Study of Land-use Change Monitoring in the Rawa Sei Seluang Irrigation Area and Belawang Irrigation Area, Barito Kuala Regency, South Kalimantan Province

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Abstract. Food security is a basic need of each country including Indonesia, whose population is increasing rapidly is not proportional to the growth in productivity of agricultural land, especially paddy fields. Swamp Irrigation Area (DIR) which was originally designed for a rice field block area program in the early opening of transmigration land outside Java, especially in the area of Barito Kuala District, South Kalimantan Province, in fact, has now turned into rubber plantations and oil palm plantations, both managed by the community or company. The study of monitoring land-use change is very important in relation to food security programs, where the change of function or land-use changes is currently developing very rapidly in line with the level of needs and population growth. Therefore, the study of monitoring land-use change needs to be carried out as a monitoring and also to find out in land-use change. The rice field in Sei Seluang DIR has 37.72 % from 3,297 ha the total area and rice filed in Belawang DIR have 7.45 % from 5,257 ha the total area. Satellite imagery as a monitoring tool or land-use monitoring study is very suitable because in addition to covering a fairly large area, information detail both in terms of pixel resolution and temporal resolution are now getting better in line with technological advancements, including advances in digital image processing software.

1. Introduction

Food security is a basic requirement of every country to meet the food needs of its population including Indonesia. One food commodity is rice produced from rice fields. The area of paddy fields in Indonesia from time to time tends to decrease or change its function to other land uses besides paddy fields, including changing into plantation land.

Swamp Irrigation Area (DIR) which was originally designed for a rice field printing program in the early opening of transmigration land outside Java, especially in the area of Barito Kuala District, South Kalimantan Province, in fact, the land-use of paddy fields has now turned into rubber plantations and oil palm plantations, both (rubber and oil palm) managed by the community or company. Satellite images covered the earth every time depend on temporal or repetitive of kind of satellite image such as Landsat ETM every 16 days acquisition the same place in earth buat for the Sentinel Satellite acquisition every 5 days on the same place in the earth and so many kinds of satellite images comercial or free of charge. So we can analyzed the satellite images for study of land-use change. Satellite image covered the large area depend of spatial resolution, for example the Landsat ETM covered 185 km x 185 km. So we can use for monitoring except should be field-check or ground truth to all area, just
only in the key areas. This method (use technology of remote sensing interpretation) could be efficient and economical for saving budget and time compared with terrestrial mapping or monitoring.

Based on the problems mentioned above (land-use change from paddy field to another land-use), this study will conduct an analysis or study of land use change monitoring in the Sei Seluang Swamp Irrigation Area and the Belawang Swamp Irrigation Area (DIR), Barito Kuala District, South Kalimantan Province using the image processing technology and data remote sensing such as satellite images.

2. Materials and Methods

The materials used for this study are:
1. 1: 50,000 scale RBI base map and a digital Administrative Map
2. Multi-temporal digital satellite imagery with the different recording time of the opening time of the DIR and the latest recording
3. DIR map sourced from Kimpraswil area of study location

While the equipment needed includes:
1. Equipment for processing digital data and GIS, among others
   - Hardware (hard ware) in the form of a computer
   - Software for image analysis is Envi version 5.1. and ArcGIS version 10.3 and Android-based Avenza Map software
2. Field survey equipment (compass, abney level, GPS, digital cameras, work maps)

The stages of the study activities are as follows:
1. Collecting data in the form of maps (digital / manual) and digital images
2. Image processing, such as radiometric correction and geometry correction including image sharpening
3. Initial classification of digital images both digitally using the unsupervised classification method, treated on two different satellite images acquisition
4. Determination of sample location on the image / map of the classification results
5. Data from field activities (field check) and supported by spectral analysis on images is used to reclassify (reclassified) using the supervised classification method, treated on two different satellite images acquisition

The flowchart of the methodology is provided in figure 1.
Figure 1. Flow-chart of Land-use monitoring methodology in Seluang and Belawang Swamp Irrigation Area, South Kalimantan Province.

2.1. Location

Research sites in the Sei Seluang Swamp Irrigation Area and Belawang Swamp Irrigation Area, Barito Kuala District (figure 2), South Kalimantan Province, include Belawang Sub-district, Berambai Sub-district and Wanaraya Sub-district, and include Karya Baru village, Belawang Kolam Kanan, Makmur Pool, Sido Mulyo, Babat Raya, Bagagap, Sungai Kali, Handil Barabai, Sukaramai, Bambangin, and Belawang Kolam Kiri, the villages of Binaan Baru, Gandaraya, Belawang, Tumih, Simpang Jaya, Mentaren, Waringin Kencana, Pinang Habang, Surya Kanta and Roham Raya. Geographically DIR Sei Seluang is located at coordinates $3^\circ 6' 27"$ S - $3^\circ 1' 27.8"$ S latitudes and $114^\circ 31' 42.5"$ E - $114^\circ 36' 29.4"$ E longitudes.
The research area can be reached from Banjarmasin by road with a travel time of around ± 4 to 5 hours drive. Field survey operations are carried out on motorbikes with the condition of the roads partly asphalt, concreted and partly in the form of dirt roads.

