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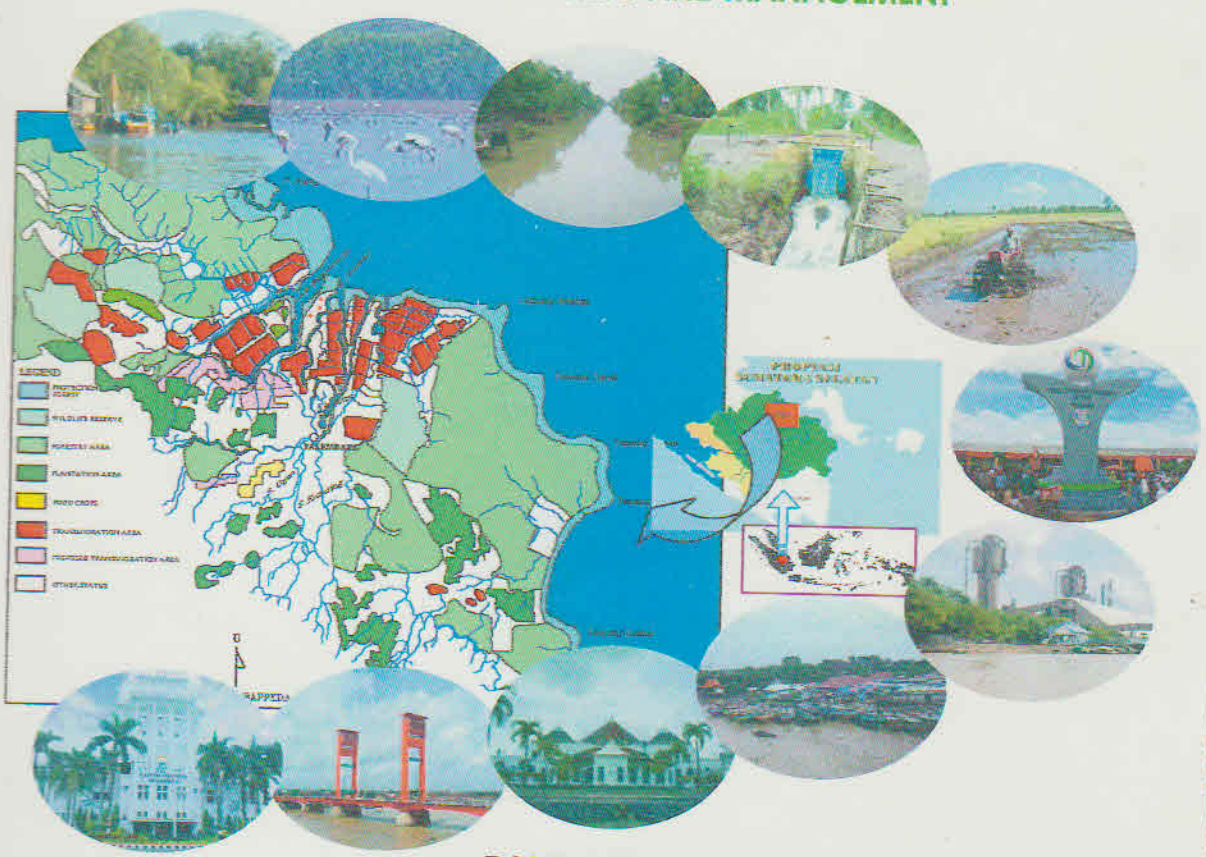
INTERNATIONAL SEMINAR-WORKSHOP ON "INTEGRATED LOWLAND DEVELOPMENT AND MANAGEMENT"

THEME:
THE ROLE OF AGRO-ECO-EDU PROGRAM THROUGH MULTISTAKEHOLDERS PARTICIPATION ON THE SUSTAINABILITY OF LOWLAND DEVELOPMENT AND MANAGEMENT



PALEMBANG CITY – BANYUASIN DISTRICT
SOUTH SUMATRA - INDONESIA
MARCH 18 – 20, 2010

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CONTENTS

SPATIAL ANALYSES OF LANDUSE CHANGING IN TIDAL LOWLAND AREAS (A CASE STUDY OF SALEH DELTA AREAS IN BANYUASIN DISTRICT, SOUTH SUMATERA)

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ABSTRACT

The aim of this research is to identify the changing of landuse in the tidal lowland areas and to determine the cropping pattern in each secondary block in related to drainage network system and hydrotophography class. The study was carried out in Saleh Deltaic areas. The used methodology was field survey and remote sensing technique. It was combined with GIS technology for spatial analysis. The research result showed that the paddy fields field is still the widest areas. However, according to Landsat Imaginary analysis showed that for 1992 up to 2002, there has been change of landuse pattern. The paddy field was significantly decreasing from 23,639.40 ha to become 18,518.40 ha or about 27,65 %. Some paddy fields field was converted to coconut areas and it was due to poor maintenance of the water system on canal, high sedimentation and the water become unavailable in the field. Thus the paddy field was changed to coconut areas. Analyzing cropping pattern show that the most available cultivation in the area is paddy fields-fallow (Cropping index 100 %). There was only about 10 % having cropping index 200 %. For that reason the improving land quality is very essential to increase landuse intensity and especially for paddy fields cultivation. Therefore, the rehabilitation of canal system and installing the hydraulic structure is the first priority for implementing agriculture program. Otherwise the paddy fields area would be reduced every year. The main impact of these is threatening to the food security in South Sumatera.

