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Zonation Compatibility on Forest Mangrove Area in Delta Mahakam, East Kalimantan Indonesia

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Abstract —Delta Mahakam, Kutai Kartanegara regency, is considered has huge and complete water resource. The ecosystem of coastal areas is consisted of mangrove, sea grass, coral reefs; natural resources of coal, oil and gas, and also fisheries resource. The objective of this research was to (1) Study the land use pattern of forest aquaculture area (KBK*)* in Delta Mahakam, and (2) Analyze the zonation compatibility of KBK in Delta Mahakam. The research method; the research was conducted in Muara Badak sub district (Muara Badak Ulu, Salo Palai and Saliki village) and Anggana sub district (Tani Baru, Muara Pantuan and Sepatin village). The data was taken using exploratory descriptive and purposive sampling method followed by data analysis and compatibility analysis. The result showed that the land use pattern of KBK in Delta Mahakam consisted of fishpond area accounted by 45,325 ha, mangrove/palm/swamp shrub area by 20,971.52 ha, open space/residential area by 18,651.54 ha and swamp forest area by 24,972.28 ha. Zonation compatibility of KBK in Delta Mahakam showed that the miss use of coastal management was 62.28% which consisted of fishpond area 44.16% and open/residential area 18.12%. Some recommendations formulated from academic point of view were as follows: research on *KBK* mismanagement effect in Delta Mahakam due to fishpond activities against the quality of environment, biodiversity and regional economy, and also research on economic and social losses due to zonation incompatibility of KBK in Delta Mahakam are needed to be done. It also recommended a regulation formulation on reformation of land use planning in Delta Mahakam and its regulation implementation so that KBK will conform to the current utilization purposes is needed to be addressed and legalization on regional regulation concerning on Strategic Land Use Planning of Delta Mahakam is immediately needed to be conducted.

Keywords — *compatibility; zonation; forest mangrove area; KBK, Delta Mahakam*

I. INTRODUCTION

Delta Mahakam area has a rainfall of more than 5 mm/hour, flowing water and sediment over 900 km2 along Mahakam river to its mouth at the Makassar strait which has strong current of north and south. Several mouths are estuaries zone with sand deposit found in the middle and south zone. Bourgeois *et al.* (2002) stated that erosion is occurred at the north side and the lowest sand is at the south side of Delta Mahakam with have wide and muddy coastal area. Mangrove ecosystem and small area of sea grass and coral reef can be found in coastal area. Besides, Mahakam watershed creates estuaries characteristic at the river mouth and Delta Mahakam area (e.g. Dutrieux, 1991; Aspar, 2001; Sidik, 2008). The complexity of ecosystem produces high resources both in fossil resource (coals, oil and natural gas) or fisheries resources in the coastal area (Bengen *et al*., 2003).

Business activities run in coastal area in Kutai regency are catch and pond fishing. But nowadays, since the increased of fish catching activities over time has caused to declined number of fishes and has led to growing activities in shrimp and milkfish pond (Dutrieux, 1991; Hopley, 1999).

In the 1990, Indonesian National Land Office (BPN) issued a decree for the possibility of someone having a letter certificate of land ownership in the Mahakam Delta, but a year later (1991) it was stated that the area belongs to forest aquaculture area (KBK) categorized in stable forest production area. Under this status, according to the Decree of the Ministry of Forestry Number 79/Kpts-II/2001 about Forests and Waters Designation Area in East Kalimantan region covering 14,651,553 ha, this area should not be converted into other functions other than forestry purposes (Local Development Planning Bureau of Kutai Kartanegara Regency, 2002).

Zonation is performed by determining zone for environmental system, agrarian and suitable land use purposes. Zone of suitable land use purposes is especially determined for sea conservation, fish catchment, arise soil, green belt, fish pond, intensive and extensive agriculture, residential and industrial purposes (e.g. Monserud and Leemans,1992; Hagen, 2003). For related stakeholders,

mangrove zonation is also designed for rehabilitation activities (Gunawan, 1998). The implementation of KBK should be not exploited due to of its status. But, the current situation shows different facts which show miss function and over exploitation. Due to this reason, the research was designed to study the real situation regarding of the zonation and utilization of the area. A question emerged "is KBK zonation designed based on the regency land use plan?". A related study on formulating better area management is needed in order to analyze the zonation compatibility of KBK in Delta Mahakam. The research is aimed at analyzing the KBK zonation compatibility in Delta Mahakam which designed to study the land use pattern and analyze the zonation compatibility of KBK in Delta Mahakam.

II. MATERIALS AND METHODS

Field work was conducted in July-December 2012 in Delta Mahakam area, Kutai Kartanegara regency, East Kalimantan province. Administratively, Delta Mahakam includes five sub districts in Kutai Kartanegara regency i.e. Muara Badak, Sanga-Sanga, Anggana, Muara Jawa and Samboja.The study was located in two sub districts i.e. Muara Badak and Anggana. In Muara Badak, the study was located in three villages i.e. Muara Badak Ulu, Salo Palai and Saliki while Anggana taken place in Tani Baru, Sepatin and Muara Pantuan village. These locations were selected due to the presence of KBK in this area and also present as wide sub district area in Delta Mahakam.

