# Remote Sensing Technology for Land Farm Mapping Based on NDMI, NDVI, and LST Feature

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***Abstract*—Remote Sensing is a reliable and efficient data acquisition techniques. This technique is widely used for land image processing. This technique has many advantages, especially in terms of cost and time. In this study, the classification between dry and irrigated land from irrigation canals is presented. Normalized Difference Vegetation Index (NDVI), Normalized Difference Moisture Index (NDMI), and Land Surface Temperature (LST) values obtained from satellite imagery data are used in this process. It is expected that through this method, the distribution and control of irrigation water can optimize existing agricultural potential. Ground Check (GC) is used for validation process. The results showed that the error rate based on the moon was not so large, i.e., 18%. The highest errors occur in February and March. This happens because those months are the rainy season, so the measured temperature is mostly the temperature above the cloud layer. On the other hand, the lowest error occurs in November. Also, it can be seen that this method can function optimally when detecting residential areas or highways.**

***Keyword*—Remote Sensing, Classification, NDVI, NDMI, LST.**

## I. INTRODUCTION

Remote Sensing (RS) is the measurement or acquisition of data from an object or phenomenon by a device that does not physically make contact with the object or the measurement of data from an object or phenomenon by a device remotely, for example from planes, spacecraft, satellites, ship, or other equipment [1], [2], as shown in Fig. 1. The tool that is currently popular used in RS is satellite. RS is a technique that is reliable and efficient which can be used for the process of taking land images [3]. With this method, Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture Index (NDMI) can be obtained from agricultural land. NDVI and NDMI can be used to classify an agricultural land between the dried. Besides that, this method has lowest environmental impact.

According to [4], this method has better accuracy compared to various existing land classification/detection techniques. The addition of other variables such as rainfall data will make the classification results more accurate [5]. However, this requires more effort because it will involve more parties. Another research used NDVI and EVI to estimate the age of rice in Indramayu region, West Java [6]. NDVI has also been used to estimate/predict productivity of wetland rice in parts of West Java and Central Java using satellite imagery [7]. The NDVI index produced ranges from -1 to +1. It is thought that the lower NDVI index value, the lower the production rate of lowland rice. In this study, the classification/grouping of dry and irrigated land from irrigation canals is presented. NDVI, NDMI, and Land Surface Temperature (LST) values obtained from satellite imagery data are used in this process.

## II. DATA AND METHODS

### A. Study Area

The data used in this study are satellite image data of agricultural land of Kebumen Regency, Central Java Province, Indonesia, taken using Landsat 8 satellite. Generally, the area of Kebumen Regency is 128,111.50 hectares. In 2013, it was recorded that 39,748 hectares (31.03%) were paddy fields and 88,363.5 hectares (68.97%) were dry land. Most of the total paddy fields (50.34%) are technical irrigated rice fields and almost all of them can be planted twice a year, semi-technical irrigated (9.23%), simple irrigated (5.77%), village irrigated (2.65%), and some in the form of rainfed and tidal rice fields (32.02%) [8].

The data were taken for 12 months, from January to December 2016. Fig. 2 shows the location of the study on Path 120/Row 65. Based on those informations, optimizing irrigation factors by classifying agricultural land between irrigated areas and non-irrigated areas is expected to be very useful, especially to support Kebumen food policy and generally at the national levels.

### B. Data

The dataset used is multiband image. This dataset is obtained from USGS EROS. USGS EROS is a research and science institution owned by the United States that is engaged in the observation of resources found on the surface of the earth. In this study, not all channels are used. Instead, only six of the eleven available channels are used, namely channel 4, 5, 6, 7, 10, and 11. Channels 4 and 5 are used to find NDVI values, channels 6 and 7 are used to find NDMI values, and channels 10 and 11 are used to find the value of LST.

### C. Method

Based on Fig. 3, there are three stages conducted in this research, namely pre-processing, processing, and classification.

At the pre-image processing stage, a radiometric correction process is carried out. This aims to eliminate noise caused by radiometric distortion due to differences in position of the sun when taking satellite imagery. This radiometric correction is done by changing the value of the Digital Number (DN) to the

