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APPLICATION OF REMOTE SENSING IN LAND USE AND LAND COVER MONITORING

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Argha Ghosh[1]* and Manoj Kumar Nanda[1]

[1]Department of Agricultural Meteorology and Physics, Bidhan Chandra KrishiViswavidyalaya, Mohanpur, Nadia-741252, West Bengal

Email: ghoshargha4@gmail.com

Remote sensing is the art and science of observing and obtaining information on an object using sensors without being in physical contact with the object (Satyawan *et al*., 2014). This technique is widely used to monitor natural resources like land, water, vegetation etc. in a very cost and time-effective manner. Satellite-based remote sensing can effectively be used for continuous monitoring land use types over a large area because satellite provides precise information with a wide field of view at a regular frequent interval (Panigrahy *et al*., 2005). Land use and land cover classification and land use mapping is the most popular utilization of high-resolution satellite imageries. Land use and land cover maps are used for resource planning and decision making purposes. Satellite sensors are to be equipped with appropriate spatial, temporal and spectral resolutions to delineate and monitor different environmental features like cropland, water bodies, natural vegetation, settlement areas etc. which exhibit significant ecological importance and to study the relationship among those ecological features (Radoux *et al*., 2016).

Satellite-based remote sensing has entered a new era with the launch of high-resolution optical satellites like Landsat-8 and sentinel-2. Landsat-8 is an American Earth observation satellite launched by NASA on 11-February, 2013 as Landsat Data Continuity Mission (LSDM). The two main sensors of Landsat-8 are Operational Land Imager (OLI) and Thermal Infrared Sensor (TRIS). OLI generates visible, near-infrared, short wave infrared, coastal and cirrus wave bands having 30 m spatial resolution and panchromatic bands having a spatial resolution of 15 m. TRIS produces two thermal bands with 100 m spatial resolution. Landsat-8 provides open-source data through USGS (United States Geological Survey) at an interval of 16 days. Landsat data is successfully used in agriculture, geology, vegetation monitoring, forestry, land use mapping, moisture estimation, hydrology, bathymetric and aerosol studies etc. (Ridwan *et al*., 2018). Sentinel-2, developed by European Space Agency

(ESA) as a part of Copernicus programme, previously known as the Global Monitoring for Environment and Security, is a constellation of two satellites, Sentinel-2A (launched on June 23rd, 2015) with a revisiting interval of 10 days and Sentinel-2B (launched on March 7th, 2017) with a revisiting interval of 5 days (Main-Knorn *et al*., 2017). Sentinel-2 is a sun-synchronous satellite equipped with an optical imaging sensor MSI (Multi-Spectral Instrument) which measures reflectance in 13 spectral bands ranging from Visible and Near Infrared (VNIR) to the Short Wave Infra-Red (SWIR) spectral range. This mission offers an unprecedented combination of systematic global monitoring of coastal land areas from 56 ° to 84 ° latitude with 290km of swath coverage. The sensors measure reflectance at 10m resolution in visible and near-infrared wavebands which are mainly used for land classification. Six spectral bands (vegetation red-edge, narrow NIR and SWIR) at 20m resolution are useful for vegetation detecting. The rest three bands at 60m resolution help to study cloud cover, atmospheric aerosols and water vapour condition (Ramoelo *et al*., 2015). Purpose of the Sentinel-2 mission is to identify crop type and tree species and to monitor forests, land-use changes, coastal and inland waters, risk mapping in the context of disaster management and mapping of built-up areas as well as different biophysical factors such as fraction vegetation cover, leaf area index, leaf water and chlorophyll content etc. (Immitzer *et al*., 2016; Drusch *et al*.,2016).

Research conducted to monitor seasonal change in land use and land cover in Gosaba Island on Indian Sundarban:

Indian Sundarban is one of the most ecologically vulnerable regions in the world. Gosaba Island (Figure 1) is the last inhabited island of Indian Sundarban before the dense mangrove forest starts.The study area extends from 22°12’ N in the North to 22°6’ N in the South and from 88°46’ E in the West to 88°52’ E in the East. The entire island constitutes around 3500 ha of the geographical area including eight numbers of villages namely Uttardanga, Bagbagan, Rangabelia, Arampur, Gosaba, Pakhirala, Dulki and Sonagaon. The study area belongs to the coastal saline zone of West Bengal. The climate of the coastal belt is normally hot humid except for a short, mild winter in the months of December and January. This area receives rainfall mostly during June to September due to South West Monsoon. People mostly rely on agriculture to sustain their livelihood. Rice (*kharif*) based mono-cropping is the normal practice in this area as the post-monsoon period is encountered with moisture stress and soil salinity build-up. Proper land use and land cover monitoring of these areas can be helpful in successful planning and utilization of natural resource management which is essential for sustainable improvement of the livelihood of the inhabitants as well as for saving the natural biodiversity.

