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Assessment of flood impact on mango orchards of Naugachhiya subdivision of Bhagalpur District, Bihar

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Abstract
Remote Sensing and GIS (Geographic Information System) have been used as emerging tools for monitoring and management of water logging and health of crops. Hence, MODIS V6 and SRTM (Shuttle Radar Topography Mission) data were used for visual interpretation, digital image processing, and mapping of the flood affected mango orchards. Results revealed that low land ecology having 10-20 m elevation and < 1% of slope gradient was severely affected due to flood. Maximum inpact of the flood on mango orchards was observed in Naugachhiya (42.50%) followed by Kharik (26.61%), Gopalpur (12.13%), Bihpur (9.08%), Narayanpur (8.15%), Imailpur (0.92%) and Rangra Chowk (0.61%) blocks of Naugachhiya subdivision. However, water logging in mango orchards in Narayanpur (31.47 km^2) and Bihpur blocks (28.13 km2) was limited due to moderately high elevation (35m). These findings may be helpful to trace out the water logged mango orchards in lower Gangetic plain of Bihar.

Keywords: Geospatial approach, horticulture, IRS AWiFS, SRTM, NDVI, GPS, GIS

Introduction
Horticulture sector played an important role to produce the agricultural outputs in developed and developing countries, and provided an opportunity to nutrient boost up in human body through healthy diet. In this context, a systematic management of horticultural crops is required in more area of the country to increase of overall production.
In India, scattered and small field sizes, comparatively short duration vegetable crops and mixed cropping sequences have great concern, and to mitigate these problems, remote sensing and GIS techniques provided an opportunity towards adaptation of managerial practices. These techniques proved their important roles with their effectiveness in advance surveying and mapping of the horticulture crops, and have been widely used for the mapping of plantation, acreage and yield of fruits of the concern area. (Panda *et al*., 2009) [7] used geospatial technology to delineate the orchards and reported that RS-GIS can provide additional information for the management practices, and decision making, in terms of the determination of fruit yield, the quantification and scheduling of precise and proper use of fertilizer, irrigation needs, and the application of pesticides for pest and disease management.
Satellite remote sensing not only provides the synoptic view of the plants but also helps to measure the spectral reflectance of the particular plants to indicate an indication of the stress condition of the plants as well as their health using Indian Remote Sensing (IRS) data (Panigrahy *et al*, 2008) [8]. The Vegetation Index such as the NDVI (Normalized Difference Vegetation Index) and SAVI (Soil Adjusted Vegetation Index) used by multispectral satellite imagery (green, red, and NIR) used to quantify variations in plant vigor, helpful to discriminate the healthy vegetation from unhealthy (Plant, 2001) [9].
(Johansen *et al*. 2013) [3] Reported that the spectral properties of the vegetation in different parts of the spectrum are useful to reveal the information about the type of vegetation, health status of crops, rangelands, forests, and plant species.
(Lillesand *et al*. 2007) [6] added infra red bands apart from green and red and found the plats reflect high energy of the near infra-red energy, comparison to green and red. (Lenk *et al*., 2007) [5] used the thermal imaging sensor data for quick investigations of vegetation stress.
Research methodology for the estimation of geographical area of the horticultural crops and their management practices under geospatial domain is current lacking, and to sort out of these problems, the present study was carried out to map the flood impact on mango orchards during monsoon 2021 for Naugachhiya subdivision Bhagalpur.

Material and Methods

Study Area

Naugachhiya Subdivision of Bhagalpur district, Bihar occupied in 86982 ha of the total geographical area. (Fig.1). The whole area is under vast alluvial plain intersected by a tributary of the Kosi. However, the Ganges across from west to east provides a large deposition of alluvial soils in *Tal*, *Diara* lands.

The *Diara* land, a natural behavior formed due to periodical erosion and deposition of sediments (alluvium) in flood prone area under the influence of meandering and course changing behavior of rivers in lower Ganges basin nominated as *Deepak*. The *Diara lands* land having light texture soil, tree less ecology, and water logging during monsoon which have been recognized in Mokamah, Maranchi and Barahiya villages of Patna district (Vimal *et al*., 2019) [12].