![Image](image_url)

**Figure 2.** Map of (a) Sei Seluang DIR research locations (b) Belawang DIR research locations

### 2.2. Climate conditions

Based on the map of Indonesian climate resources [1] part of Barito Kuala District is classified as a type of wet climate (III-C)). Areas with pattern III-C that have rainfall of 2,000 - 3,000 mm / yr with dry months (<100 mm / mo) <4 months and wet months (> 200 mm / mo) 6-8 months.

Based on the criteria of Oldeman [2], most of the Barito Kuala Regency areas belong to the Agro-climate zone C2, which has a wet month rainfall (> 200 mm / month) for 5-6 months, and a dry month (<100 mm / month) for 2 - 3 months in a row (figure 3). Data on average rainfall and rainy days in the Barito Kuala District area in 2009 (average period 1995-2008) are presented in table 1.

| Station  | Jan | Feb | Mar | Apr | Mei | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total | Type of Rain | Zone Agroclim... |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|---------------|-----------------|
| Marabahan| 360 | 291 | 205 | 199 | 92  | 86  | 16  | 26  | 10  | 165 | 260 | 334 | 2.046 | B              | C2              |
| Barabai  | 285 | 268 | 206 | 186 | 53  | 92  | 51  | 18  | 22  | 189 | 248 | 287 | 2.721 | B              | C2              |

**Source:** BMG Jakarta (1995-2008); Schmidt & Ferguson rain type (1951); Agro-climate zone Oldeman et al. (1980); Barito Kuala Agriculture Agency (2009).

Wet months with rainfall >200 mm occur for 5 months, from November to March, while dry months with rainfall <100 mm occur for 5 months, from May to September. The driest months <60 mm occur over 3 months, namely July, August and September. Average monthly air temperature ranges from 27-28°C, humidity 84-89% and 51-82%. This condition is very suitable for the development of agricultural food crops.
The Barito Kuala District is traversed by the Barito River which flows from north to south, where most of the area is a tidal swamp area that has been reclaimed by the construction of drainage / irrigation networks. The tidal patterns that occur in Sei Seluang DIR are daily tides. The overflow types found in the survey area consist of overflow B and C. Overflow B types are land that is overflowed by large tides and land with overflow C type land is not affected by large tides, but the groundwater depth at tide is less than 50 cm.

**Table 2. Temperature and humidity data from Syamsuddin Noor Airport, Banjarmasin**

| Parameters            | Jan  | Feb  | Mar  | Apr  | Mei  | Jun  | Jul  | Ag  | Sep  | Oct  | Nov  | Dec  | Average |
|-----------------------|------|------|------|------|------|------|------|-----|------|------|------|------|---------|
| Temperature max (°C)  | 31.0 | 31.8 | 31.9 | 32.2 | 32.1 | 32.9 | 32.1 | 32.1| 31.0 | 31.8 | 31.3 | 30.9 | 31.5    |
| Temperature min (°C)  | 22.1 | 22.3 | 22.5 | 23.0 | 21.6 | 22.7 | 22.6 | 22.7| 23.6 | 24.2 | 24.3 | 24.0 | 22.9    |
| Temperature average (°C) | 27.1 | 27.3 | 27.4 | 27.6 | 27.7 | 28.0 | 28.1 | 27.8| 27.4 | 27.7 | 27.3 | 27.6 |         |
| Humidity (%)          | 89   | 85   | 84   | 88   | 87   | 87   | 84   | 85  | 86   | 87   | 88   | 87   |         |
| Solar radiation (%)   | 53   | 68   | 70   | 69   | 70   | 79   | 82   | 76  | 55   | 54   | 52   | 51   | 64      |

**Source:** Syamsuddin Noor Airport Banjarmasin Meteorological Station in 2010.

The rainfall pattern at the research location is presented in figure 4. below:
Figure 4. Rainfall pattern in the study area (average of 13 years)

2.3. Geology and Parent Material

Based on the Geology Map of Banjarmasin Sheet (1712) scale 1: 250,000 [3] all research areas in the Sei Seluang DIR are included in Alluvium (Qa) which are composed of gravel, silt and silt, silt and sand (figure 5). Based on observations in the field, the main soil material found in the form of fine deposited alluvium deposits (clay and dust) has a sand texture.

Figure 5. Geology map of DIR Sei Seluang and DIR Belawang
3. FIELD OBSERVATION RESULTS

Field maps from the results of secondary data analysis and image analysis are used as supporting data in the process of field observation or checking, this map already has a sample location of coordinates which will be checked on conditions in the field and recorded both position and information in the form of land cover and other supporting information. Based on field observations, the survey area and its surroundings are landforms of the fluvio-marine, which is land that is formed from marine sediments which are covered by river sediments or fluvial materials. The land is still affected by tides in the form of a flat area with a slope of 0 - 2%, located at an altitude between 4 - 8 m above sea level. Types of land-use at the study site are presented in table 3.

