IOSR Journal Of Humanities and Social Science (IOSR-JHSS)
Volume 31, Issue 8, Series 3 (August, 2026) 07-12
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Assessing The Relationship Between Waterlogging And Mustard Cultivation Using Remote Sensing: Evidence From The Lower Shilabati, Dwarkeswar, Rupnarayan, And Mundeswari River Basins

Sk Majharul Islam,
Bangabasi College

Abstract
Mustard is one of the major oilseed crops and an important source of edible oil in India. It is predominantly cultivated during the winter (Rabi) season in many parts of India and other regions of the world. The Nadia–Murshidabad–Dakshin Dinajpur belt is the principal mustard-producing region of West Bengal (ICAR, 2026). The flood-affected lower reaches of the Shilabati, Dwarkeswar, Rupnarayan, and Mundeswari river basins also constitute an important mustard-producing region. This study presents a simple, cost-effective, and freely available approach for mapping mustard fields in the flood-prone blocks of Arambag, Goghat-I, Goghat-II, Khanakul-I, Khanakul-II, Chandrakona-I, Chandrakona-II, Daspur-I, Daspur-II, Ghatal, Keshpur, Amta-I, Amta-II, and Udaynarayanpur using Sentinel-2 imagery and remote sensing techniques. Furthermore, Geographic Information System (GIS)-based analysis was employed to investigate the spatial relationship between mustard fields and flood-induced waterlogged zones, thereby assessing the extent to which flooding influences mustard cultivation in the study area.

Keywords: *Mustard crop, Sentinel-2 imagery, Spectral Angle Mapper (SAM), Flood impact, Remote sensing*

Date of Submission: 05-08-2026 Date of Acceptance: 15-08-2026

I. Introduction

Mustard (*Brassica* spp.) is one of the major oilseed crops and an important source of edible oil in India. It is predominantly cultivated during the winter (Rabi) season in many parts of India and other regions of the world. The highest mustard production and consumption are observed in India. Rajasthan contributes approximately 50% of India's total mustard production. Other important mustard-producing states are Uttar Pradesh, Haryana, Madhya Pradesh, and West Bengal. According to ICAR, the cultivated area of West Bengal is 5.5 million hectares (62% of the total geographical area), and the total mustard-producing area is only 0.4 million hectares. The Nadia–Murshidabad–Dakshin Dinajpur belt is the major producer in West Bengal (ICAR, 2026).

During winter, the agricultural fields of the lower Shilabati, Dwarkeswar, Rupnarayan, and Mundeswari River Basins are covered with potato, mustard, groundnut, and other rabi crops. Most farmers sow mustard in November and harvest the crop between February and March. It takes about 85 to 110 days to harvest mustard after sowing. This area is dominated by low-lying and flat topography, which is affected by regular flood events. In some areas of the lower reaches of the Shilabati, Dwarkeswar, Rupnarayan, and Mundeswari River Basin, flood water remains stagnant until late November. Therefore, the crop calendar of this area is different from that of the surrounding regions of South Bengal. Regular flooding is a major determinant of the socio-economic conditions and livelihoods of a major part of this study area.

The blocks of Arambag, Goghat-I, Goghat-II, Khanakul-I, Khanakul-II, Chandrakona-I, Chandrakona-II, Daspur-I, Daspur-II, Ghatal, Keshpur, Amta-I, Amta-II, and Udaynarayanpur are highly susceptible to annual flooding (Panda and Dandapat, 2017; Kar and Das, 2020; Mondal and Patel, 2023; Bhadra et al., 2024; Baral et al., 2025). Based on farmers' perceptions, late recession of floodwaters causes water to remain in agricultural fields until the end of November. Such prolonged waterlogging creates unfavourable conditions for mustard cultivation. In this paper, these mustard crops have been easily mapped using remote sensing technology. Freely available Sentinel-2 images have been processed using QGIS software for the last three monsoon and winter seasons.