A research on zonation compatibility analysis on KBK was focused on zonation area which had been stated in Kutai Kartanegara regency in 1999 and the decree of Minister of Forestry (MoF) Number 79/Kpts-II/2001 about Forests and Waters Designation Area in East Kalimantan. According to land use plan of Kutai Kartanegara regency in 1999 and land use plan map of East Kalimantan province based on MoF's decree Number 79/Kpts-II/2001, KBK zonation is designed in three sub districts i.e. Muara Badak, Anggana and Muara Jawa. As stated in land use map of Kutai Kartanegara regency, KBK in Delta Mahakam covers 102,632.95 ha from the total delta area accounted by 109,919.95 ha. The total area including administrative boundaries of coastal villages is 225,914.21 ha. Table 1 shows the area of Delta Mahakam by each villages and sub districts. The research found that Delta Mahakam area was 8.2% of the total area of Kutai Kartanegara regency which was equal to 2,726.310 ha.

Based on the data analysis, it could be found that Anggana sub district was the widest sub district in Delta Mahakam regency accounted by 111,279.48 ha or equal to 50% of the total area of Delta Mahakam and followed by Muara Badak with 70,670.68 ha or equal to 31.3% of the total area of Delta Mahakam. Several main points for analyzing the zonation compatibility of KBK are as were as follows: 1) the pattern of land use zonation, 2) the pattern of existing land use, 3) the pattern of miss uses, and 4) recommendations on policies and strategies for KBK zonation management in Delta Mahakam.

Tabel 1. Delta Mahakam Area by Each Sub Districts and Villages

Sub District	Sub District Area (Ha)	Village	Village Area (Ha)
Muara Jawa	35,696.65	Muara Jawa Ulu	4,195.51
		Muara Jawa Tengah	6,625.77
		Muara Jawa Ilir	13,451.03
		Muara Kembang	5,216.75
		Dondang	4,304.90
		Tamapole	1,902.69
Muara Badak	70,670.68	Saliki	24,286.72
		Salo Palai	1,487.14
		Muara Badak Ilir	32,664.33
		Muara Badak Ulu	12,232.48
Anggana	111,279.48	Tani Baru	21,398.01
		Anggana	2,238.09
		Handil Terusan	13,761.38
		Kutai Lama	23,428.70
		Muara Pantuan	10,359.51
		Sungai Meriam	411.49
		Sepatin	39,682.32
Samboja	5,724.69	Muara Sembilang	5,724.69
Sanga-sanga	2,542.72	Sanga-sanga Muara	833.32
		Pendingin	1,709.40
The total area of Delta Mahakam			225,914.21

The variety of pattern approaches regarding the utilization and management of KBK zonation area in Delta Mahakam among stakeholders are potential to generate frictions between them. Frictions and conflicts concerning on utilizing coastal area in KBK in Delta Mahakam has occurred between traditional pond farmers with oil and gas companies. The KBK zonation compatibility analysis in Delta Mahakam was conducted through several approaches i.e. compatibility analysis in order to determine the miss use of existing KBK zonation area against land use plan of Kutai Kartanegara regency. Remote sensing and Geographic Information System (GIS) analysis were used to identify the form of existing KBK area utilization. SIG analysis provides compatible analysis which will support better planning on development program. The input data of SIG can be obtained from any sources that will be presented in the format of map and digital database.

Related to the objectives of this research i.e. zonation compatibility analysis of KBK area, the identification process on existing pattern of KBK zonation area used Citra Landsat Thematic Mapper 2009. The produced map was then compared to Land Use Plan of Kutai Kartanegara regency in order to determine the miss use of KBK zonation area.

III. RESULTS AND DISCUSSION

Kutai Kartanegara has an area of 27,263.10 km2 lies between 115°26 W and 117°36' Elongated and 1°28' N and 1°08' S latitude. Administratively, the regency is surrounded by Malinau at the north side, East Kutai

regency and Makassar strain at the east side, Pasir regency at the south side and West Kutai regency at the west side.

Kutai Kartanegara is divided into 18 sub districts i.e. Samboja, Muara Jawa, Sanga-sanga, Loa Janan, Loa Kulu, Muara Muntai, Muara Wis, Kota Bangun, Tenggarong, Tenggarong Seberang, Sebulu, Anggana, Muara Badak, Marangkayu, Muara Kaman, Kenohan, Kembang Janggut and Tabang. It has several rivers spread along the sub districts which then become the main transportation besides of land transportation. The longest river is Mahakam River that flows along 920 km. Muara Badak subdistrict is located at the north side of Delta Mahakam. Most of residents are immigrants with *Bugis* as dominant ethnic. The economic activities are fishermen and farmers using bus, motor cycle, *ketinting* and motor boats as their mobility access.

Among three villages, it is known that Saliki village has the most fishpond aquaculture households (RTP) which accounted by 1,475. Badak Ilir village also has the most sea aquaculture households which accounted by 1,905. Generally, there is no village which had water and fish cages farming aquaculture households

Table 2. The Number of Aquaculture Households by Villages in Muara Badak Sub District

Sub District/Village	Fispond	Sea Fisheries	Total
Muara Badak sub district	4,360	1,647	6,007
Muara Badak Ulu village	1,775	361	2,136
Salo Palai village	115	69	184
Saliki village	1,475	21	1,496

Anggana sub district is the center of fish pond activities in Delta Mahakam reaches up to 48.488 ha wide and 7,633.3 tons of fish production. Fish ponds (*kolam*) and fish cages (*karamba)* farming only produce 7.6 and 20.9 ton, respectively. Mostly, the community's economic activity is fishpond farmers. Among three locations used in this study are, Sepatin and Muara Pantuan havefishpond aquaculture household of 695 and 518, respectively. While no aquaculture households are found for fish cages, sea and water fisheries in these three villages.

East Kalimantan is one of provinces which have various coastal systems due to human activities influences. Oil and gas exploration have been widely found in the coastal area of East Kalimantan. Rivers are wide and flowing up to 400 km. As a comparison, In West Java, the rivers only reach up to 60 km long (Detrieux, 2001).

