Monitoring of Ground Subsidence and Coastal Geomorphology in Special Reference to ERS SAR and Envisat Data of Kolkata City and Part of Coastal Region of West Bengal

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ABSTRACT

In this work, attempts have been made to study subtle ground subsidence in Kolkata city primarily due to over-extraction of ground water, mapping and monitoring of coastline and coastal geomorphology in a part of coastal region to the south of Kolkata city.

Attempts have been made to assess potential ground subsidence from the evolution of piezometric surface in Kolkata city during last few decades and to measure actual ground subsidence from ERS Synthetic Aperture Radar (SAR) data by differential SAR interferometric technique.

In the coastal test site, attempts have been made to study the potential of ERS SAR and ENVISAT ASAR amplitude and interferometric coherence information of ERS SAR tandem pair for mapping coastline and coastal geomorphology. Multipolarization ENVISAT ASAR data (HH, HV and VV) in IS2 beam mode have also been evaluated for mapping the elements of coastal geomorphology. Finally, based on multi temporal optical and microwave SAR data, the changes in coastline in terms coastal erosion and accretion, and patio-temporal changes of coastal geomorphological elements have been studied.

Potential ground subsidence of Kolkata city, due to inelastic compression of impervious combining layers of the productive aquifers, has been found to vary spatially from 0.397 mm/year to as high as 20.13mm/year. Regionally maximum potential subsidence has been found to occur in central and north-eastern regions.

Due to the lack of adequate coherence in many of the interferometric SAR data pairs, and presence of heterogeneous atmospheric artifacts, actual ground subsidence of Kolkata city, as estimated from interferometric SAR data, can not definitively state the subsidence areas. In five out of 24 interferograms, some fringes are observed. Further post processing of the interferograms may be helpful to identify the ground subsidence fringes.

In coastline mapping, interferometric coherence information of ERS SAR data has been found to be better suited then other microwave SAR and optical remote sensing data used in this work. Among multipolarization ENVISAT ASAR data, HH- polarization followed by HV and VV polarizations are appropriate in order of decreasing significance for coastline mapping.

The characterization of geomorphological elements in relation to amplitude information of ERS SAR and ENVIAST ASAR data and interferometric coherence information of ERS SAR tandem data pair shows that in totality out of the ten geomorphologic classes, five are well separable and two are fairly separable. River channel, creeks, and estuary are similar in nature in respect to amplitude information of ERS and ENVISAT VV polarization IS2 beam data and coherence

information of ERS SAR tandem pair. In multipolarization ENVISAT ASAR data (HH, HV and VV in IS2 beam), on the other hand, creeks and estuary units are separable.

All the geomorphologic units are therefore statistically separable in relation to ERS SAR amplitude, multi-polarization ENVISAT ASAR amplitude (HH, HV, and VV) in IS2 beam and coherence information of ERS SAR tandem pair taken together.

From multidate coastline maps, prepared from optical and microwave SAR data,it is observed that during 1987-1996, 980 km^2 area has been eroded, whereas 447 km^2area has been added or accreted, during 1886-1898, 114 km^2 area has been eroded and 220 km^2 area has been added or accreted, during, 1998 to 2004, 211.5 km^2 area has been eroded and 717 km^2 area has been added or accreted with the existing coastal area.

It is observed that during 1987-1996, the geomorphologic units viz; mud flat, sand flat, dune field, and coastal alluvial plain have been reduced appreciably whereas beach, estuary, alluvial plain, mangrove swamps and river channel units have been increased appreciably in their spatial coverage. On the other hand, during 1998-2004, river channel, beach and mangrove swamp units have been reduced appreciably where as dune field, sand flat, mud flat, alluvial plain, creeks and coastal alluvial plain units have been increased significantly in their spatial coverages. During the total period of study (1987-2004), however, dune field, estuary, alluvial plain and creeks show an overall increase whereas, rest of the units show overall decrease in there spatial coverages.