About the Study Area

The study area is located in the southern part of West Bengal, India, within the flood-prone lower reaches of the Shilabati, Dwarkeswar, Mundeswari, and Rupnarayan river basins. Based on the literature review and the present remote sensing analysis, the blocks of Arambag, Goghat-I, Goghat-II, Khanakul-I, Khanakul-II, Chandrakona-I, Chandrakona-II, Daspur-I, Daspur-II, Ghatal, Keshpur, Amta-I, Amta-II, and Udaynarayanpur were identified as the blocks most frequently affected by annual flooding (Figure 1). These blocks have been selected to assess the spatial relationship between flood-induced waterlogging and mustard-cropped areas using remote sensing and Geographic Information System (GIS) techniques.

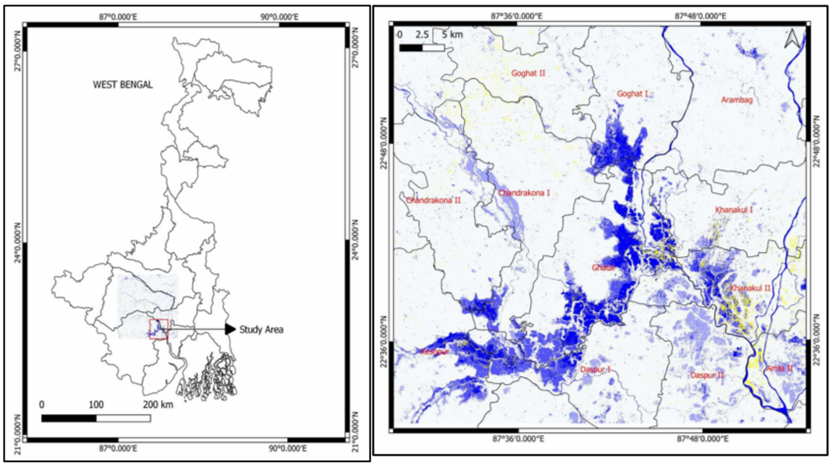

Figure 1: Location of the study area, mustard-cropped area (yellow), and flooded area (blue).

II. Literature Review

There are many researchers who have published articles on cropland mapping using remote sensing technology. Some of them have used Sentinel-2 satellite images. Sentinel-2 images have wide coverage with a 10 m spatial resolution and a 5-day revisit interval, making them suitable for short-term crop mapping. These images have been freely available since 2016. Bhagat et al. (2023) and Das et al. (2025) highlighted mustard crop production, phenology, and controlling factors in India. Hemraj et al. (2025) and Gumma et al. (2022) identified mustard crops from other crops using remote sensing data. Although several studies have explored crop mapping using remote sensing, there is a lack of research integrating remote sensing and GIS to assess the relationship between waterlogging and mustard cultivation in flood-prone regions.

III. Materials And Methodology

The methodology adopted in this study is illustrated in the methodology flowchart (Figure 2). Spectral characteristics of mustard fields derived from ten Sentinel-2 spectral bands covering wavelengths between 490 and 2190 nm (Figure 3). The spectral response exhibits a distinct pattern that enables mustard fields to be differentiated from other land-cover classes. Reflectance remains relatively low within the visible spectrum because of chlorophyll absorption, followed by a pronounced increase in the near-infrared (NIR) region, where peak reflectance occurs at Band 8 (842 nm) and 8A (865 nm). Beyond the NIR region, reflectance declines across the shortwave infrared (SWIR) bands (1610 and 2190 nm), primarily due to the influence of leaf water content. These spectral characteristics provide a reliable basis for identifying and mapping mustard-cropped areas using Sentinel-2 imagery. The locations of mustard fields have been collected through ground surveys with the help of Google Earth and mobile GPS.