It has been known since tertiary era that rivers in East Kalimantan have developed delta system and this process still continue. Some formation of delta that can be found is prograding deltas such in Delta Mahakam and also tides delta such in Delta Berau. The variety of ecosystem with its diversity (coral reef, sea grass, mangrove and fish) is influenced by the abiotic condition such as the presence of suspended sediment (turbidity), nutrition availability, current dynamic and tides. While in the water area of Delta Mahakam, sea habitat such as coral reef and sea grass is not found due to the quality of water and oceanographic factors which do not support their live (Detrieux, 2002).

Table 3. The Number of Aquaculture Households by Villages in Anggana Sub District

Sub District/Village	**Pond**	**Fish Cages**	**Total**
Anggana sub district	1,714	43	1,757
Sepatin village	695	0	695
Tani Baru village	262	0	262
Muara Pantuan village	518	0	518

Source: Anggana sub district in number (2012)

Delta Mahakam is placed at the eastern coastal of Kalimantan island with Mahakam river which has 920 km long and becomes the longest river in Indonesia. The watershed of Mahakam is 98.194 km2 wide. Administratively, Delta Mahakam belongs to five sub districts i.e. Muara Badak, Anggana, Muara Jawa, Sanga-sanga and Samboja that lies between 117°15' - 117°45' E of longitude dan 00^{c}15' - 01°00' S latitude. In the coastal area of East Kalimantan Province, Delta Mahakam represents modern delta which formed after Holocene process about 10,000 years ago (Allen and Chambers, 1998). The delta was formed into fan-shaped with ±1,800 km2 and influenced by fluvial factors and sea level variations. Delta area is not affected by storm surge located in ashallow area with a distance of about 25 km from the deep sea with a tidal ranges up to 2.9 m (Allen and Chambers, 1998). Geologically, the delta is divided into three parts, i.e.: 1) delta plain is a delta which have mud flats that mostly is marshy. Part of the mouth area is called upper delta plain, whereas that juts into the sea is called the lower delta plain; 2) Delta front is a sandy tidal area or exposure delta; 3) Pro delta is area which is composed of tempting stone that juts into the open sea area and is always flooded by sea water.

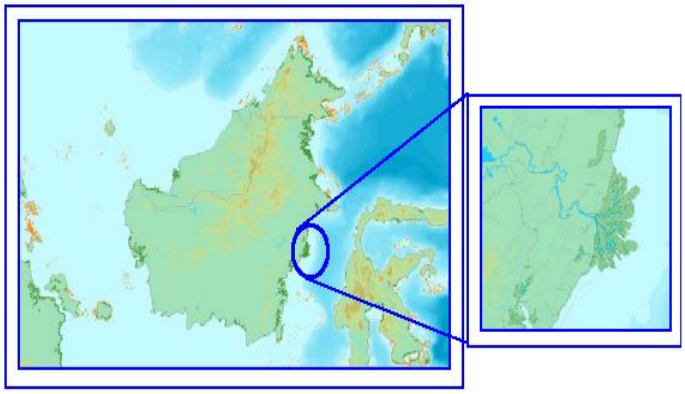

Figure 1. The location of Delta Mahakam in East Kalimantan province, Indonesia

Each of delta area has specific vegetation that mostly belong to mangrove vegetation, except the up stream of upper delta plain. Nibung is mostly found in upper delta plain while palm is mostly found in upper delta plain and lower delta plain which containes brackish water and saltwater. Avicennia sp dominates the lower delta plain containing salt water and slightly brackish (Sidik, 2008). This vegetation, particularly in lower delta plain has started to destroy due toheavy land clearing for shrimp pond aquaculture.

Delta Mahakam is created from sedimentation process by the rivers flowing to the mouth side. The main factor in the delta formation is high sedimentation supply carried

by rivers and a decrease in basic basin where sediment is deposited. However, the configuration of Delta Mahakam formation is controlled by several factors (Allen dan Chambers, 1998) as follows: a) the coastal morphology, shoreline configuration, the slope of bottom coastal area, b) the direction and intensity of the waves from the open sea, c) the number of coastal sedimentation transport associated with the sediment distributary (the main river in the delta), and d) the effect of the tides.

Geologically, Delta Mahakam has developed since million years ago that continue its sediment accumulation in Mahakam river to Makassar strait. The distribution of ancient delta has been lifted in the mainland of East Kalimantan and formed elongated hills from Semberah in the north, Sanga-Sanga, Pamaguan, Mutiara, and Samboja in the south side. However, Delta Mahakam is now defined as modern delta which forms islands that are arranged into fan-shaped morphology at the mouth of Mahakam River into Makassar strait.

Thus causes Delta Mahakam is surrounded by fan-shaped morphology composed of islands through distributary rivers (branches of) Mahakam River. Delta border to the mainland of Kalimantan is a distributary river that pass on the east coast of Kalimantan island i.e. Muara Berau distributary that flows to the north and to Muara Jawa distributary that flows to the south. The starting point of delta is Tanjung Una located at Sanga-Sanga in the mouth of Mahakam River. The boundary of Delta Mahakam as mentioned above is in accordance with the boundaries used in the previous researches such as Allen et al (1975) or Dietrieux (1999).

Bourgeois *et al*. (2002) had identified land cover changes in Delta Mahakam for several period: 1) prior to residential settlement, 2) in 1992, 3) in 1996, 4) in 1999 and 5) in 2001 (see Fig. 2). Findings are briefly described as follow: prior to residential settlement in 1950, the original vegetation in Delta Mahakam is mangrove forest. The first map of the delta showed the condition from upstream to the sea: a mixing succession of fresh water forest, fresh water mangrove, mixed of palm and *api-api* plant also with dense degraded mangrove forest. The total area was approximately 106,000 ha. Palm was main variety that contributed 55% of the total delta while the fresh water mangrove only accounted by 17% and dense fires. In these present days, Delta Mahakam is known as the world's largest palm vegetation.