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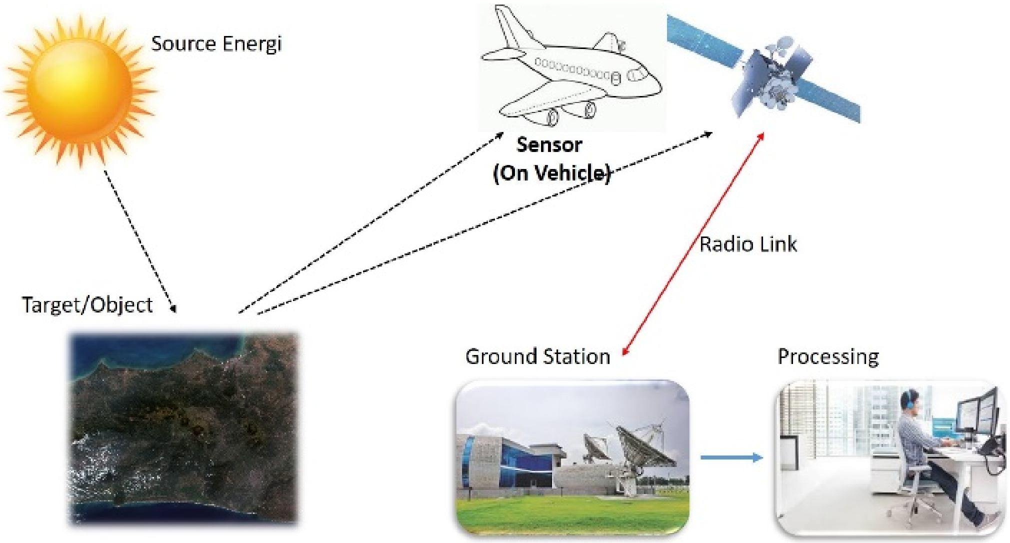


Fig. 1 Remote sensing process.

reflectance value. From Fig. 4, after radiometric correction, there is a difference value at the same pixel point between the original value and the final value. This value can be searched using (1).

$$L\lambda = \left\{\frac{Lmax - Lmin}{Qcalmax - Qcalmin}\right\} x(Qcal - Qcalmax) \quad (1)$$

where $L\lambda$ is value of radiance, $L_{max/min}$ are the maximum/minimum levels of radiance detected, $Q_{calmax/calmin}$ are maximum/minimum pixel value of image, and $Q_{cal}$ is digital value for each pixels.


Fig. 2 Location of the selected Landsat-8 Path120/Row65 scene and study area.

The next step is image processing. At this stage, there are two processes, namely by looking for NDVI and NDMI values. These two variables describe aspects of the reality of vegetation and the reflection of electromagnetic waves found in plants.

*1) Normalized Difference Vegetation Index (NDVI):* NDVI is a method commonly used in comparing the greenness of vegetation in plants. This value can be computed using (2).

$$NDVI = \frac{NIR(band5) - RED(band4)}{NIR(band5) + RED(band4)} \quad (2)$$

where NIR is near infrared waves and RED is a red wave.

*2) Normalized Difference Moisture Index (NDMI):* NDMI is similar to NDVI. While NDVI indicates the level of greenness, NDMI shows the level of moistures in plants. This value can be obtained using (3) and (4).

$$NDMI\ 6 = \frac{SWIR1(band6) - NIR(band5)}{SWIR1(band6) + NIR(band5)} \quad (3)$$

$$NDMI\ 7 = \frac{SWIR1(band7) - NIR(band5)}{SWIR1(band7) + NIR(band5)} \quad (4)$$

where SWIR1 is shortwave infrared.

In addition to looking for NDVI and NDMI values, in the second stage, the value of LST is also sought to sort out existing land data. The process of finding this LST consists of three steps. First, change the DN value to the Radiance value, then change the Radiance value to Kelvin temperature, and lastly, change the Kelvin temperature to Celsius.

The last step in this research is the classification stage using a rule. There are three processes in this stage. The first stage is NDMI clustering for all pixel points. The results are three clusters, namely cluster 1, cluster 2, and cluster 3. Then, cluster 1 is filtered twice. First, it is filtered using NDVI and NDMI variables (mean and standard deviation), as shown in Fig. 3. Secondly, it is filtered using LST variables. Based on cluster 1 filtering, there are two classes, namely ‘Irrigated’ and ‘Non-irrigated’ classes. The next step is filtering cluster 2 which will produce a ‘Non-irrigated’ class and the remainder will be grouped in cluster 3, using NDVI variables, NDMI mean, and LST, simultaneously. The last step is cluster 3 filtering using LST, which will produce an ‘Irrigated’ and ‘Undefined’ class. The standard LST used for thresholding is influenced by the geographical position of a country. The closer a country to the equator, the lower the LST value. This is because the value of LST is influenced by solar radiation and existing water discharge [9], [10]. Because Indonesia is a country crossed by the equator, Indonesia’s LST value is lower than countries far from the equator such as Turkey, which is approximately 27$^{o}$C.