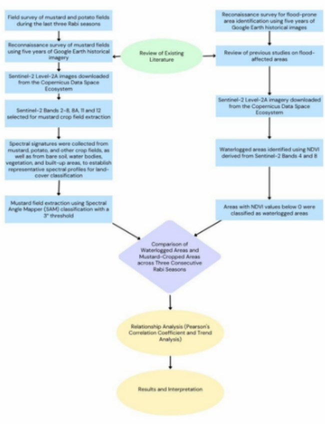

Figure 2: Methodology flow chart

Level-2A (surface reflectance) Sentinel-2 satellite images have been downloaded from the Copernicus website of ESA. The Sentinel-2 satellite sensor has 13 unique spectral bands spanning visible, near-infrared (NIR), and shortwave infrared (SWIR) wavelengths. The spatial resolution of Sentinel-2 Bands 2, 3, 4, and 8 is 10 m, whereas Bands 5, 6, 7, 8A, 11, and 12 have a spatial resolution of 20 m. The temporal resolution of this sensor is 5 days. In this study, Band 2 - Band 8, Band 8A, Band 11 and Band 12 were used to distinguish mustard crops from other land use types.

The images have been classified using QGIS 3.1 and the SCP plugin (Version 7). Spectral Angle Mapper (SAM) classification has been used to segregate mustard crops from other crops and land-use types. Accuracy assessment has been carried out for the classified images. The flooded area map has been prepared using NDVI derived from Band 4 and Band 8 of Sentinel-2 imagery. The relationship between waterlogged area and mustard-cropped area was examined using statistical techniques, including Pearson's correlation analysis and temporal trend analysis.

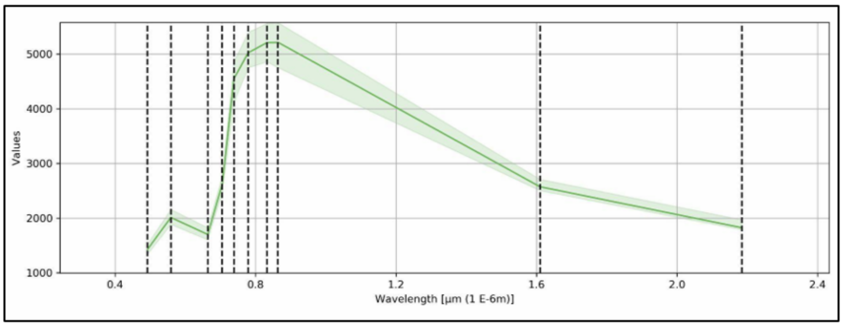

Figure 3. Spectral signature of mustard-cropped fields derived from Sentinel-2 multispectral bands acquired on 04.01.2024.

IV. Results And Discussion

Using the Spectral Angle Mapper (SAM) with a threshold value of 3 showed better results. A threshold value of less than 3 does not include all the mustard crop fields, whereas a threshold value of more than 3 includes other crops like potatoes. The overall accuracy of the classification is around 97 percent, and the Kappa value is 0.95. Among the flood-affected blocks, Khanakul-II block cultivated the highest area of mustard crops (Table 1). Spatial analysis of the flooded area and mustard-cropped area showed that 1,132 hectares of mustard-cropped area lie within the low-lying, regularly flooded area out of a total of 3,014 hectares of mustard-cropped area in and around the study area during 2023–24 (Figure 6 and Table 1). Mustard cultivation in the study area exhibits considerable interannual variability, largely influenced by the timing and duration of flooding. In years when floodwaters recede early, agricultural fields become suitable for cultivation by November, resulting in an expansion of the area under mustard cultivation. Conversely, when floods occur later or floodwater remains inundated for a prolonged period, land preparation and sowing are delayed, leading to a significant reduction in the mustard-cultivated area. The flood scenarios during the 2023–24 and 2024–25 Rabi seasons are presented in Figures 4 and 5, respectively. The comparison indicates a significant expansion of waterlogged areas in 2024–25 relative to 2023–24. In contrast, the extent of mustard-cropped area decreased during the same period, suggesting an inverse relationship between waterlogging and mustard cultivation (Figures 4,5,6 and 7).

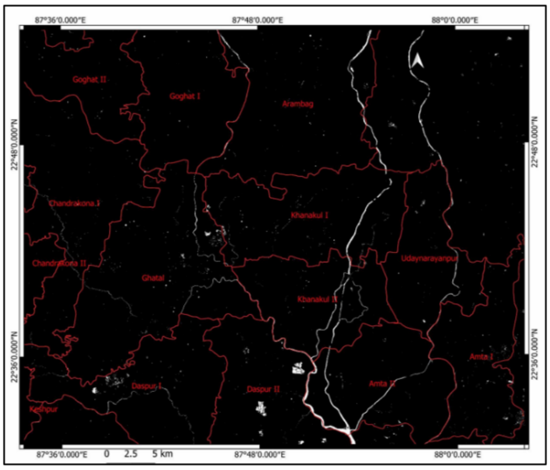

Figure 4: Flood waterlogging (white) in the study area on 31/10/2023.