Further change in land cover condition of Delta Mahakam was occurred in 1992. Bourgeois *et al.* (2002) explained that on those days, the fishponds appeared on the map especially in Muara Pantuan at the ex-coconut plantation acre as along the delta off shore. The total fishpond area in Delta Mahakam in 1992 was 3% of the total delta area which increased up to 120,000 due to the increased of aquaculture area along the coastal in the island. In 1992, the effect of fishpond clearing against the ecosystem was very limited. Delta Mahakam was dominated by palm, fresh water mangrove and dense fires with similar proportion as in previous period. Fig.2 shows the land cover changes of Delta Mahakam in 1992.

Land cover in Delta Mahakam in 1996 was indicated with obvious marks. Even palm still dominated the total area by 48% but this number of vegetation had decreased. Fresh water mangrove was the second largest and still left untouched. The fundamental change was presented by huge land cover change of fishpond area showing 14% change of the total delta or the third largest land cover change. The fishpond had been built by converting 5,000 ha of palm area, 2,000 ha of palm and scanty fires area, 1,600 ha of dense fires and 1,500 ha of degraded forest area. Land clearing for the fishpond area was conducted in several places showing obvious pattern from the inner side of delta to the outer side at the edge of delta. The specific thing occurred here was that residential is settled around the resources area (Bourgeois *et al*., 2002) (see Fig. 2).

In 1999, the map showed dramatic changes in palm vegetation. Bourgeois *et al.* (2002) stated that about 36,000 ha of palm area had been converted into fishpond or prepared-fishpond in the next 3 years. The land cover of dense fires also showed changes about 3,700 ha and 5,500 ha of palm and dense fires. Another important value was indicated by 5,500 ha of fresh water mangrove that was prepared for fishpond area.

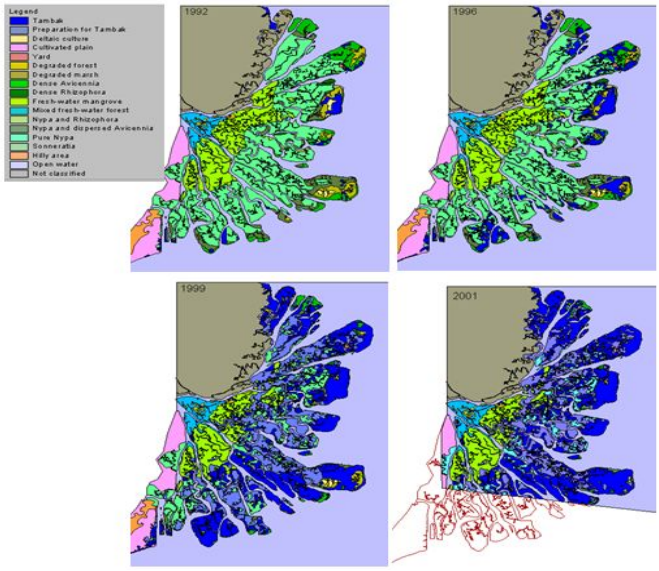

Figure 2. Land cover changes of Delta Mahakam in 1992, 1996, 1999 and 2001 (Bourgeois *et al*., 2002)

It should be consider that fresh water mangrove should not be converted for fishpond due to insufficient salinity. A conversion on this ecosystem to fishpond area was due to physical and chemical changes of the delta environment where there was an intrusion of sea water into the river mouth. Fishpond dominated the area by 63% consisted of productive area by 34% and prepared-fishpond area by 29%. While the original palm only occupied 15% of the delta which only showed little difference with fresh water mangrove (11%) and mixed fresh water forest (3%) (see Fig. 2).

In 2001, Bourgeois *et al.* (2002) stated that this year is the peak land cover changes in Delta Mahakam. Even the map of 2001 does not present the entire delta but the 90,000 ha have been matched with other map data (110,000 ha). In this year, fresh water mangrove and fresh water forest was almost disappear due to the increased number of fishpond area accounted by 75% of the total delta area. It consisted of production area with 50,000 ha

and prepared area with 31,000 ha. About 7,000 ha of palm area had been converted. Dense fires, degraded forest, palm and scanty fires which accounted by 6,000 ha in 1999 were decreased to 2,500 ha in 2001. Palm area was only 8% and fresh water mangrove was 11%. Fig. 2 shows land cover changes of Delta Mahakam in 2001

Delta Mahakam has important role in terms of economic on local, regional and national scale. This is due to the oil and gas resources which had been developed since the Dutch colonial era. Based on gross regional and domestic product (PDRB) of Kutai Kartanegara, oil and gas sector contributes about 70% to the local economic development. Therefore, the province of East Kalimantan very depends on this sector. Fisheries sector is another economic source which gives important contribution for the coastal community which also provides significant contribution for local government. For example, frozen shrimp export reached USD 182,685,106.79 which exported to European, America, Japan and others Asia countries (Marine and fisheries bureau of East Kalimantan, 2012).

But unfortunately, the economic success derived from the fisheries sector is not followed with good spatial planning. This is reflected by the massive expansion of aquaculture which converts mangrove forest in Delta Mahakam. Furthermore, the oil and gas and fisheries show negative externalities. The farmers and fishermen blame oil companies for causing crop failures and damage to their catchment area. In the other side, oil and gas companies believe that their slow exploitation is occurred due to this social conflict.