Table 3. Areas of Land-use in the DIR Sei Seluang and DIR Belawang

| Land use            | Sei Seluang | Belawang |
|---------------------|-------------|----------|
|                     | Area (ha)   | Area (%) | Area (ha) | Area (%) |
| Tidal rice fields   | 1.243,5     | 37.72    | 388       | 7.45     |
| Citrus plant        | 17.3        | 0.53     | -         | -        |
| Rubber Plantation   | 800,5       | 24.28    | -         | -        |
| Rubber/Citrus       | 12.0        | 0.36     | -         | -        |
| Rubber/Oil palm     | 1.171,1     | 35.52    | 4.788     | 91.96    |
| Shrub/bush          | 16.9        | 0.51     | -         | -        |
| Water body          | 35.7        | 1.08     | -         | -        |
| **Total**           | **3.297,0** | **100.00** | **5.207** | **100.00** |

Source: Analysis of result image interpretation

3.1. Tidal Rice Fields

Most of the paddy fields in this area are only planted with rice once a year with local varieties for the main reason of the water problem, in some places the community has tried to plant twice a year, but many still fail to harvest because of water problems, especially in the dry season. From the area of DIR Sei Seluang covering an area of 3,297 ha, the land that is still used for paddy area is only 1,243.5 ha or 37.72% while of the Belawang DIR area is 5,207 ha, the land that is still used for paddy area is only 388 ha or 7.45%. Some photographs of the paddy field in the area are shown in figure 6 – 9.
3.2. Citrus Plants

Citrus plants in Sei Seluang DIR are plants that are planted in paddy fields with a surjan system whose position extends in the direction of the paddy fields, planted in the paddy fields as far as the paddy fields. Of the total area of DIR Sei Seluang covering an area of 3,297 ha, the area planted with oranges is 17.3 ha or 0.53%. Some photographs of the citrus in the area are shown in figure 10 and 11.

3.3. Rubber plants

Rubber plants in the Sei Seluang DIR are plants that are planted in the rice field area so that land conversion occurs. Of the total area of DIR Sei Seluang covering 3,297 ha, land planted with rubber is 800.5 ha or 24.28%. Some photographs of the rubber in the area are shown in figure 12 and 13.
3.4. Rubber / citrus plants

Rubber plants with citrus are rubber plants that will be gradually replaced with citrus (figure 14 and 15). Of the total area of DIR Sei Seluang covering an area of 3,297 ha, land planted with rubber / citrus is 12.0 ha or 0.36%.

3.5. Oil Palm / rubber plantation

Oil palm / rubber plantations are community plantations and some have become plasma, in the Sei Seluang DIR, it has changed land use, the largest area is in the village of Binaan Baru and Suryakanta. Of the total area of DIR Sei Seluang covering 3,297 ha, land that is still used for rubber / palm is 1,171.1 ha or 35.52%. Oil palm / rubber plantations are community plantations and some have become plasma, in Belawang DIR it is the largest plantation that has changed the land use change, located in Karya Baru village, Swimming right, Babat Raya, Sido Mulyo and Kolam Makmur village. of the Belawang DIR area of 5,207 ha, the land used for rubber / palm is 4,788 ha or 91.96%. Some photographs of the oilpalm/rubber in the area are shown in figure 16 and 17.

Figure 14. Photograph of the state of rubber/citrus in the plants in the Sei Seluang DIR

Figure 15. Photograph of the state of rubber/citrus in the plants in the Sei Seluang DIR

Figure 16. Photograph of the state of oil palm / rubber in Sei Seluang

Figure 17. Photograph of the state of oil palm / rubber in Belawang DIR
3.6. Shrubs

The use of shrub land is an area of DIR that is not cultivated by its owner, vegetation in the form of piai and gelam and other shrubs and grass. From the total area of DIR Sei Seluang covering an area of 3,297 ha, shrub land covering an area of 16.9 ha or 0.51%. Some photographs of the rubber in the area are shown in figure 18 and 19.

![Figure 18](image1.png) Photograph of shrubs in Sei Seluang DIR

![Figure 19](image2.png) Photograph of shrubs in Belawang DIR

4. Conclusion

The study of land use change monitoring using remote sensing technology, both analysis and use of software and also multi-time satellite imagery data is very appropriate especially in monitoring changes in land in the Swamp Irrigation Area which was originally intended for paddy field to non-rice fields in the form of oil palm and rubber plantations. The rice field in Sei Seluang DIR has 37.72 % from 3,297 ha the total area and rice filed in Belawang DIR has 7.45 % from 5,257 ha the total area. Remote sensing technology using optical satellite imagery is very efficient in saving time and energy cost. While terrestrial mapping or field observation takes a long time and more cost especially its areas are difficult to reach, with remote sensing technology is quite key areas (key areas) that needs to be observed in the field and extrapolated throughout the study area based on the similarity of tone patterns and signatures as well as digital values of satellite imagery.

5. Reference

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