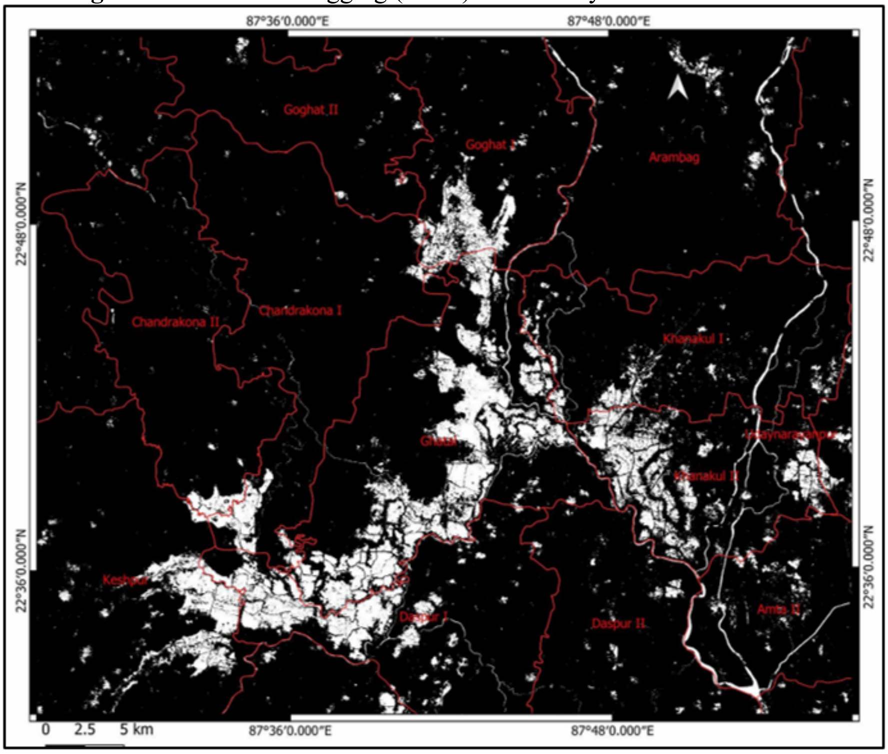

Figure 5: Flood waterlogging (white) in the study area on 30/10/2024.