(Manish *et al*., 2013) reported that the *Oxbow* as a semi-circle or curve shaped physiographic structure found in lower Ganga basin is formed when a wide meander from a stream or river is cut off from the main channel to form a lake. It is locally known as *Moun* in Gandak river basin in Bihar. Oxbows with plenty of water are found in Narayanpur, Bihpur, Kharik, Naugachhiya, Gopalpur, Ismailpur and Rangra Chowk blocks. The climate of the study area is semi humid to humid having mean daily maximum ambient temperature in summer is close to 43 ^{0}C and mean daily minimum ambient temperature in winter is 8 ^{0}C. Summer season starts from March to early June followed by rainy season starts from mid-June to September end and winter starts from November to February. The relative humidity is generally above 80% during monsoon period from July to September. Rainfall is mainly by south west monsoon active from mid-June to September end.

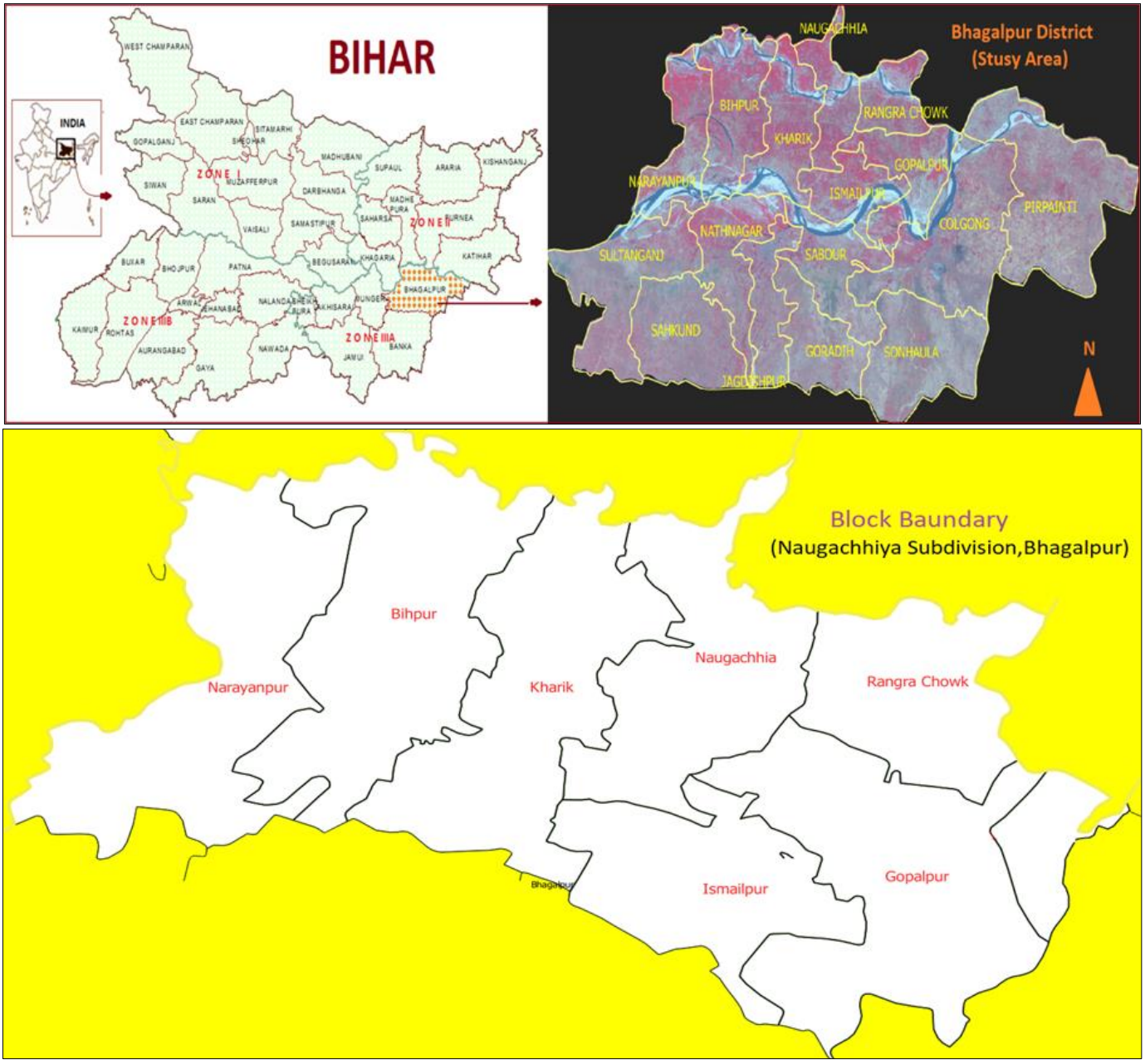

Fig 1: Location map of study area

Hard ware, Software and Satellite Data Used

In present study, the multi spectral satellite image of IRS AWiFS (2018) was used for visual interpretation of mango orchards, and their tonal variation from other land use pattern. However, Google map and Bhuvan portal were also used as supporting references for the delineation and characterization of mango growing area. Shuttle Radar Topography Mission (SRTM) and Carto DEM data were also used for extraction of elevation and slopes. Water logged and moist lands were also analyzed by NDVI image of (MODIS V6, 2021) and ancillary data. Hence, topographical sheets at the scales of 1:250000 and 1:50000 were used to trace out the administrative boundaries of different blocks of Naugachhiya Subdivision, and to perform the digital activities *viz.* interpretation of satellite, digitization, digital image processing and mapping, QGIS software (Version 3.10) was also used.

Methodology

Field survey was done during the month of May-June, 2021 and randomly 27 mango orchards were selected from different blocks of Naugachhiya subdivision for their visual interpretation and further analysis. In this context, sampling sites were selected by using visual interpretation of satellite images and delineated orchards using Google and Bhuvan data.

Topographical maps, documented soil survey reports and ancillary data were also used for reference purposes during field survey and validation of the research findings. Shape files (shp. file) of different blocks by using topographical sheets were digitized after tracing out the boundaries to fill the necessary information in attribute table which was used to map preparation. The NDVI was used to measure the vegetative cover on the land surface over wide areas and confirmation of orchards and the tree less ecology. The NDVI introduced in the early seventies by (Rouse *et al*., 1973) is expressed as the difference between the near infrared (NIR) and red bands (RED) normalized by the sum of those bands. It helped to characterize the agricultural and horticultural land units.

To fulfill the objectives, a comprehensive methodology is summarized in a flow chart. (Fig. 2).