Keywords: Tidal lowland, landuse change, GIS technology

INTRODUCTION

A. Background

Swamp land in Indonesia is estimated to 39.4 million hectares, comprising 24.7 million hectares of tidal land and 14.7 million hectares of lowland swamp. Approximately 33.7 million hectares of swamp land is located in the island of Sumatra, Kalimantan, Sulawesi, and Papua. From these acreages, 9.65 million hectares have the potential to become agricultural land, but only about 13.5 percent of which was utilized (Euroconsult, 1995).

Land clearing of tidal land in Air Sugihan Kanan, Air Saleh and Telang I was purposed for transmigration program. The tidal land was given to the population of transmigration per head of household (COW) area of 2.25 ha. It consisted of business land I (1 ha), N II (2 ha) and 0.25 ha for garden. After some years occupied, some land was converted to others purposes, not cultivated or becoming fallow. While the cultivated land, planting patterns that are generally not the same applied, in a tertiary plot with other tertiary plot.

The areas of Delta reclaimed were not all used for business, but there is a conservation area, green lines, residential areas, location of economic activity. After occupied for the transmigration program has undergone many changes. It also built infrastructure to support community activities.

Based on hydrotopography type, the land reclamation was done by doing drainage channels which is likely to change a shift. Not available time series data to see a change in landuse patterns, park, condition of existing infrastructure, these often lead to make mistakes in decision-making development of the tidal area (Armanto, 2003).

Changes in landuse, conditions and information hydrotopography as well as planting patterns in the field can be more easily interpreted by the help of remote sensing technology without having to survey the entire region. While Infrastructure and other land conditions can be recorded through field observations and interviews with the community. Remote Sensing Technology in this case using Landsat TM image is able to detect various types of landuse, vegetation and pools. With such capabilities, the potential image is used as a means of identification of landuse, cropping patterns and hydrotopography of tidal land (Armanto, 2005).

B. Problem Definition

Problems that developed in the Sugihan Delta Kanan, Delta Saleh and Delta Telang I since reclaimed for transmigration program till today are follows, i.e. change in landuse patterns are difficult to be estimated area and its distribution in detail from year to year with conventional methods. Application of planting patterns that are not uniform and not suitable with the land condition especially in each secondary plots, thus it is causing low production. The variety of infrastructure condition in each delta, so it affected landuse patterns, land productivity and local community welfare. Conditions and design of various drainage networks are resulting in the availability of water in different fields and ultimately planting patterns and landuse vary also. Currently not available time series data of land development of tidal land is the main problem in developing land management plans and land improvement.

C. Research Objectives

This study aims to utilize remote sensing technology and GIS in knowing the distribution of landuse change and tidal land. From these conditions, it can be seen cropping patterns on each of the secondary block and its relation to the condition of the water system network.

IRESEACH METHODOLOGY

A. Place and Time

This research was conducted in the Air Sugihan Kiri, Delta Saleh Kecamatan Muara Padang and Mekarti Jaya and Delta Telang I Kecamatan Muara Telang Banyuasin District. The study was carried out from May to December 2008.

B. Materials and Equipments

Materials used in this study are: 1) Map of study sites reclamation network, 3) hydrotopography map, 4) Landsat TM image Path / Row 124/62 in June 1992 record, June 2001 and August 2002 that packaged in a CD-media ROM, 5) for data collection Questioner reclamation network conditions, planting patterns, tracking network. While tools used are as follows: *Global Position System* (GPS), Drill the ground, Peroxide (H_2O_2), Label, Elastic Band, Plastic sample, program of image interpretation tool Arc View GIS Tool 3.2 and stationery.

