology makes it even more prone to subsidence

FUTURE WORK

1. . A long time series InSAR approach can be used to see the behavior of subsidence over time.
2. Ground field measurements such as GPS, levelling and extensometers can be taken to verify the results obtained using InSAR.
3. Health of roads and Highways can be monitored using the PS points derived from InSAR
4. By incorporating geology and geomorphology along with groundwater depletion and land subsidence, a hazard map showing regions more prone to subsidence can be identified.