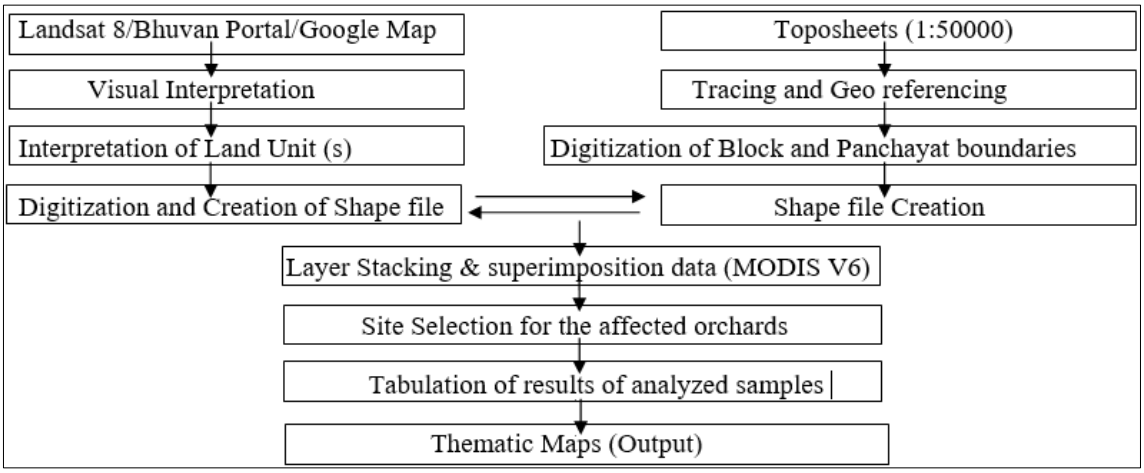

Fig 2: Flow chart of methodology

Results and Discussion

Out of the total geographical area 86982 ha, only 5312.38 ha land was covered with mango orchards in Naugachhiya Subdivision. The maximum coverage of mango orchards was traced in Bihpur (1738.23 ha) block followed by Kharik (1285.57ha), Naugachhiya (1072.82 ha), Narayanpur (546.47 ha), Gopalpur (520.61ha), Rangra chowk (131.47 ha) and Ismailpur (17.21ha) blocks (Table 1). 75% of the total area of mango orchards was traced on natural levees or on elevated plain (stable *Diara*) of the Kosi and the Ganga rivers, and these natural levees provided as a safeguard from minor flood and water logging (Fig.3). However, lowlands were also affected due to flood during monsoon caused congenial environment for disease and pest attacks. (Coakley *et al*., 1999) [1] reported that relative humidity for longer periods, may increases the risk from pathogen infection, an ideal situation for fungal and bacterial growth, and favorable condition for growing of pupas of the insects and pests. Based on interpretation of satellite images and weather data, it was observed that the graph of rainfall during the months of July, August and September was comparatively in maximum peak caused water logging in lowlands of northern part of river Ganges, and plenty of water was observed in *Tal* and *Diara* lands in the month of September (Fig. 4). Hence, temporal changes in NDVI (MODIS V6, 2021) indicated water logging in mango orchards apart from *Tal* and *Diara* lands.

(Datt *et al*. 2006) [2] Reported that the precise knowledge of an area under orchards helped the farmer to apply the right amount of pesticides to the affected areas. Similarly, successful evaluation of remotely sensed data (IRS-1-C) was conducted for detection, mapping and monitoring of rubber plantations affected by Corynespora and Gloeosporium fungi which causes leaf spot and leaf fall disease. (Ranganath *et al*., 2004) [10]. Based on interpretation of the NDVI image of the study, the distinct tone (blue) over *Tal* and *Diara* lands was appeared as hot spots and high vulnerable zones for least growing of plantation.