Sentinel-2 imageries acquired on 26-December, 2017 and 14-February, 2018 was downloaded from the data archive of ESA and supervised classification was employed using SAGA (6.4.0) software after atmospheric and radiometric correction of the imageries in QGIS (2.18.12) software. This period was chosen due to very little cloud cover so that there was more possibility to get good quality satellite imageries. Moreover, the ecological features of that region could be detected accurately due to less water logging during this dry period. The ground truth survey was done through transact walk across the island to identify different ecological features.

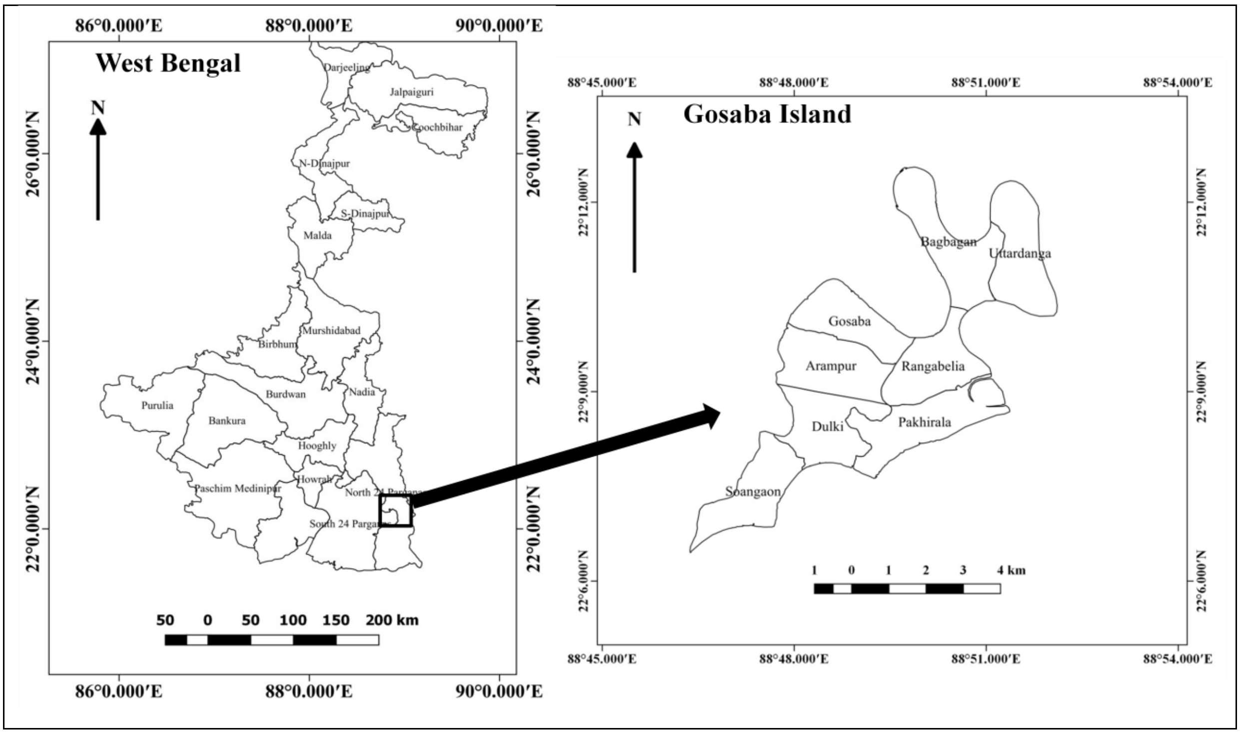

Fig 1: Study area

Major findings

The area under water bodies over the study period did not changes to a considerable extent. The area under the perennial trees (including settlements) was observed to be slightly higher in December which may be attributed to the regrowth from the paddy stubbles left over the field after harvesting of rice. During the month of December, residual moisture content in the field was much higher than during February, and this might lead to stubble regrowth in December. The cropped area was much higher in February. In December grass pea growth was not so prominent that it could be detected in a satellite image. On the other

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hand, in the month of February, a number of post-monsoon crops were at their peak growing stages which reflected in the increased cropped area during that time. Besides some class mixing was observed in between wet fallow land and initial grass pea growth in the December image. With the advancement of the post-monsoon period, moisture availability in the field decreased, which is represented by more dry fallow land and less wet fallow land in February and vice-versa in December. In the month of December, a considerable proportion of land was waterlogged or substantially wet, which became dry gradually with the progress of the dry period. In February, very less area was waterlogged, but in some portion of the island, the field was puddled for *boro* rice cultivation.