Based on SIG analysis, it was known that Delta Mahakam occupied 225,914.24 ha which consisted of five coastal sub districts in Kutai Kartanegara regency. It was calculated that Anggana sub district had the largest area with 111,279.48 ha or 49.3% of the total area of Delta Mahakam. Followed by Muara Badak sub district with 70,670.68 ha or 31.3% of the total delta area. The smallest sub district was Sanga-Sanga with only 2,542.72 ha or 1.13% of the total area. While the largest village was Sepatin with 39,682.32 ha and followed by Muara Badak Ilir (32,664.33 ha) and Saliki (24,286.72 ha).

Remote sensing, SIG and field survey based on actual condition were carried out in order to define the existing utilization of Delta Mahakam and KBK in Delta Mahakam. Based on the satellite image processing using Landsat Thematic Mapping 2009 path/row: 116/60-61 and SIG, it had been known that Delta Mahakam area was 109,920.06 ha (included delta and small islands) while the KBK of Delta Mahakam was 102,632.97 ha. The utilization area of 109,920.06 ha of Delta Mahakam was for: 1) fishpond area, 2) mangrove/palm/shrub swamp area, 3) residential area, and 4) secondary swamp forest area. Calculation resulted that fishpond, mangrove/palm/shrub swamp, residential and secondary swamp forest area in Delta Mahakam were accounted by 45,325 ha, 20,971.52 ha, 18,651.54 ha, and 24,972 ha, respectively.

This presented that the land uses for fishpond area was the largest accounted by 41.2% of the total area of Delta Mahakam followed by secondary swamp forest by 22.7%. Table 4 shows the existing land uses of Delta Mahakam.

Aquaculture area is an area designed for fisheries cultivation as the main function which built based on natural, handmade and human resources. Local Development Planning Bureau of Kutai Kartanegara regency (Bappeda) (2006), the aquaculture area in Kutai Kartanegara regency consisted of stable production forest, limited production forest and convertible production forest and non-forest aquaculture area (NKBK). The NFAA includes area for agriculture, plantation, animal husbandry, fisheries and mining, residential, industry, mining and tourism purposes.

Table 4. The Existing Land Use of Delta Mahakam

Sub District	Village	Land Use	Area (Ha)
Muara Jawa	Muara Jawa Ulu	Fishpond	216.11
		Mangrove/palm/swamp shurb	993.91
		Resedintial	419.79
		Secondary swamp forest	164.56
	Sub Total		1,794.37
	Muara Jawa Tengah	Fishpond	1,798.37
		Mangrove/palm/swamp shurb	353.41
		Resedintial	970.40
		Secondary swamp forest	196.29
	Sub Total		3,318.13
	Muara Kembang	Fishpond	2,491.34
		Mangrove/palm/swamp shurb	3,268.85
		Resedintial	2,374.76
		Secondary swamp forest	1,083.83
	Sub Total		9,218.78
	Total		14,331.28
Muara Badak	Saliki	Fishpond	5,611.20
		Mangrove/palm/swamp shurb	1,407.01
		Resedintial	657.42
		Secondary swamp forest	1,142.75
		Fishpond	1,354.67
		Mangrove/palm/swamp shurb	218.27
		Resedintial	25.42
		Secondary swamp forest	127.43
	Sub Total		10,544.17
	Muara Badak Ulu	Fishpond	460.78
		Mangrove/palm/swamp shurb	146.25
		Resedintial	76.78
	Sub Total		683.90
	Total		11,228.07
Anggana	Tani Baru	Fishpond	8,874.85
		Mangrove/palm/swamp shurb	2,987.88
		Resedintial	2,021.04
		Secondary swamp forest	2,713.87
		Fishpond	3,188.43
		Mangrove/palm/swamp shurb	1,000.39
		Resedintial	541.13
		Secondary swamp forest	70.42
	Sub Total		21,398.01
	Anggana	Fishpond	20,137
		Mangrove/palm/swamp shurb	114.38
		Resedintial	58,613
		Secondary swamp forest	37.88
	Sub Total		231.01
	Handil Terusan	Fishpond	1,736.20
		Mangrove/palm/swamp shurb	2,218.71
		Resedintial	1,585.12
		Secondary swamp forest	2,792.96
	Sub Total		8,332.99
	Kutai Lama	Fishpond	
		Mangrove/palm/swamp shurb	3,240.54
		Resedintial	254.59
		Secondary swamp forest	861.66
	Sub Total		4,356.79
	Muara Pantuan	Fishpond	5,061.59
		Mangrove/palm/swamp shurb	1,872.137
		Resedintial	1,649.27
		Secondary swamp forest	1,015.67
		Fishpond	687.71
		Mangrove/palm/swamp shurb	9.78
		Resedintial	16.94
		Secondary swamp forest	46.42
	Sub Total		10,359.52
	Sepatin	Fishpond	19,054.52
		Mangrove/palm/swamp shurb	3,358.29
		Resedintial	7,999.81
		Secondary swamp forest	9,269.47
	Sub Total		39,682.32
	Total		84.360.71
The total land use of Delta Mahakam			109,920.06

Source: Analysis result (2013)

General criterions for aquaculture area are designed under land suitability factors for developing certain farming. In detail, classification and criterion of KBK and NFAA are shown in Table 5.