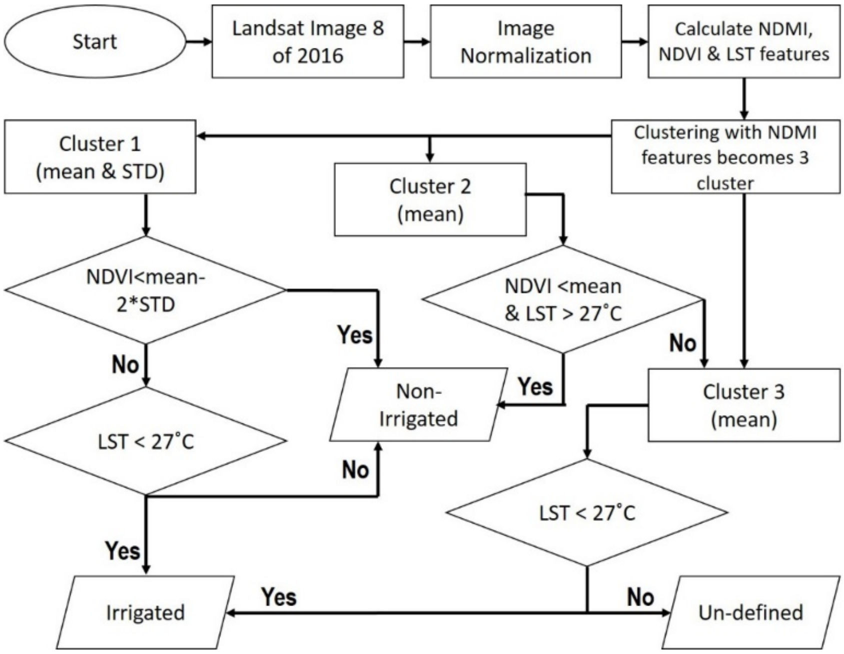


Fig. 3 The architecture of the applied method.

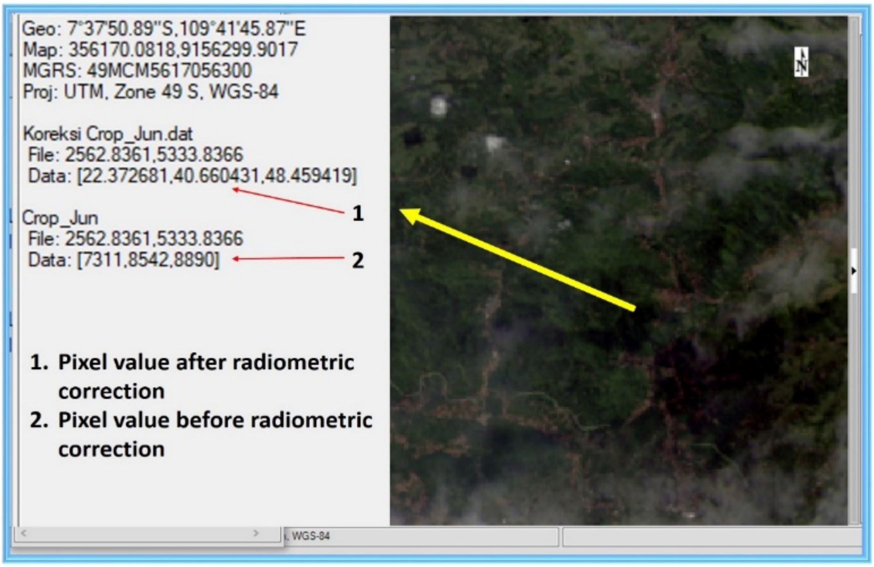


Fig. 4 The results of pre-satellite image processing with radiometric correction techniques.

## III. RESULTS AND DISCUSSIONS

Based on the research that has been done, new maps for NDMI, NDVI, and LST for each month are obtained. Fig. 5 shows that cluster 1 has the lowest NDMI value compared to other clusters, while cluster 3 has the highest NDMI value. On the other hand, Fig. 6 shows that the relationship between NDMI and NDVI generally is directly proportional, namely the higher the vegetation, the higher the humidity, but not vice versa. In addition to NDMI and NDVI, new maps of LST are also obtained for each month. Based on the research that has been done, NDVI and LST are always directly proportional. However, LST, compared to NDMI, is not always directly proportional.