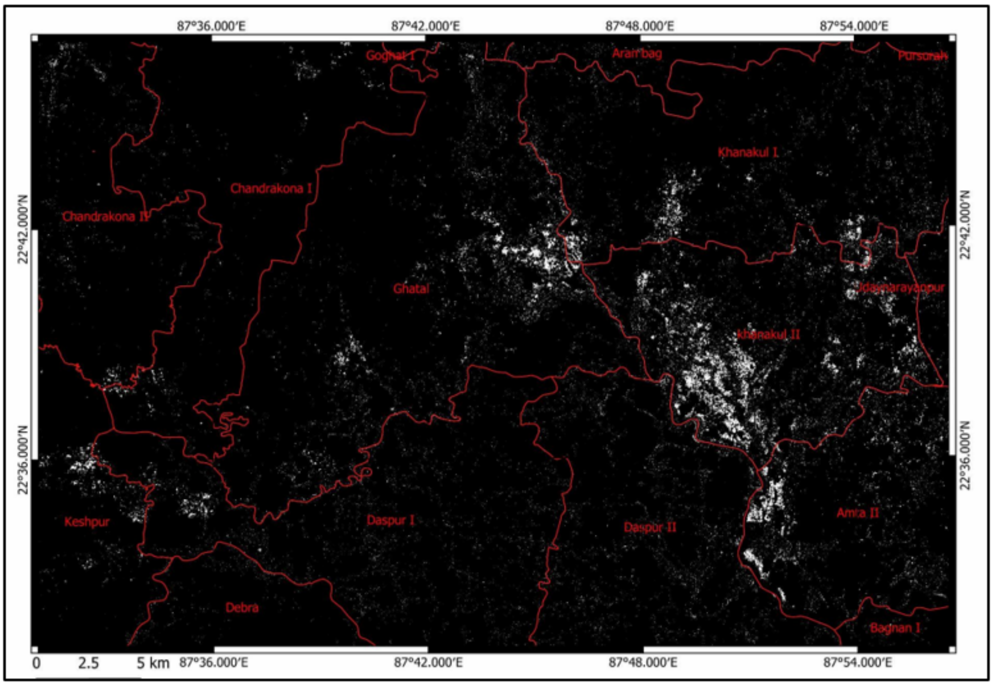

Figure 6: Mustard fields (white) in the study area on 04/01/2024.

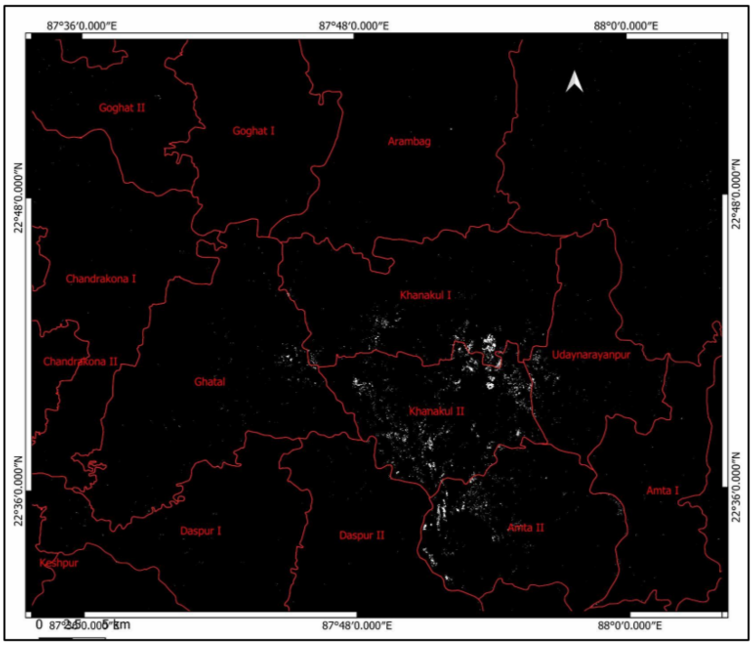

Figure 7: Mustard fields (white) in the study area on 03/01/2025.

Table 1: Block-wise waterlogged area and mustard-cropped area in hectare

Block	2022–23		2023–24		2024–25	
	Waterlogged area	Mustard cropped area	Waterlogged area	Mustard cropped area	Waterlogged area	Mustard cropped area
Arambag	366	4	301	43	886	1
Goghat I	90	3	50	21	1480	0
Goghat II	129	1	84	161	237	2
Khanakul I	204	56	154	257	1040	125
Khanakul II	288	485	247	847	3029	273
Chandrokona - I	102	1	42	195	972	2
Chandrokona - II	91	1	49	112	418	2

Daspur - l	121	16	134	107	3054	3
Daspur - ll	317	4	277	107	363	3
Ghatal	227	77	195	413	6934	28
Keshpur	87	10	36	136	2484	2
Amta - l	120	1	105	92	1184	2
Amta - ll	485	90	438	415	1000	133
Udaynarayanpur	105	2	93	108	555	28
Total	**2732**	**751**	**2205**	**3014**	**23636**	**604**

V. Conclusion

According to the results of the accuracy assessment, this method can easily and accurately map mustard fields. It will help assess the mustard production status of the flood-affected lowlands in the lower reaches of Shilabati, Dwarkeswar, Rupnarayan and Mundeswari river basins. From this study, it is observed that the timing and duration of floods are determinant factors of mustard cultivation in the Arambag, Goghat-I, Goghat-II, Khanakul-I, Khanakul-II, Chandrokona-I, Chandrokona-II, Daspur-I, Daspur-II, Ghatal, Keshpur, Amta-I, Amta-II and Udaynarayanpur blocks. The higher mustard production observed during the 2023–24 winter season can be attributed to the smaller extent of waterlogged areas compared with the preceding and subsequent years, which allowed a larger area to be cultivated.