Table 5. Classification and Criterion of KBK

Type	Function	Criterion	Remark
Forest mangrove area (*KBK*)	Stable production area	Forest area with the score of slope, soil type and rainfall is less than 124 beyond the conservation forest, tourism forest and other convertible forest(Decree of the Minister of Agriculture No. 683/Um/8and837/KPTS/Um/11/1980	The recommendation on the development of limited, stable and convertible production forest are: Forest category Re-evaluation of synchronized map Physical analysis result by considering the
	Limited production area	Forest area with the score of slope, soil type and rain fall is 125-174beyond the conservation forest, tourism forest and other convertible forest(Decree of the Minister of Agriculture No. 683/KPTS/Um/11/1980)	limitation territory, in accordance with the Presidential decree No 32/1990 for conservation areas In order to provide recommendation for forest aquaculture development, the area covers convertible
	Convertible production area	Forest area with the score of slope, soil type and rain fall is less than 124, beyond the conservation forest, tourism forest, stable production forest, limited production forest and other convertible forest(Decree of the Minister of Agriculture No. 683/Um/8 and 837/KPTS/Um/11/1980)	production as designed above after deducted with potential area for more intensive aquaculture activities. Recommendations for limited production area are: Re-evaluation of synchronized map Physical analysis result by considering the limitation territory, in accordance with the Presidential decree No 32/1990 for conservation areas
Non-forest mangrove area (NFAA)	Wet land agriculture area	a. High< 1000 m dpl b. Slope < 40% c. Effective deep soil> 30 cm d. Availability of irrigation system (technical, semi-technical and traditional)	The recommendation for wetland agriculture development is based on the potency and land suitability with the support of irrigation
	Dry land agriculture area	a. High< 1000 m dpl. b. Slope < 40% c. Effective deep soil> 30 cm	The scale map of1 : 100.000 only conducted in dry land agriculture which also includes wet land agriculture area.
	Annual plant/ plantation area	a. High< 2000 m dpl b. Slope < 40% c. Effective deep soil> 30 cm	The recommendation of this area is based on the potency of plantation development and also land suitability based on the analysis result.
	Animal husbandry area	a. High> 1000 m dpl b. Slope > 15% c. The soil type/climate aggress with meadow	-
	Fisheries area	a. Slope< 8% b. Sufficient availability of surface water	-
	Residential area	a. Slope< 15% b. Water availability is assured c. Good accessibility d. Not in disaster prone area e. The location is near to the center of activities	This area includes urban and rural settlement area. For the capital city of regency and sub districts, the region is adapted to the urban development boundary (for cities that have already city planning) or having land suitability for city development (in accordance with the decree of Ministry of Home Affairs No. 7/1986 and the Instruction of Ministry of Home Affairs No. 34/1986 about the decision of city boundaries). For rural settlements, the current existence becomes the basis for considering the development.
	Mining area	The area has mining resources	The region cannot be specifically developed in scale of 1: 100.000. The contract of work area and existing mining rights should be confirmed into larger scale to prevent overlap with other regions.
	Tourism area	a. Has a beautiful and natural scenery b. Has a high value culture c. Has a historical building	-

Source: Local Development Planning Bureau of Kutai Kartanegara Regency (2006)

According to the Bappeda of Kutai Kartanegara regency (2006), land use planning for aquaculture purposes are formulated as follows:

a. Forest aquaculture area (KBK) is designed for 1,169,735.96 ha (39.21%), which consits of:
   - Stable production area is 157,209.28 ha (5.27%),
   - Limited production area is 832,882.82 ha (27.92%),
   - Convertible production area is 179,643.86 ha (6.02%)
b. Non-forest aquaculture area (N*KBK*) is designed for 958,525.22 Ha (32.13%), which consists of:
   - Agriculture area is 5,397.45 ha (0.18%),
   - Plantation area is 899,335.17 ha (30.14%),
   - Fisheries area is 42,137.58 ha (1.41%),
   - Residential area is 11.655.02 ha (0.39%).

In this research, the KBK of Delta Mahakam was built based on land use planning map of Kutai Kartanegara regency year 1999. Based on SIG analysis, the KBK of Delta Mahakam was 102,632.95 ha which consisted of Muara Jawa, Muara Badak and Anggana sub district.

The calculation result showed that Anggana sub district had the largest area of KBK in Delta Mahakam which accounted by 78,799.42 ha or 76.78% of the KBK total area. The following area was Muara Jawa sub district with 14,331.27 ha (13.96%) and Muara Badak sub district with 9,502.26 hektar (9.26%).The largest village in KBK of Delta Mahakam was Sepatin (39,682.32 ha) while the

smallest was Anggana (231.01 ha). Table 7 shows the area of each village and sub district.

Table 6. Land Use Planning of Forest Aquaculture Area in Kutai Kartanegara Period 2007-2017