C. Research Methods.

Data processing and analyses were carried out in stages. The stages can be explained in the flow diagram of Figure 1. Data analyses included as follows:

1. ***Pre processing:*** Activities include image rectification process on a scale of 1: 50,000 which are doing the rotation, translation and geometric correction of remote sensing imagery to obtain the position and location in accordance with the position and location on the earth's surface in a Universal Transverse Mercator System *(UTM)*. It was followed by atmospheric correction to minimize variations in the value of an object under the influence of the spectral atmospheric particles and radiation of the sun.
2. ***Processing:*** This includes: 1) Sharpening the image contrast stretching and balancing. Special sharpening is also performed on the territory where there are shadows or cirrus clouds using contrast stretching the original data format 11, 2) Vectorisation including the process objects digitize landuse, roads, irrigation, rivers, settlements, fields, bushes, grass, etc. Delineation of each object was stored in the coverage area of different layers, so it is possible for the object of analysis in accordance with the objectives and specific needs, 3) Interpretation of land coverage of Landsat data based on the key remote sensing data interpretation, and 4) data format conversion of GIS of thematic maps include administrative, soil, slope, elevation, geology, climate, etc. into a digital map (Dadi, 2005).
3. ***Field Survey:*** The field survey aims to conduct field checking or verification of land coverage information and check the class boundaries, especially boundaries plantations
4. ***Analysis:*** This activity involves the analysis of availability and landuse pattern. Landuse pattern analysis is done by combining spatial information with land coverage of spatial information of land characteristics, analysis of changes carried out only in 1992; 2001 and 2002. This was done according to the availability of satellite images.

RESULTS AND DISCUSSION

1. Overview of the Delta Saleh

Delta Saleh is geographically located 105° 02'31" to 105° 33'66" BT and 2° 20'10" up to 3° 07'43" LS. Delta Saleh in northern is bordered limits by Bangka Strait, southern of the river Musi and Cinta Manis Transmigration area, bordering the eastern with River Saleh, while the western bordering with Upang River (Figure 2).