The validation process is carried out using the Ground Check (GC) method for several sample regions, as seen in Fig. 7. The red dot is the location of the GC in this study. Determination of of the GC location is done with consideration of the area of agricultural area and the existence of irrigation channels in the area. Due to the GC process carried out in 2019, it is necessary to assume that the real conditions in 2019 are the same as in 2016, especially the areas of water bodies, such as rivers and irrigation channel, so the validation process can be carried out. Table I shows that the error rate, from the result by month, is not so large, i.e., 18%. This value is obtained from the average misidentification of land conditions (3.6) divided by the number of GC sample points (20). The most errors occur in

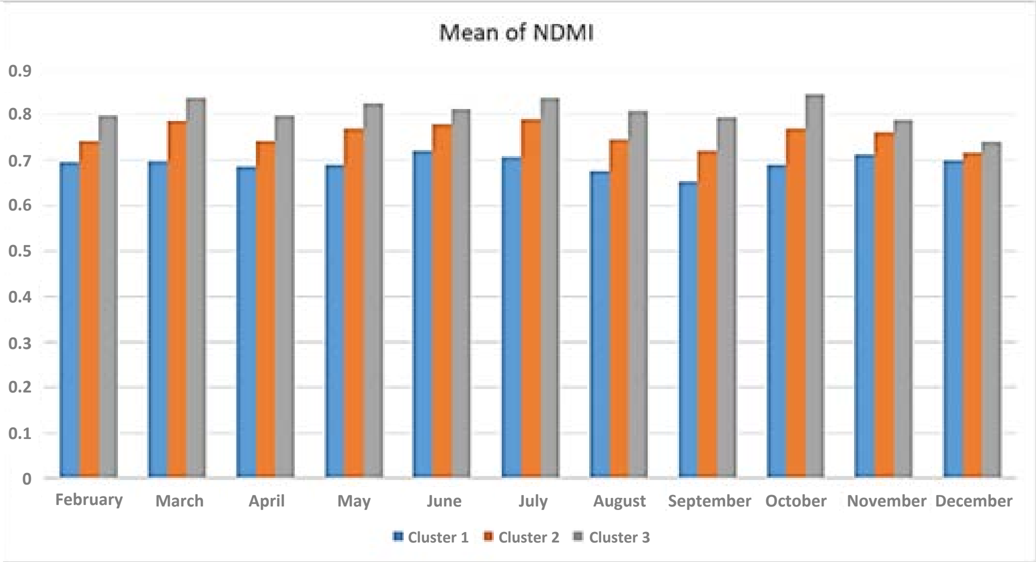


Fig. 5 NDMI mean graph for 2016.

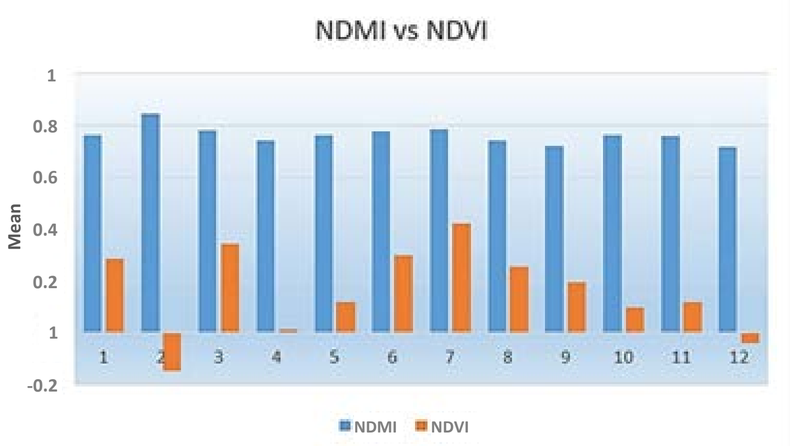


Fig. 6 Relationship between mean of NDMI and NDVI.

February and March. This happens because those months are the rainy season, so the measured temperature is mostly the temperature above the cloud layer. Meanwhile, the lowest error is in November. Table I also shows that the method used can function optimally when detecting residential areas or highways. However, for water areas, such as reservoirs and rivers, the method did not function optimally. This occurred due to several factors including variable LST and position when doing GC.

## IV. Conclusions

Overall, determining the status of agricultural land using the remote sensing method using features of air humidity, vegetation level, and surface temperature is a prospective and reliable method. The existence of several deficiencies in this study can be done in subsequent studies, including the time used in the validation method with the GC technique should be carried out in accordance with the dataset used in the study. The features used for classification can also affect accuracy. In other words, standard adjustment of features will greatly affect the classification results.