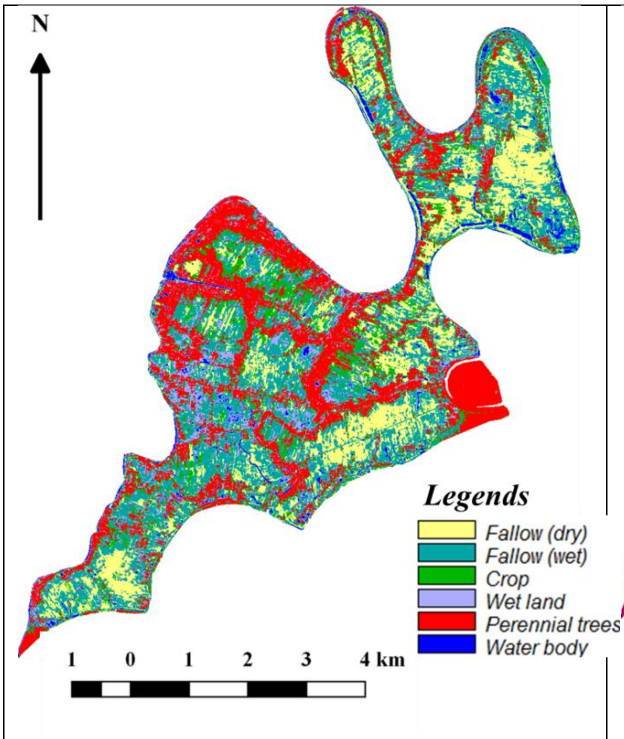

Figure 2a: Land use and land cover map of 26-December, 2017

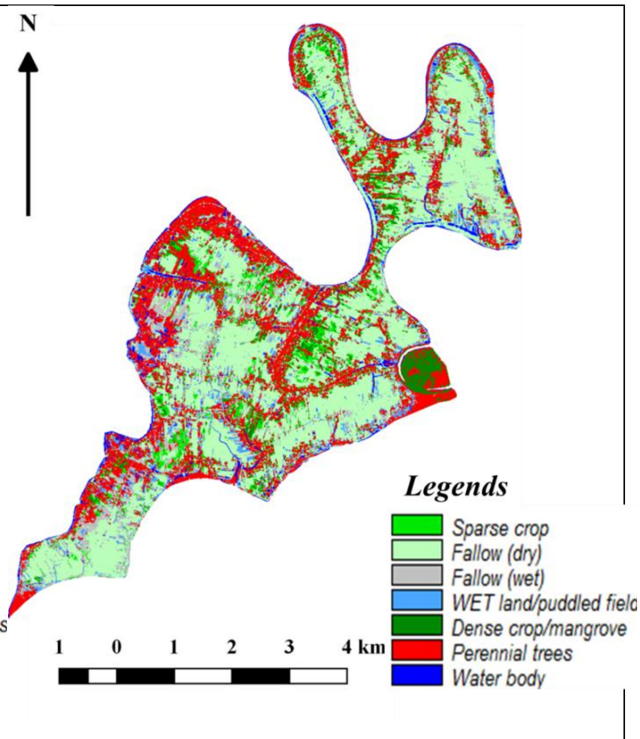

Figure 2b: Land use and land cover map of 14-February, 2018

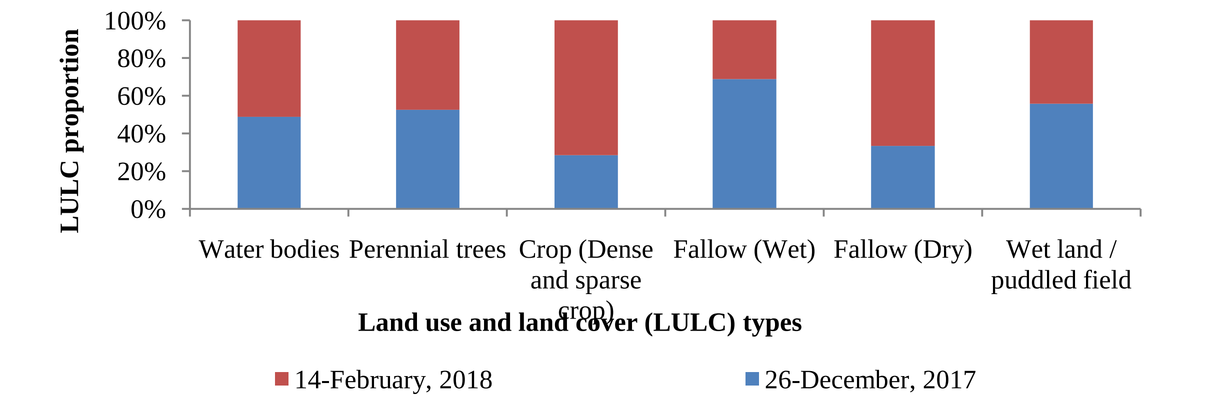

Fig 3: Changes under different land sue and land cover from 26-December, 2017 to 14-February, 2018

Conclusions

Satellite-based remote sensing has great potential to be effectively used in land use and land cover monitoring in any area. Sentinel-2 data with its fine spatial resolution and high temporal frequency can be applied successfully to assess the seasonal variability in land use pattern. Seasonal dynamics of fallow and cropland can be accurately determined by using sentinel-2 data. Cropping system analysis and cropping intensity mapping can also be done. There is a great future scope of Sentinel-2 data for use in crop monitoring, field moisture estimation and identification of the suitable areas for sustainable intensification.

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