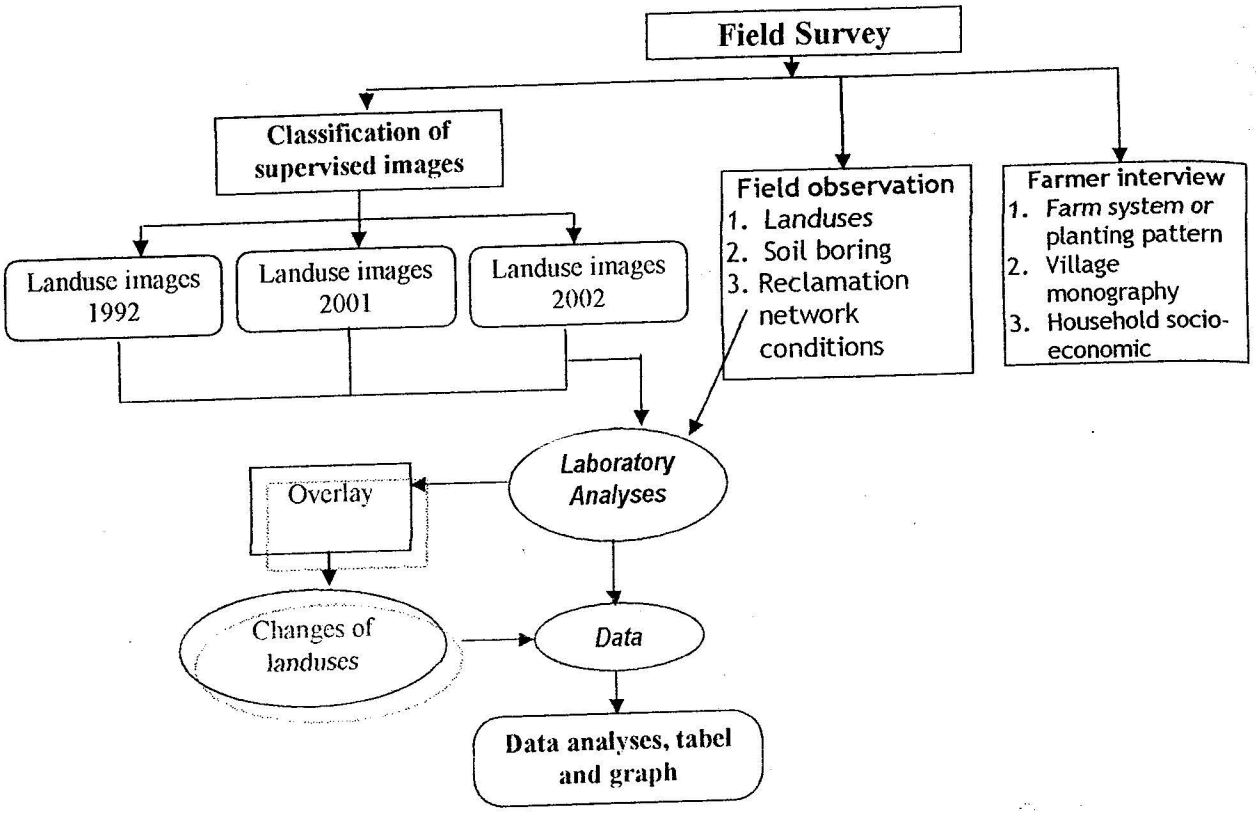

Figure 1. Flowchart of field activities and data analysis

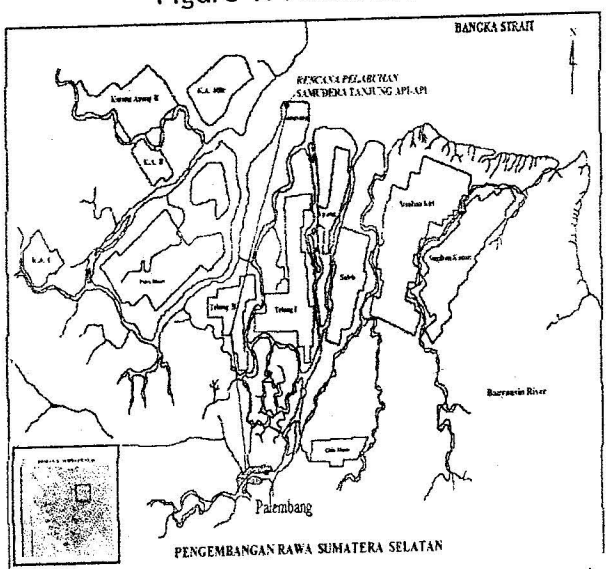

Figure 2. The map of reclamated swamp in South Sumatra

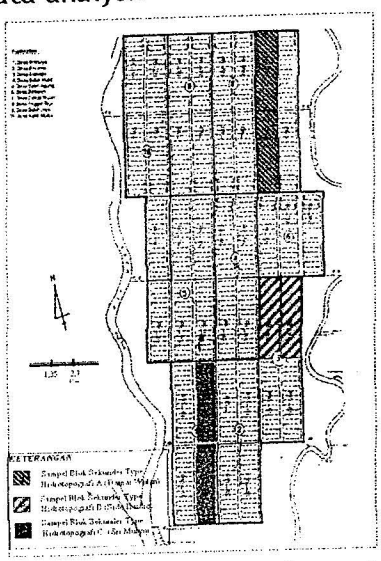

Figure 3. The hydrotophography map of Delta Saleh

Delta Saleh is a tidal land that is reclaimed and occupied migration began in 1981. According to Agricultural Research (1999), based on the type of land reclamation in its Saleh Delta hydrotophography, the flood type B has 1,856 ha area, type C is 5,630 ha and type D is covering 2,944 ha (Figure 3). The dominant land is a potential land area of 9,438 ha, and acid sulphate soil is around 992 ha.

2. Landuse Change Analyses

Delta Saleh was opened since the 1970's designed for transmigration program which is based on agricultural businesses. Since its opening until now in the Delta Saleh has undergone many changes in landuse. Landuse change mainly is because of the

pressure of population increases in order to fulfill the need for food also increased. Based on the results of Landsat image interpretation in 1992, the year 2001 and year 2002 in Delta Saleh, the acquired types of landuse is following on Table 1 to Table 3.

Table 1. Landuse in the Delta Saleh in year 1992

No	Landuse	Acreage (ha)	Percentage (%)
1	River /Water body	6,643.53	12.92
2	Primarily Mangrove Forest	3,259.44	6.34
3	Secondary Mangrove Forest	2,579.94	5.03
4	Brush	7,889.40	15.35
5	Upland /mix crops	7,410.87	14.41
6	Paddy fields	23,619.40	45.93
7	Coconuts	-	-
	Total	51,422.58	100

Source: Landsat interpretation and field survey (2008)

Table 2. Landuse in the Delta Saleh in year 2001

No	Landuse	Acreage (ha)	Percentage (%)
1	River /Water body	6,559.83	12.76
2	Primarily Mangrove Forest	1,318.56	2.56
3	Secondary Mangrove Forest	2,921.58	5.68
4	Brush	8,756.48	17.03
5	Upland /mix crops	9,924.89	19.30
6	Paddy fields	18,518.40	36.01
7	Coconuts	3,422.84	6.66
	Total	51,422.58	100

Source: Landsat interpretation and field survey (2008)

Table 3. Landuse in the Delta Saleh in year 2002

No	Landuse	Acreage (ha)	Percentage (%)
1	River /Water body	6,539.18	12.72
2	Primarily Mangrove Forest	2,068.56	4.02
3	Secondary Mangrove Forest	2,921.58	5.68
4	Brush	9,345.78	18.17
5	Upland /mix crops	9,206.24	17.90
6	Paddy fields	17,518.40	34.07
7	Coconuts	3,822.84	7.43
	Total	51,422.58	100

Source: Landsat interpretation and field survey (2008)