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TABLE I
RECAPITULATION OF RESEARCH RESULTS

| No | Sample of GC Area | Coordinate | | Ground Check (GC) State | Result by Month | | | | | | | | | | | | Error/Sample (times) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | Y | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| 1 | Candirenggo | 323535 | 9148705 | Irrigated | I | I | I | I | I | I | I | I | I | I | N | N | **2** |
| 2 | Purbowangi | 332505 | 9157525 | Irrigated | N | N | N | I | I | I | I | N | I | I | I | I | **3** |
| 3 | Sempor | 333075 | 9163435 | Reservoir | I | N | N | I | I | I | I | I | I | I | I | N | **3** |
| 4 | Sidomukti_Kwr | 335115 | 9149425 | Irrigated | N | N | I | I | I | I | I | N | I | I | I | N | **4** |
| 5 | Gombong | 336375 | 9158905 | Settlement | N | N | I | N | N | N | N | I | N | N | N | N | **2** |
| 6 | Kedungpuji | 338985 | 9159145 | Irrigated | U | N | I | I | I | I | I | N | N | I | I | I | **4** |
| 7 | Kaleng | 339135 | 9143275 | Non-Irrigated | N | N | N | I | N | I | N | I | I | N | N | N | **3** |
| 8 | Sidomulyo_Krng | 340125 | 9157435 | Irrigated | I | N | I | I | I | N | I | N | N | I | I | I | **4** |
| 9 | Jatiluhur_Krngnyr | 342195 | 9155095 | Irrigated | N | N | I | I | I | I | N | I | N | I | I | I | **4** |
| 10 | Karanggayam | 343245 | 9161335 | Non-Irrigated | I | N | I | N | I | I | I | N | I | I | I | I | **3** |
| 11 | Purwodesa_Sruw | 343575 | 9154195 | Irrigated | I | N | I | I | I | I | I | N | N | I | I | I | **3** |
| 12 | Petanahan | 344535 | 9143575 | Settlement | N | N | N | N | N | N | N | N | N | I | N | U | **1** |
| 13 | Kebulusan_Peja | 348825 | 9151105 | Irrigated | I | N | N | N | N | I | I | I | N | I | I | N | **6** |
| 14 | Kedungsari | 350625 | 9143365 | River | I | N | N | I | N | N | I | I | I | I | I | N | **5** |
| 15 | Muktisari | 351795 | 9148555 | River | I | N | I | I | N | I | I | N | I | N | I | I | **4** |
| 16 | Bumirejo_Kota | 351945 | 9152365 | Settlement | N | N | I | N | N | N | N | N | N | N | N | N | **1** |
| 17 | Sidomoro | 353805 | 9145825 | Non-irrigated | N | N | I | I | I | I | I | N | N | I | N | N | **6** |
| 18 | Waluyo | 355035 | 9140605 | Non-irrigated | I | N | I | I | I | N | I | N | N | I | N | I | **6** |
| 19 | Sawangan_Alian | 357345 | 9155755 | Irrigated | N | N | N | I | N | I | I | N | I | N | I | I | **6** |
| 20 | Lajer | 360045 | 9144685 | Irrigated | I | I | N | I | I | I | I | I | N | I | I | I | **2** |
| | | | | | | | | | | | | | | | | | **3.6** |
| **Error/Month (times)** | | | | | **5** | **11** | **11** | **4** | **7** | **5** | **3** | **9** | **8** | **6** | **2** | **7** | **6.5** |

**Note:**
**I : Irrigated area**
**N : Non-Irrigated area**
**U : Undefined area**

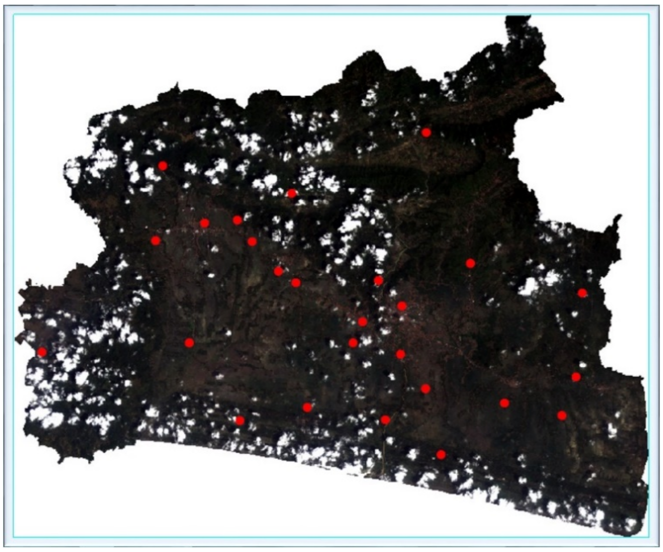

Fig. 7 Ground check sample area (GC).