The Type of Area	The Objective of Aquaculture	Spatial Planning	Location
Forest aquaculture area			
a. Stable production forest b. Limited production forest c. Convertible production forest d.	- Utilizing the forest products under selective logging or clear-cutting and planting - Utilizing the forest products with limited number where the exploitation is under selective logging and planting	- Establishing production forest boundaries - Monitoring and controlling forest management activities - Managing production forest under forest concession license (HPH) and implement selective logging on the production forest area - Strict supervision on reforestation and soil rehabilitation program on the ex-HPH area - Overcoming the overlap issues with other aquaculture activities	Kec. Samboja Kec. Muara Jawa Kec. Loa Janan Kec. Loa Kulu Kec. Muara Muntai Kec. Muara Wis Kec. Kota Bangun Kec. Sebulu Kec. Tenggarong Seberang Kec. Muara Badak Kec. Marang Kayu - Kec. Muara Kaman - Kec. Kenohan - Kec. Kembang Janggut - Kec. Tabang
Non-forest aquaculture area			
a. Crop farming in wetland area	Development of rice cultivation in the appropriate areas according to land suitability analysis supported with water infrastructure / irrigation	- Development of irrigation infrastructure - Control of other activities for not disturbing the fertile area - The expansion of rice cultivation - Development of transmigration program to support the development of crop farming in wet land area	Kec. Samboja Kec. Muara Jawa Kec. Sanga-sanga Kec. Loa Janan Kec. Loa Kulu Kec. Muara Muntai Kec. Muara Wis Kec. Kota Bangun Kec. Tenggarong Kec. Sebulu Kec. Tenggarong Seberang Kec. Muara Badak
b. Crop farming in dryland area	Developing dryland crop areas by utilizing the potential and suitability of land	- Expansion of dry land agricultural areas - Monitor and control moving cultivation land - Development of dry land farming areas according to optimal land suitability	Kec. Marang Kayu Kec. Muara Kaman Kec. Kenohan Kec. Kembang Janggut Kec. Tabang
c. Annual plant/plan tation	Developing plantation production particularly for primary commodities by utilizing the potential and land suitability	- Expansion and rejuvenation the plantation area - Optimal development of plantation area that suits the land potential. - Controlling the plantation activities in order to maintain sustainable environment.	
d. Animal husbandry area	Developing farm or grazing area by utilizing the potential and land suitability	- Developing intensive animal husbandry/grazing area - Controlling land utilization on the animal husbandry area in order to maintain the sustainability of feed source for large livestock's animal	
e. Fisheries area	Developing fisheries production by utilizing the potency.	Developing fisheries production while maintaining the sustainability.	
f. Urban residential area	Developing the residential area as a concentration place that supported by urban facilities and infrastructure that suits the hierarchy and function.	- Spatial planning cities (master plan of city of Kutai Kartanegara (RUTRK), the detailed plan of Kutai Kartanegara (RDTRK), land use plan(RTRK) forms in a urbanland use plan or review of urbanland use plan - Monitor and control the conformity of urban space utilization with urban space use plan. - Improving facilities and infrastructure for housing, especially clean water, drainage, sewage, garbage, electricity, and telecommunications.	
g. Rural residential area	Developing rural Residential areas that closely relates to the potential agricultural cultivation which spread in several locations.	- Developing the villages into the center of growth - Provide supporting facilities and infrastructure that suit the functions and hierarchies. - Improving the communication and marketing infrastructures between rural and urban areas.	
h. Mining area	Utilizing the strategic and permitted mining potential area for exploration and exploitation activities	- Utilize and control mining activities to avoid damage on the conservation area - Controlling on conservation area or land rehabilitation on the ex-land of mining	
i. Tourism area	Developing a service center for tourism activity through providing the facilities and infrastructures as well as traditional art performance and craft/local souvenirs.	- Developing the detailed plan of tourism area - Improving area accessibilities - Developing a tourist promotion	

Source: Local Development Planning Bureau of Kutai Kartanegara Regency (2006)

The KBK in Delta Mahakam which includes three sub districts is considered having high potency in mangrove and palm resources. This factor drives immigrant from South Sulawesi especially *Bugis* people to come and look for better live in Delta Mahakam. They generally open fishpond and build residential in Delta Mahakam.

Table 7. The Area of KBK in Delta Mahakam by Village and Sub District

Sub district	Village	Area (Ha)
Muara Jawa	Muara Jawa Ulu	1,794.37
	Muara Jawa Tengah	3,318.13
	Muara Kembang	9,218.78
	Sub Total	14,331.28
Muara Badak	Saliki	8,818.37
	Muara Badak Ulu	683.90
	Sub Total	9,502.26
Anggan	Tani Baru	16,597.64
	Anggana	231.01
	Handil Terusan	8,332.99
	Kutai Lama	4,356.79
	Muara Pantuan	9,598.33
	Sepatin	39,682.33
	Sub Total	78,799.43
The total area of FAA in Delta Mahakam		102,632.97

The changes of land use in Delta Mahakam cannot be separated with the historical background of its opening area by immigrant coming from outside of Kalimantan, the existence of oil and gas companies, the effect of cold storages facilities and the prohibition from government for not to use trawl for fisheries in Delta Mahakam area. Brief explanation about the historical background in opening Delta Mahakam and others related factors are shown below. Based on the mapping analysis produced from satellite image processing using Landsat Thematic Mapper and SIG, it could be found that miss use of coastal area in KBK of Delta Mahakam was about 63,966.80 ha. Anggana sub district experienced the largest miss use as shown with 48,315.98 ha and followed by Muara Jawa (8,844.55ha) and Muara Badak (6,806.27 ha). The miss use of fishpond area in Sepatin village, Anggana sub district was 1,905.76 ha and residential area was 7,999.81 ha. Table 8 shows the miss use of FAA in Delta Mahakam.

Table 8. The Miss Use Area in KBK of Delta Mahakam

Sub District	Village	Miss use	Area (Ha)
Muara Jawa	Muara Jawa Ulu	Fishpond	216.11
		Open space/ residential	993.91
	Muara Jawa Tengah	Fishpond	798.03
		Open space/ residential	970.40
	Muara Kembang	Fishpond	2,491.34
		Open space/ residential	2,374.76
	Sub Total		**8,844.55**
Muara Badak	Saliki	Fishpond	5.611.20
		Open space/ residential	657.42
	Muara Badak Ulu	Fishpond	460.78
		Open space/ residential	76.87
	Sub Total		**6,806.27**
Anggana	Tani Baru	Fishpond	8,874.85
		Open space/ residential	2,021.04
	Anggana	Fishpond	20.14
		Open space/ residential	58.61
	Handil Terusan	Fishpond	1,736.20
		Open space/ residential	1,585.12
	Kutai Lama	Fishpond	-
		Open space/ residential	254.59
	Muara Pantuan	Fishpond	5,061.59
		Open space/ residential	1.649.27
	Sepatin	Fishpond	19.054.76
		Open space/ residential	7.999.81
	Sub Total		**48.315.98**
Total miss use area of KBK			**63.966.80**

From the recapitulation result, it could be obtained that the total area of KBK zonation in Delta Mahakam was 93.4% of the total area of Delta Mahakam (delta and small islands), the remain value of 6.6% was designed for KBNK zonation area. The percentage number of coastal miss use of KBK in Delta Mahakam was 62.28% consisted of fishpond farming and residential i.e. 44.16% and 18.12%, respectively. Table 9 shows the value in detail.