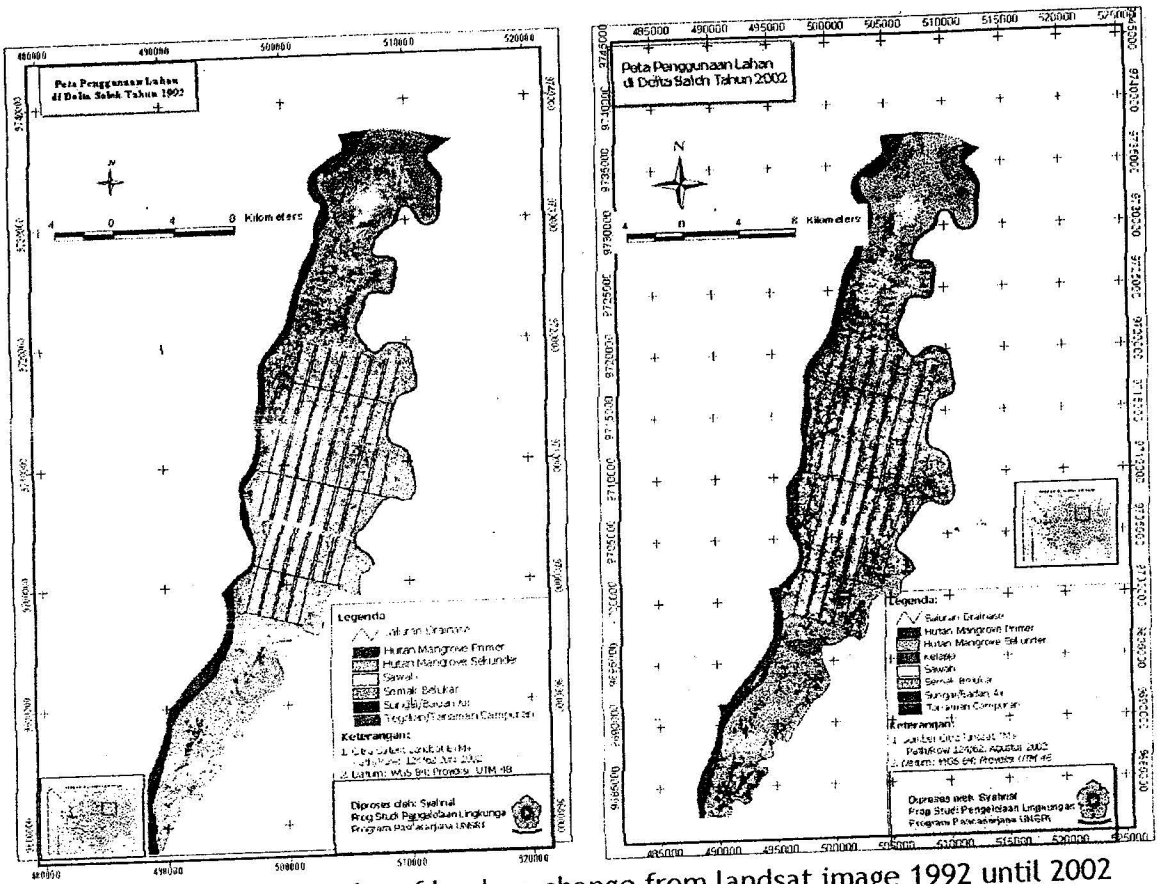

Figure 4. Analysis results of landuse change from landsat image 1992 until 2002

From the results of interpretation of Landsat images in 1992 and 2002, there were changes in the type of significant landuse from 1992 to 2002. Changes in landuse are even up to more than 100 percent, either increase or reduction.

Large decrease in the river or water body was from 6643.53 ha to 6539.18 ha or 1.60% down. This is expected because the narrowing of the body due to sedimentation of the river, and land in 1992 was still under water, because of the making of the channel by the tribe Bugis, so the land can be cultivated for paddy fields or coconut plantation. There are significant changes in the Primary Mangrove Forest, widespread decline around 1,940.08 ha (147.20%).

Direct interpretation resulted that most of the mangrove forest was converted into a secondary mangrove forest and scrub. This is presumably because the felling of mangrove forests and on the left just like that, so becoming the shrubs. On the other hand an increase in secondary mangrove forest area of 345.64 ha (11.81%) it is probably derived from primary mangrove forest in the cut so that a secondary mangrove forest.

Significant changes also occurred in the shrubs in 1992 the extent of 7,889.40 ha in the year 2001 and area of 8,756.48 ha, while in 2002 to 9,291.78 ha. Thus, in ten years it was an increase in area of 1,042.38 ha or 17.78 %. This happens because the mangrove forest cut down and then left alone so that the shrubs. Shrubs land also comes from fields that are not cultivated, it is because inadequate drainage infrastructure and lack of manpower and technology to work on these fields.

In 1992 the land area or an upland mixed crops was 7,410.87 ha area, in the year 2001 and increase to 9,924.89 ha and 9,206.24 ha. From 1992 to 2001 it was an increase of 2,514.05 ha (33.92%). Whereas in 2002, a decline number was 718.65 ha (7.24%) from the year 2001. This field caused by a lot of land that is not to be cultivated and becoming shrubs.

During the last ten years a decline in the paddy fields field was from 23,639.4 ha to 18,518.40 ha or 27.65%. This was due to conversion of paddy field to plantation crops (coconut), besides that, because the inadequate drainage facilities causes the water is not available in the fields so that fields cannot be cultivated.