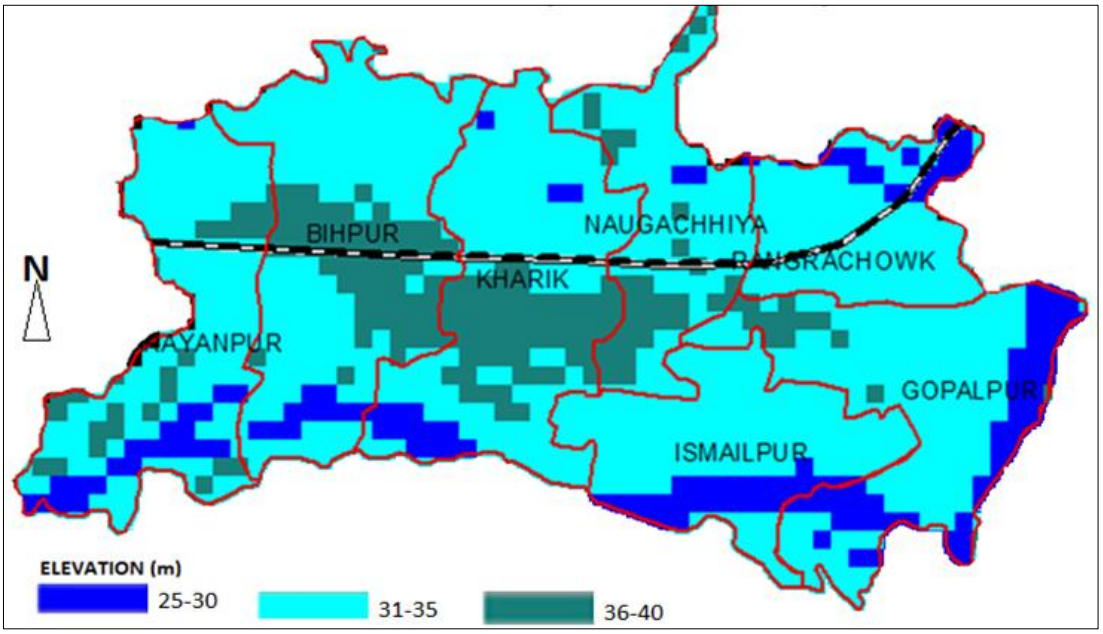

Fig 3: Elevation map of Naugachhiya Subdivision

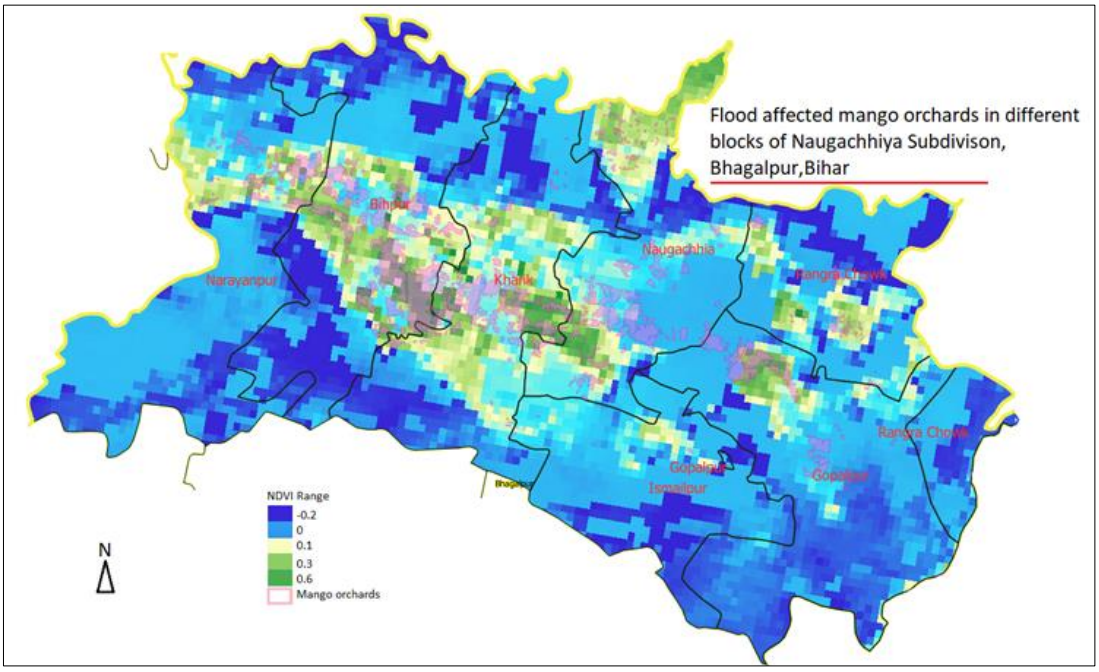

Fig 4: Flood affected mango orchards

Table 1: Acreage of mango orchards in Naugachhiya subdivision of Bhagalpur district

C. D. Block	Total Geog. Area (ha)	Area under mango orchards (ha)	Flood affected mango orchards (ha)	% of flood affected areas
Narayanpur	14427	546.47	142.97	8.15
Bihpur	15208	1738.23	159.44	9.08
Kharik	13157	1285.57	466.98	26.61
Naugachhiya	10670	1072.82	745.82	42.50
Rangra Chowk	11994	131.47	10.71	0.61
Gopalpur	13257	520.61	212.83	12.13
Ismailpur	8269	17.21	16.09	0.92
Total	86982	5312	1755	100

Conclusion

In the study area, modern technology (remote sensing and GIS) was used to map the expansion of the mango orchards, and their topographical set- up. The digitization process was also helpful to map the mango orchards which may be used as a data source towards future planning. In the management point of view, approx. 4513 ha lands of the mango orchards were traced as the congenial environment which are in linear pattern from west to east in adjoining of the river Ganges and the Kosi, provided as a platform for the fungal, bacterial and viral attacks.

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