The temporal analysis reveals that mustard cultivation is highly sensitive to post-monsoon waterlogging. A reduction in waterlogged area promoted the expansion of mustard cultivation during 2023–24, whereas extensive waterlogging during 2024–25 resulted in a marked decline in mustard-cropped area across almost all blocks, highlighting the adverse impact of flood-induced waterlogging on winter agriculture. Correlation analysis revealed a weak negative relationship between waterlogged area and mustard-cropped area, indicating that an increase in waterlogging was generally associated with a slight decline in mustard cultivation. Trend analysis showed that waterlogged area increased considerably in 2024–25, while mustard-cropped area declined during the same season. The highest mustard cultivation occurred in 2023–24 under comparatively lower waterlogged conditions, indicating an inverse temporal trend between waterlogging and mustard cultivation. However, this is a preliminary study, and further ground verification and detailed analysis are required to improve the accuracy and precision of the findings.

References

[1]. Baral, M., Chakraborty, A., Mukherjee, K., Bhadra, T., Dash, P., & Sarkar, R. (2025). A Comprehensive Flood Risk Mapping In The Gangetic Interfluvial Floodplain Region. Discover Geoscience, 3(1), 45.

[2]. Bhadra, T., Mukherjee, K., Dash, P., Saha, J., & Das, R. (2024, August). Flood Monitoring And Mapping In The Ghatal Region Of West Bengal, India. In IOP Conference Series: Earth And Environmental Science (Vol. 1382, No. 1, P. 012002). IOP Publishing.

[3]. Bhagat, R., Singh, M., Sharma, B. C., & Singh, G. (2023). Influence Of Sowing Date On Growth And Productivity Of Rapeseed-Mustard: A Review. Link: Https://Epubs.Icar.Org.In/Index.Php/JOB/Article/View/157703

[4]. Das, R., Biswas, S., & Dutta, A. (2025). Pattern Of Seed Development In Rapeseed-Mustard Genotypes Grown Under Varying Seed Priming Options In The Lower Gangetic Plains Of India. Discover Plants, 2(1), 108.

[5]. Gumma, M. K., Tummala, K., Dixit, S., Collivignarelli, F., Holecz, F., Kolli, R. N., & Whitbread, A. M. (2022). Crop Type Identification And Spatial Mapping Using Sentinel-2 Satellite Data With A Focus On Field-Level Information. Geocarto International, 37(7), 1833–1849.

[6]. Hemraj, Pal, O., Sharma, M. P., & Singh, S. (2025). Identification And Differentiation Of Mustard Crop With Associated Other Land Cover Features Using Multi-Temporal Synthetic Aperture Radar (SAR) And Multispectral Instrument (MSI) Data With A Machine Learning Approach Over Haryana, India. Agricultural Research, 14(2), 375–386.

[7]. ICAR. (2026). West Bengal. Link: Https://Www.Icar.Gov.In/En/Node/17296?Utm_Source=Chatgpt.Com#Main-Content

[8]. Kar, N. S., & Das, S. (2020). Flood-Prone Ghatal Region, India: A Study On Post-'Phailin' Inundations Of 2013. In Water Management In South Asia: Socio-Economic, Infrastructural, Environmental And Institutional Aspects (Pp. 69–89). Cham: Springer International Publishing.

[9]. Mondal, S., & Patel, P. P. (2023). An Account Of The Flood History In The Ghatal Region Of West Bengal, India. In Floods In The Ganga–Brahmaputra–Meghna Delta (Pp. 351–363). Cham: Springer International Publishing.

[10]. Panda, G. K., & Dandapat, K. (2017). Flood Hazard Assessment At Block Level And Its Management Strategy In Paschim Medinipur District, West Bengal, India. IOSR Journal Of Humanities And Social Science, 22(06), 07–14.