The miss use area of fishpond shows different value compared to other study. On the research, Sumaryono et al. (2008) who also studied zonation map of fishpond in Delta Mahakam stated that the area of fishpond in Delta Mahakam covered 54,444.5 ha. The distribution is as follows: (1) 12,936.50 ha from mangrove forest, (2) 38,415.61 ha from palm swamp forest, (3) 3,092.39 ha from mixed forest of hard timber plants and palm. The differences of the number could be due to the difference on the delineation boundaries of the studied area. In his study, Sumaryono *et al.* (2008) used the area of Delta Mahakam is 108,251.31 ha. Similar result was also found in the study conducted by LAPI ITB in 2002 which stated that the area of Delta Mahakam was10,702.02 ha (Local Development Planning Bureau of Kutai Kartanegara Regency, 2003).

Based on the field survey, the main coastal miss use pattern of Delta Mahakam is local fishpond conducted by people with their traditional character and built wide fishpond area. Generally, the fishponds are equipped with one water gate. The fishpond farming uses monoculture method which raises shrimp or milkfish only and the other is poly culture which raises shrimp and milkfish together. The main product of traditional pond is *windu* shrimp and milkfish. The others products that can be obtained by farmers are spot shrimp and crab which derived from the sea that naturally comes into fishpond during tide period.

Table 9. The Recapitulation Number of Several Types of KBK in Delta Mahakam

Land Use Type	Area (Ha)
Land use area of the delta	109,920.06
KBK zonation area in Delta Mahakam	102,632.97
NKBK zonation area KBK Delta Mahakam	7,287.09
Miss use area of KBK in Delta Mahakam	63,966.80
Pond area of KBK in Delta Mahakam	45,325.00
Residential area in Delta Mahakam	18,651.54

Based on the compatibility matrix, it can be generated the KBK coastal land use in Delta Mahakam from the relationship between existing and designed land use of Kutai Kartanegara in 1999. The type of existing land use includes fishpond, mangrove/palm/swamp shrub, open space/ residential, secondary swamp forest and oil and gas exploration. The land allotment includes KBK and *KBNK* or areas for others purposes. The compatibility matrix is shown in Table 10.

Table 10 shows that the land use for fishpond and open space/residential is not compatible with KBK in Delta Mahakam. The allowable use in KBK is for mangrove/palm/swamp shrub and secondary swamp forest. Oil and gas exploration activities can be in the two areas either in KBK or KBNK due to strategic industry that has permission from the central government.

Table 10. The Evaluation Matrix of Land Use of KBK in Delta Mahakam

Land allotment / Existing land uses	Ponds	mangrove/palm/ swamp shrub	open space/residential	secondary swamp forest	oil and gas exploration
Forest aquaculture area	X	√	X	√	0
Non-forest aquaculture area/areas for others purposes	0	0	√	0	0

Delta Mahakam has strategic role for local or national government both in terms of the ecological and socio-economical due to three main reasons, i.e.: first, Delta Mahakam is a transition region (*ecoton*) between land and sea in East Kalimantan. Therefore, the coastal ecosystem in Delta Mahakam region which is dominated by mangrove ecosystem has high productivity of biological diversity. The coastal area also gets biological input (nutrient) which enables the production of biological process takes place throughout the year. Secondly, as natural environment, Delta Mahakam is a place for various renewable resources and non-renewable resources that potentially generates over exploitation on the resources utilization and creates

high environmental stresses. Thirdly, Delta Mahakam is considered as common property resources which lead into open access for anyone and any purposes.

With all three main reasons mentioned above, it can be obviously said that the utilization of natural resources in Delta Mahakam requires optimal and integrated management in order to ensure the sustainability of strategic areas.

IV. CONCLUSIONS

Based on the result and discussion related with zonation compatibility analysis of KBK in Delta Mahakam, East Kalimantan province, it can be concluded some points below:

1. The land use pattern of KBK in Delta Mahakam consisted of fishpond, mangrove/palm/swamp shrub, open space / residential, secondary swamp forest with 45,325 ha, 20.971,52 ha, 18,651.54 ha and 24,972.28, respectively.
2. Zonation compatibility of KBK in Delta Mahakam showed that the miss use of coastal area was 62.28% consisted of land use for ponds and for open space/residential area which accounted by 44.16% and 18.12%.
3. Academic recommendations that can be produced based on the study are as follows: a research on the effect of miss use of KBK in Delta Mahakam due to fishpond activities against the quality of the environment, biodiversity, local economy, and the potential of economic and social losses due to KBK zonation compatibility in Delta Mahakam should be conducted. The recommendation also suggests to formulate the policy that used for legislation revision on spatial planning of Delta Mahakam and the implementation rules so that the KBK status presents the current condition and the needs for immediate legalization regarding with the local regulation on Strategic Spatial Planning of Delta Mahakam.

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