In the year 1992 there have not detected any coconut plantation, while in 2001 showed an area of coconut plantation 3,422.84 ha and 3,622.84 ha in 2002. This land had been a paddy field or shrubs, most of these events in the north Delta Saleh. This is because of the activities of the tribe Bugis making channel to open the land into coconut plantations or paddy fields.

3. Relationship of Hydrotophography with the Landuse

To determine the effect of hydrotophography landuse patterns and farming systems, it was carried out detailed observations on several blocks that have secondary hydrotophography or different type of flood.

The observation in the village of Sri Mulyo, primary secondary block 10 South 2 (P10-2S) and P10-2N, mostly it is including category III or type C overflow or in other words, this land is not flooded by large and small pairs, but less ground water level of 50 cm. This information shows that this land could be used for paddy field, but need good water management. This land can also be used for plantation crops.

Observations in the village of secondary block Sido Harjo Q8 and Q8-6S-7s, mostly it was including category II or Type B flood (periodically inundated by the high tide, the surface soil above the water level below the lowest tide but high tide). This land could be used for information with paddy fields.

Damarwulan village in the secondary block P6-P6-7s and 7N, mostly it was including category I or type A flood (periodically inundated by the pairs of large and small pairs). This land is suitable for paddy fields. Landuse in each hydrotophography the year in 1992 and 2002 presented in Table 4. While landuse maps in each type of hydrotophography in 1992 and 2002 in Delta Saleh presented in Figure 5.

From the image interpretation results of 2002 shows the type of land as hydrotophography A (Damarwulan Village Primary Secondary 6 Block 7 South (P6-7s) and (P6-7N) in 2002) most of the landuse was for paddy fields 250.28 ha -262.80 ha (62.72% -65.59%) of these secondary block area. Upland crops or mixed crops was in the second place 90.66 ha - 10.736 ha (22.72% -26.80%).

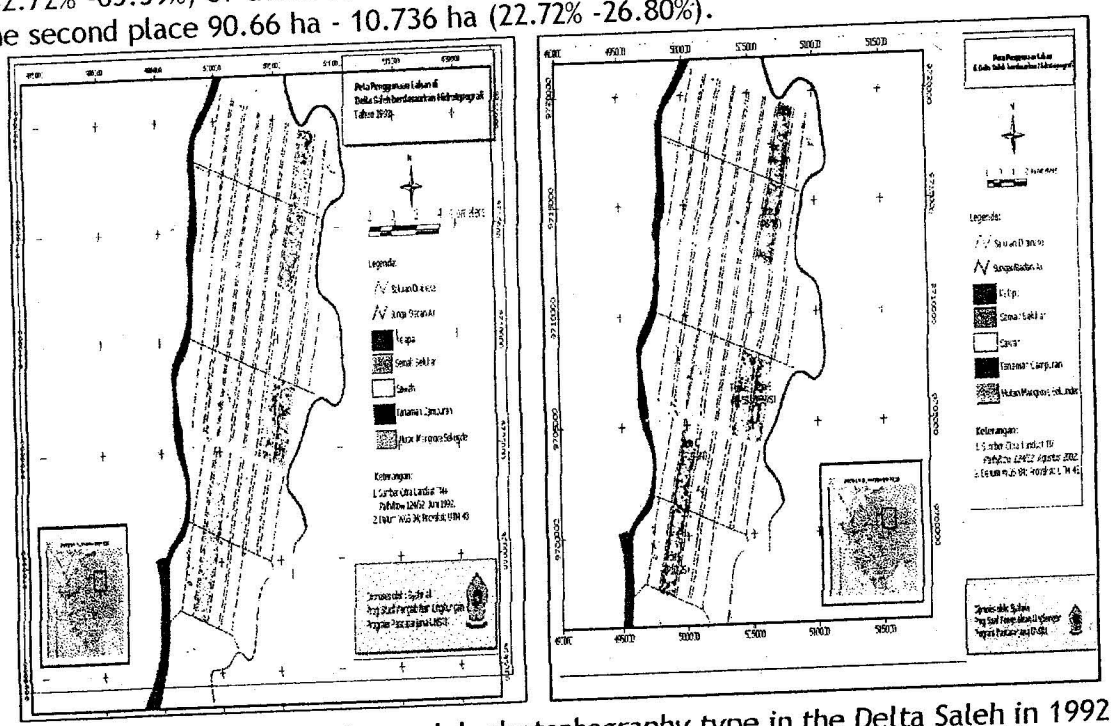

Figure 5. Landuse maps for each hydrotophography type in the Delta Saleh in 1992 and 2002

In the type of land in the village hydrotophography B Sido Hardjo (Q8 and Q8-6S-7s) shows that the largest fields ha or 283.14 -314.20 ha (70.70 to 78.48%). While the upland crops were in the second place. On this site, channel or water body was not interpreted because the channel was covered with grass. At this location is not found in coconut plantations, because of its location is far away from the river so that the coconut is less fertile.

Land that has hydrotophography type C in the village of Sri Mulyo (P10- 2S and P10-2N), identified as paddy fields around 283.03 -300.41 ha (70.66 to 75.02%). Dry Field area in second place 94.85 - 102.78 ha (23,69-25,66%). Coconut occupies the smallest area of 0,09-0,27 ha, planted with coconut usually planted in garden.

From the GIS analysis indicated that the uncultivated land or shrubs was in the largest type of hydrotophography A 10.80 ha (2.70%) ha and the smallest in hydrotophography C is 2.97 ha (0.74%). From these data show that although type A is still a lot of land is not utilized due to lack of appropriated drainage network conditions, so there is land that is flooded, and there is a drought.

Image analysis showed the greatest changes in landuse occur in the type of area hydrotophography A was 123.31 ha in the Secondary Block P6-7s and 130.31 ha in the Secondary Block P6-7N. The biggest change in the paddy field to reach 48.64%, decreased area changes, the broad field of 1992 reached 80.29% of the secondary block, whereas in 2002 the area was decreased 65.59%. Widespread decline of this field is due to the drainage channels that are not equipped with proper infrastructure to support so that land can no longer be used as paddy fields. Beside that lack of technology of land cultivation that causes farmers could not work on all the land he owned.

From the results of imagery landsat interpretation and field observation for ten years, changes in landuse this field into the shrubs land, upland crops or a mixed crops and coconut trees. This is reflected by an increase in the shrubs area in 1992 covering 15.23 ha (3.81%) to 37.53 (9.41%) in 2002 for a secondary block, and the addition of coconut was 11.16 ha in 2002.

Wide-enhancing land also occurred in the field or mixed crop. In 1992 its extent was 52.58 ha and 62.73 ha (13.14% and 15.69%) while in 2002 reached 90.66 ha or 107.36 (22.72% and 26.80%). Changes occurred for 22.65% and 44.06%. This increase occurred because the water is not sufficient that a mix plants that do not require so much water.

On hydrotophography B in Sidoharjo Village (Q8 and Q8-6S-7S), it occurred reduction of the shrubs area 25.00 ha and 48.71 ha (6.24% and 12.19%) in 1992 to 18, 58 ha and 12.78 ha (4.64% and 3.19%) in 2002. This was caused a lot of shrubs land in many open fields or crops to be mixed crops. This is reflected in the increasing expansion of the mixed crops in 1992, covering 55.17 ha and 70.12 ha (13.78% and 17.55%) and increased to 104, 57 ha and 102.78 ha (26.11% and 25.66%) in 2002, in other words an increase in area of 12.42 ha and 34.45 ha (50% and 43.37%).

While on hydrotophography C land the village of Sri Mulyo (P10-P10-2S and 2N), it declined fields of 59.37 ha and 57.35 ha (45.24% and 38.97%). The same thing happened in the shrubs decrease of 6.21 ha and 15.40 ha (4.73% and 47.43%). From field observations and images showed changes paddy fields and shrubs is a field or crop mix, it is seen with increasing upland crops 61.98 ha of mixed crops and 73.42 ha (47.23% and 47.43%). This happens because of lack of water and the dry land can only be planted with crops.

4. Farm System

Farmers in Saleh Delta come mostly from Java. Land is allocated for transmigration area of 2 ha, consisting of Business Land I (LU-I) 1 ha and Enterprises Land II (LU-II) 1 ha.

Table 6. Planting patterns and agricultural production in the Delta Saleh

No	Location/ Village	Planting patterns			
		MT-I		MT-II	
		LU-I	LU-II	LU-I	LU-II
1	Damar Wulan (P6-7N)	Paddy (84,37%) Coconut (6,25%) Coconut+Paddy (9,38%)	Paddy (71,8%) Coconut (12,5%) Fallow (15,7%)	Coconut+Fallow (9,38%) Coconut (6,25%) Fallow (84,37%)	Fallow (87,5%) Coconut (12,5%)
2	Damar Wulan (P6-7S)	Paddy (85,93%) Coconut (4,69%) Coconut+Paddy (9,38%)	Paddy (88,2%) Coconut+Paddy (2,34%) Fallow (9,38%)	Coconut+Fallow (9,38%) Coconut (4,96%) Fallow (85,93%)	Coconut+Fallow (2,34%) Fallow (97,64%)
3	Sidoharjo (P8-6S)	Paddy (80,46%) Paddy+Vegetable (9,38%) Fallow (10,16%)	Paddy (92,97%) Fallow (7,03%)	Vegetable+Fallow (7,03%) Vegetable (3,90%) Fallow (89,07%)	Fallow (100%)
4	Sidoharjo (P8-7S)	Paddy (84,37%) Vegetable+Paddy (12,5%) Fallow (3,13%)	Paddy (89,84%) Vegetable+Paddy (10,16%)	Vegetable (12,5%) Fallow (87,5%)	Fallow (100%)
5	Sri Mulyo (P10-2N)	Paddy (84,37% Coconut+Paddy (6,25%) Coconut (0%) Fallow (3,13%)	Paddy (86,75%) Fallow (13,28%)	Coconut+Fallow (6,25%) Coconut (6,25%) Fallow (86,75%)	Fallow (100%)
6	Sri Mulyo (P10-2S)	Paddy (93,75%) Coconut+Paddy (6,25%)	Paddy (100%)	Corn (15,63%) Coconut+Fallow (6,25) Soya (6,40%) Fallow (71,72%)	Corn (6.4%) Fallow (95,6%)

Source: Landsat interpretation and field survey (2008)

From Table 6 in the Village Damarwulan represented by hydrotophography type A in Block Secondary (P6-7N) showed the Season Planting (MT)-I. LU I mostly was cultivated for paddy fields (84.37%) and 9.38% was planted with coconut along boundaries of Paddy fields in order to increase farmers' income. LU-II was still dominated by Paddy fields 718%, but the LU-II in MT-I still have fallow of 15.7%

Whereas on the MT-II, both LU-I and LU-II, most of area was not cultivated (fallow) 84.37% on the LU-I and 87.5% on the LU-II. Generally on the MT-II, the land was fallowed due to lack of irrigation infrastructure which cause flood on the land.

In the secondary block (P6-7S) on the MT-I, both LU-1 and MT-II, mostly only paddy fields was cultivated (85.93%) in the LU-1 and (88.2%) in the LU-II, while on the MT-II generally, it was followed by farmers.

The same thing it happened in the Village Sidoharjo (Q8-6S) and (Q8-7S), it was a land type B. In both MT-I both LU-I and LU-II were dominated by paddy fields (more than 80%). In this village LU-I is not only cultivated monoculture, but also intercropping between Paddy fields and Vegetables 12.5% in the LU-I and 10.16% in the LU-II.

On the MT-II most of land was fallow mainly in the LU-II (100%), whereas in the LU-1 is still planted vegetables (11.01%). This is because the land is relatively dry although its drainage infrastructure does not work; farmers can still grow vegetables, if only to meet the needs of their own households.

In the type C land in Sri Mulyo village (P10-2N) in both MT-1 both for LU-I and LU-II all were planted with paddy fields, although there is intercropping with coconut trees. While on the MT-II, the land was fallowed because the drainage network is not functioning, and not equipped with water gates in the end the water shortage plants.

In the secondary block (P10-2S), on the MT-1 93.75% -100% was cultivated with paddy fields, while on the MT-II, the LU-I there cultivated corn 15.63%, 6.40% soybean., at this location is technically in the MT-II can still be cultivated both grain and cash crop, because it was equipped with facilities adequate drainage network, but it was clean channels, the drainage systems are equipped with water gate. Only socio-economic problems are causing farmers cannot plant twice of paddy fields.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

1. *From the analysis of satellite imagery and field surveys indicate that over the* last ten years a decline in the paddy field area of 23,639.4 ha to 18,518.40 ha or 27.65%.
2. *Decreasing* river acreage or water body also occurs from 6,643.53 ha to 6,539.18 ha or fall 1.60
3. In the year 1992 it have not detected any coconut plantation, while in 2001 showed an area of coconut plantation 3,422.84 ha and 3,622.84 ha in 2002.
4. *Significant changes* are also presented in primary mangrove forest, widespread decline around 1,940.08 ha (147.20%). Direct interpretation results that most of the mangrove forest was converted into secondary mangrove forest and scrub.
5. *Linkage with land hydrotophography class showing that* the land with hydrotophography A type was majority for paddy fields 250.28 -262.80 ha (62.72% -65.59%). Mixed crop fields were in second place with acreage of 90.66 - 10,736 ha (22.72% -26.80%).
6. To land with hydrotophography type B showed the widest paddy fields (283.14 - 314.20 ha or 70.70 - 78.48%), followed by upland crops.
7. The land with hydrotophography type C, identified broad paddy fields was 283.03 -300.41 ha (70.66 to 75.02%), followed by upland crops 94,85-102,78 ha (23,69-25,66%), and coconut was the smallest 0,09-0,27 ha.
8. Planting pattern, generally IP-100 on MT-I both Land Enterprises (LU)-I and LU-II planted with paddy fields, while the MT-II are generally not cultivated land (Fallow

Advice

Necessary control measures reducing mangrove forest area and green area around the river delta of tidal marsh. This condition occurs due to water systems in areas that lack adequate swamp, so that farmers can only use the land for planting paddy fields once. As a result they are looking for new acreage, and only use minimal technology without considering the aspects of conservation. Water system infrastructure improvements must also be balanced with the increased role of institutional and empowerment of farmers.

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